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Master's Thesis of Public Health

Catastrophic health expenditures
for households with multiple
chronic conditions in Korea
Health Panel 2011 and 2012

복합만성질환 가구의 재난적의료비 분석
(2011,2012한국의료패널 이용)

February 2016

Graduate School of Public Health
Seoul National University
Public Health Major

Heejung Choi

Catastrophic health expenditures for households with multiple chronic conditions in Korea Health Panel 2011 and 2012

Academic Advisor: Sung-il Cho

Submitting a master's thesis of Public Health

November 2015

Graduate School of Public Health
Seoul National University
Public Health Major

Heejung Choi

Confirming the master's thesis written by

Heejung Choi

December 2015

Chair	<u>Joohon Sung</u>	(Seal)
Vice Chair	<u>Ho Kim</u>	(Seal)
Examiner	<u>Sung-il Cho</u>	(Seal)

Abstract

Backgrounds

The simultaneous presence of multiple conditions in one patient (multiple chronic conditions, MCC) is a key challenge facing healthcare systems globally (Violan et al. 2014). With population aging, prevalence of MCC increases. Measurement MCC capacities has been constrained by lack of consistency in definitions and diagnostic classification schemes (Goodman et al. 2013). In addition, the management of MCC is associated with potentially severe economic consequences. There are too many previous researches to measure catastrophic health expenditures (CHE), but it is hard to find out the one measured CHE for MCC group in spite of the great medical expenditure burden of multiple chronic conditions (MCC).

Subject and Method

This study used and analyzed the data from the KHP 2011 with a total 5654 households and the KHP 2012 with a total 5378 households. This study focused on multiple condition groups who were defined as a 20yr old or over household member with at least two chronic conditions and the condition last one year or more. This study measured CHE according to the proportion of out-of-pocket health expenditure to non-food household expenditures reported by Wagstaff et al. This study calculated CHE with 25% and 40% catastrophic threshold and those figures were made a comparison each other with entire KHP households, chronic condition group, MCC group. Then, associated factors of CHE were

estimated using ordinary least square and logistic regression modeling.

Results

Household with more member of multiple chronic conditions (MCC) retention faced more catastrophic health expenditures (CHE). According to the CHE threshold 40%, catastrophic health expenditures occurred, 3.69% in 2011, 4.32% in 2012 at non MCC group, 9.45% in 2011 9.95% in 2012 at 1 MCC group, 22.02% in 2011, 15.74% in 2012 at 2 MCC group, and 0% in 2011 and 2012 at 3 MCC group. Except 3 MCC group, the number of MCC members in a household was proportional to the incidence of catastrophic health expenditures. As in the CHE threshold 25%, catastrophic health expenditures took place 8.89% in 2011, 7.88% in 2012 at non MCC group, 19.02% in 2011, 19.77% in 2012 at 1 MCC group, 33.93% in 2011, 30.86% in 2012 at 2 MCC group, and 50% in 2011, 0% in 2012 at 3 MCC group.

Regardless of catastrophic thresholds, 'chronic kidney disease', 'cardiac arrhythmias', 'cancer', 'osteoporosis', 'diabetes', 'arthritis' significantly affected to the incidence of CHE.

Conclusion

This study found that, even though there are some cases with too small number of CHE likewise in the 3 MCC group, there were trend that the more a household has MCC member in a household, the bigger there were CHE incidence. However, with regard to the intensity of CHE, there was not evident trend with the number of MCC member in a household.

Keyword: Multiple chronic conditions, Multimorbidity, MCC, Catastrophic health expenditures, CHE, Office of the Assistant secretary of Health, OASH, OASH list

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Chapter 1. Introduction

1.1. Study Background

The simultaneous presence of multiple conditions in one patient (multiple chronic conditions, MCC) is a key challenge facing healthcare systems globally. Multiple chronic conditions(MCC) is the presence of more than one health condition in an individual(Violan et al. 2014; Wolff et al. 2002) and it is a manifestation of multi-comorbidity (Hoffman et al. 1996; Vogeli et al. 2007). Health initiatives have begun to expand to include not only chronic disease but also chronic conditions such as functional limitations; anatomic problems that are not manifestations of physical disease but are permanent or long-standing (eg, developmental disorders, limb dysfunction, visual impairment); and a broad spectrum of behavioral health problems, some of which have traditionally not been classified as diseases (Anderson 2012; Health and Services 2010; Hwang et al. 2001). People who have MCC may require increased coordination of care from clinicians, public health, and social programs to improve their overall quality of life(Goodman et al. 2013). Organization for Economic Cooperation and Development (OECD) suggested that the issue on multiple chronic conditions(MCC) is one of the urgent assignments to solve(Development. 2011). Although preventing and mitigating the effect of chronic conditions requires sufficient measurement capacities, such measurement has been constrained by lack of consistency in definitions and diagnostic classification schemes and

by heterogeneity in data systems and methods of data collection (Goodman et al. 2013).

In 2013, OASH (Office of the Assistant Secretary of Health in the USA) outlined a conceptual model for improving understanding and standardizing approaches to defining, identifying, and using information about chronic conditions in the United States. They organized MCC working group involving subject matter experts in clinical medicine, epidemiology, and public health and suggested an aggregate set of 20 conditions; arthritis, asthma, autism spectrum disorder, cancer, cardiac arrhythmias, chronic kidney disease, chronic obstructive pulmonary disease (COPD), congestive heart failure, coronary artery disease, dementia, depression, diabetes, hepatitis, human immunodeficiency virus (HIV) infection, hyperlipidemia, hypertension, osteoporosis, schizophrenia, stroke, and substance abuse disorders. In addition, they addressed the definition of chronic illnesses are “conditions that last a year or more and require ongoing medical attention and/or limit activities of daily living” (such as physical medical conditions, behavioral health problems, and developmental disabilities) (Goodman et al. 2013).

On the other hand, the management of multiple chronic conditions (MCC) is associated with potentially severe economic consequences for patients and their households, partially due to the financial burden associated with out-of-pocket payments for medical and health-related care. In USA, the percentage of MCC increased from 24% in 2001 to 28% in 2006, accordingly health

care expenditure for chronic disease was also increased from 78% in 2002 to 84% in 2009 (Kim et al. 2014). Even in the report from Australia in 2010, 70% burden of disease for chronic disease and 87.5% of medical expenditure were informed (McRae et al. 2013).

Household medical expenditure can be measured directly with a specific amount of money, and when medical fee exceeds from it, it can be regarded as a large amount of medical fee. (Ok-ryun et al. 1993; Yoo 1988). However, the large amount of medical fee is different burden feeling depending on individual's socio-economic status, income, or other undetected factors. With these reason, some studies surveyed subject burden feeling about medical expenditure (Choi et al. 2011).

In the macroscopic level, measured medical expenditure can be compared with other countries' national health coverages. Fairness in Financial Contribution [FFC] is the typical parameter for its example (WHO, 2000). WHO used FFC in the year of 2000 reports, but this parameter was not sensitive to vertical disparity and cannot measure medical expenditure in microscopic level (Wagstaff, 2002).

As an alternative way to measure medical expenditure with FFC, the concept of catastrophic health expenditures (CHE) came into sight in the early 2000s. This indicator can measure medical expenditure in both micro and macro level (Sohn et al. 2010). A sound financing system should ensure a fair distribution of the burden of health costs, protect households against health shocks, and improve access to health services by promoting an equitable

distribution of public expenditures(Yang 2014). CHE have advantage of understanding a lot about the equity and efficiency of health-care financing mechanisms(Ruger 2003). CHE can be a parameter measuring minimal safeguard of health care(Kim and Yang 2009).

There are many previous researches to measure catastrophic health expenditures (CHE)for many subjects, however, it is hard to find out studies measured catastrophic health expenditures (CHE) for multiple chronic conditions (MCC) group in spite of the great medical expenditure burden of multiple chronic conditions (MCC).

1.2. Research objectives

The thesis has following research objectives

; Determinants of catastrophic health expenditures (CHE) would be estimated and check out whether multiple chronic conditions (MCC) attribute to the incidence and intensity of catastrophic health expenditures (CHE).

With this purpose, the thesis has following hypotheses:

- (1) Household with more multiple chronic conditions (MCC) members would have more incidences of catastrophic health expenditures (CHE)
- (2) Household with more multiple chronic conditions (MCC) members would have bigger intensity of catastrophic health expenditures (CHE).
- (3) Depending on the catastrophic thresholds, chronic condition determinant factors would be varied.

1.3. Research frame

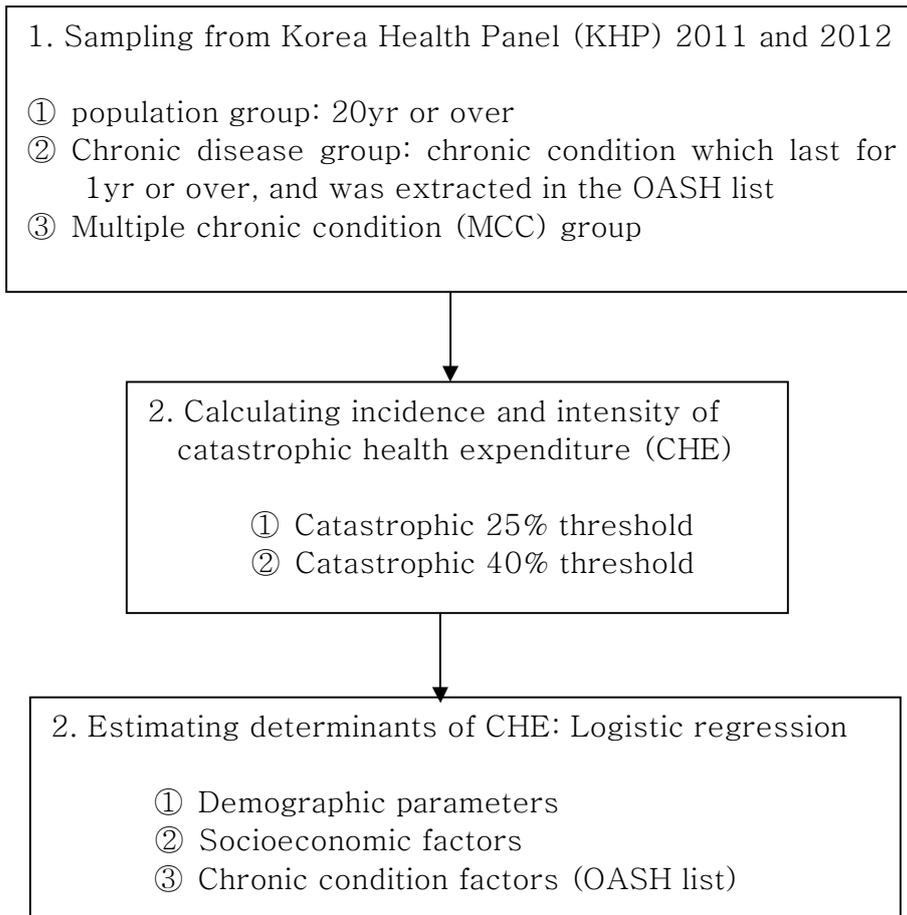


Figure 1. Research frame

Chapter 2. Literature review

2.1. Definition of chronic disease

For the globally understanding and consistency of classification for chronic disease, this study followed the definition addressed by OASH (Office of the Assistant Secretary of Health in the USA).

In 2013, OASH (Office of the Assistant Secretary of Health in the USA) outlined a conceptual model for improving understanding and standardizing approaches to defining, identifying, and using information about chronic conditions in the United States. They organized MCC working group involving subject matter experts in clinical medicine, epidemiology, and public health and suggested an aggregate set of 20 conditions; ; arthritis, asthma, autism spectrum disorder, cancer, cardiac arrhythmias, chronic kidney disease, chronic obstructive pulmonary disease (COPD), congestive heart failure, coronary artery disease, dementia, depression, diabetes, hepatitis, human immunodeficiency virus (HIV) infection, hyperlipidemia, hypertension, osteoporosis, schizophrenia, stroke, and substance abuse disorders. They addressed the definition of chronic illnesses are “conditions that last a year or more and require ongoing medical attention and/or limit activities of daily living” (such as physical medical conditions, behavioral health problems, and developmental disabilities) (Goodman et al. 2013).

OASH list was made based on many definitions for chronic condition as follows.

Hwang et al, 2001 (Hwang et al. 2001) defined a person as having a chronic condition if that person' s condition had lasted or was expected to last 12 or more months and resulted in functional limitations and/or the need for ongoing medical care. Authors noted that they defined "chronic condition" broadly for several reasons, including the following: 1) a high proportion of individuals who have a chronic condition have more than 1 chronic condition; 2) functional limitations and other consequences of health problems often are independent of specific diseases; and 3) whereas diagnoses are important for medical management, a diagnosis alone may provide incomplete information on morbidity because of variations in condition-specific severity.

Bernstein et al, 2003 defined that a chronic disease or condition has 1 or more of the following characteristics: is permanent; leaves residual disability; is caused by nonreversible pathological alteration; requires special training of the patient for rehabilitation; or may be expected to require a long period of supervision, observation, or care. (Bernstein 2003)

Warshaw et al, 2006 defined, according to a common definition, chronic illnesses are "conditions that last a year or more and require ongoing medical attention and/or limit activities of daily living" (Warshaw 2006)

Friedman et al, 2008 defined that chronic condition is a condition that lasts 12 months or longer and meets 1 or both of the following tests: 1) it places limitations on self-care, independent living, and social interactions; and 2) it results in the need for

ongoing intervention with medical products, services, and special equipment (Friedman et al. 2008).

Anderson, 2010 defined that chronic condition is a general term that includes chronic illnesses and impairments. It includes conditions that are expected to last a year or longer, limit what one can do, and/or may require ongoing medical care. Serious chronic conditions are a subset of chronic conditions that require ongoing medical care and limit what a person can do. (Anderson 2010)

National Center for Health Statistics in the USA, 2011 (Statistics 2010) defined that a health condition is a departure from a state of physical or mental well-being. In the National Health Interview Survey, each condition reported as a cause of an individual's activity limitation has been classified as chronic, not chronic, or unknown if chronic, based on the nature and duration of the condition. Conditions that are not cured once acquired (such as heart disease, diabetes, and birth defects in the original response categories, and amputee and old age in the ad hoc categories) are considered chronic, whereas conditions related to pregnancy are not considered chronic. Other conditions must have been present for 3 months or longer to be considered chronic. An exception is made for children aged less than 1 year who have had a condition since birth: such conditions are always considered chronic.

US Department of Health and Human Services (HHS), 2010 defined that chronic illnesses are "conditions that last a year or more and require ongoing medical attention and/or limit activities of daily living." (such as physical medical conditions, behavioral

health problems, and developmental disabilities) (Health and Services 2010)

World Health Organization, 2011 defined that chronic diseases are diseases of long duration and generally slow progression.

In Korea, ‘National Health & Nutritional Examination Survey’ and ‘Ministry of Health and Welfare’ proposed lists for chronic disease and the contents of them are as follows.

Table 1. Classification for chronic diseases

	2005 Korea National Health & Nutritional Examination Survey	2007 Korea National Health & Nutritional Examination Survey	Korea Ministry of Health & Welfare notification ¹⁾		Office of the Assistant Secretary of Health in the USA
					OASH list
Cancer	Gastric cancer, Liver Cancer, Colorectal cancer, Breast cancer, Cervical cancer, Lung cancer, Other cancer	Gastric cancer, Liver Cancer, Colorectal cancer, Breast cancer, Cervical cancer, Lung cancer, Other cancer	Malignant neoplasm	C00 ~ C97 D00 ~ D09	Cancer
Musculoskeletal system	Osteoarthritis (degenerative), Rheumatoid arthritis, Osteoporosis, Lumbar herniated intervertebral disc	Osteoarthritis (degenerative), Rheumatoid arthritis, Osteoporosis, Backache			Arthritis,
					Osteoporosis
Endocrine, metabolic system	Diabetes, Thyroid disorder,	Diabetes, Thyroid disorder	Diabetes, Thyroid disorder	E10 ~ E14 E00 ~ E07	Diabetes
Digestive system	Gastro-duodenal ulceration, Chronic	Gastro-duodenal ulceration, Hepatitis B,	Liver disease (including Chronic	B18, B19 K70 ~ K77	Hepatitis

	hepatitis, Liver cirrhosis, Anemia ²⁾	Hepatitis C, Liver cirrhosis	hepatitis)		
Cardio-vascular system	Hypertension, Hyperlipidemia Cerebral palsy (Strokes), Cardiac infarction, Angina pectoris, Hemorrhoids	Hypertension, Hyperlipidemia Cerebral palsy (Strokes), Cardiac infarction, Angina pectoris, Hemorrhoids	Hypertensive disease, Cardiac disease, Cerebral vascular disease	I10 ~ I15	Hypertension
				I05 ~ I09	Congestive heart failure
				I20 ~ I27	Coronary artery disease
				I30 ~ I52	Cardiac arrhythmias
				I60 ~ I69	Hyperlipidemia
					Stroke
Respiratory system	Tuberculosis (Pulmonary TB, Non-pulmonary TB), Asthma, Chronic obstructive pulmonary disease, (Chronic bronchitis, Emphysema) Chronic rhinosinusitis (Sinusitis)	Tuberculosis (Pulmonary TB, Non-pulmonary TB), Asthma, Chronic obstructive pulmonary disease, (Chronic bronchitis, Emphysema) Chronic rhinosinusitis (Sinusitis)	Pulmonary Tuberculosis	A15 ~ A16 A19	Asthma Chronic obstructive pulmonary disease
Eye, ear	Cataract, Glaucoma Chronic otitis media	Cataract, Glaucoma Chronic otitis media			
Tooth /mouth	Dental caries, Periodontal diseases, Temporomandibular joint disease	Temporomandibular joint disease			
Others	Atopic dermatitis, Allergic skin disease, Chronic kidney disease, Anisuria, Anemia ²⁾	Atopic dermatitis, Chronic kidney disease, Anisuria, Depression Anemia ²⁾	Mental and behavior disorder (including epilepsy) Chronic kidney disease,	F00 ~ F99	Autism spectrum disorder
				G40 ~ G41	Chronic kidney disease
				N18	Dementia
					Depression
				G00 ~	HIV/AIDS ³⁾ Schizophrenia

			Nervous system disorders	G37 G43 ~ G83	Substance abuse
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- 1) Korea Ministry of Health & Welfare notification #2002-40, June 10, 2002
- 2) In 2005, it was classified with digestive system
- 3) Human immunodeficiency virus/acquired immune deficiency syndrome
- 4) Resource: 3rd and 4th Korea National Health & Nutritional Examination Survey, 2008 Korea Health Panel basic analysis report (I), in 2009.

2.2. Multiple chronic conditions (MCC)

The definition of multiple chronic conditions (MCC) in this study is based on those addressed by OASH (Office of the Assistant Secretary of Health in the USA). This study synthesizes the definition of multiple chronic conditions as follows.

- ① Chronic condition is defined as one of 20 Chronic conditions in OASH list: (it is regarded that the characteristics of the chronic condition such as, requiring ongoing medical attention and/or limiting activities of daily living” defined by OASH working group is already involved in the OASH list chronic disease.)
- ② Multiple chronic conditions is at least two chronic conditions
- ③ Each conditions last a year or more

There are many kinds of definition and measurement for multiple chronic conditions (MCC).

Huntley et al, 2012 defined multimorbidity is the co-occurrence of multiple diseases or medical conditions within1 person(Huntley et al. 2012).

Valderas et al, 2009 defined that multimorbidity is the presence of more than one health condition in an individual (Valderas et al. 2009).

Fortin et al, 2005 defined that multiple chronic conditions (MCC) may be as the simultaneous occurrence of several medical conditions in the same person (Fortin et al. 2005).

Violan et al. defined that multiple chronic conditions (MCC) is the presence of more than one health condition in an individual (Violan et al. 2014; Wolff et al. 2002) and it is a manifestation of multi-comorbidity (Hoffman et al. 1996; Vogeli et al. 2007). Health initiatives have begun to expand to include not only chronic disease but also chronic conditions such as functional limitations; anatomic problems that are not manifestations of physical disease but are permanent or long-standing (eg, developmental disorders, limb dysfunction, visual impairment); and a broad spectrum of behavioral health problems, some of which have traditionally not been classified as diseases (Anderson 2012; Health and Services 2010; Hwang et al. 2001).

2.3. Economic burden of chronic conditions

There are few valid data that describe the extent of the multiple chronic conditions (MCC) phenomenon. It is estimated that 57 million Americans had multiple chronic conditions in 2000 and that this number will rise to 81 million by 2020.

Chronic conditions can cause economic burden in an individual

and households. In Australia (McRae et al. 2013), over 70% of the burden of disease is attributable to chronic conditions (Australian Institute of Health and Welfare 2010), and 87.5% of total recurrent health expenditure can be attributed to the 12 major chronic disease groups (Australian Institute of Health and Welfare 2006). Previous studies conclude not only that the prevalence of chronic conditions is increasing (Goss 2008) but that the greatest growth is in the prevalence of people with multiple complex chronic diseases (Hwang et al. 2001; Paez et al. 2009). Almost all older Australians have at least one long-term condition and over 80% have three or more long-term conditions (Australian Bureau of Statistics 2009a). The management of multiple conditions increases the economic impact chronic illnesses have on patients and their households due in part to the out-of-pocket health care costs associated with greater health service use. The financial stress caused by these costs in some cases can be severe, leading to an inability to afford necessary health care services, which may compound the health and financial pressures faced by the patients.

2.4. Catastrophic health expenditures (CHE)

Household medical expenditure can be measured directly with a specific amount of money, and when medical fee exceeds from it, it can be regarded as a large amount of medical fee. (Ok-ryun et al. 1993; Yoo 1988). However, the large amount of medical fee is different burden feeling depending on individual' s socio-economic

status, income, or other undetected factors. With these reason, some studies surveyed subject burden feeling about medical expenditure(Choi et al. 2011).

In the macroscopic level, measured medical expenditure can be compared with other countries' national health coverages. Fairness in Financial Contribution [FFC] is the typical parameter for its example (WHO, 2000). WHO used FFC in the year of 2000 reports, but this parameter was not sensitive to vertical disparity and cannot measure medical expenditure in microscopic level (Wagstaff, 2002).

As an alternative way to measure medical expenditure with FFC, the concept of catastrophic health expenditures (CHE) came into sight in the early 2000s. This indicator can measure medical expenditure in both micro and macro level(Sohn et al. 2010). A sound financing system should ensure a fair distribution of the burden of health costs, protect households against health shocks, and improve access to health services by promoting an equitable distribution of public expenditures(Yang 2014). CHE have advantage of understanding a lot about the equity and efficiency of health-care financing mechanisms(Ruger 2003). CHE can be a parameter measuring minimal safeguard of health care(Kim and Yang 2009).

Catastrophic health expenditures (CHE) was commonly used to track the level of financial protection in health with the incidence of catastrophic health expenditures (CHE) and the incidence of impoverishment due to out-of-pocket health payments. The former

indicates the number of households of all income levels that incur health payments that are higher than their resources, while the latter captures the degree to which health spending causes extreme hardship by pushing families below the poverty line (WHO & Bank, 2014).

There are many studies measuring CHE for various subjects.

Wagstaff and van Doorslaer (2003) used the Vietnam Living Standards Surveys in 1993–94 and 1997–98 to measure the incidence and intensity of catastrophic health payments and their impact on poverty in Vietnam. They found that the incidence and intensity were reduced during the study period, and the poor were less likely to suffer from catastrophic health payments in terms of both incidence and intensity. The poverty impact of catastrophic health payments had declined over time. The impact on poverty was largely due to the poor becoming poorer rather than the non-poor becoming poor. (Wagstaff and Doorslaer 2003)

Ghosh (2010) used the 1993–94 and 2004–05 National Sample Survey to measure catastrophic payments and impoverishment due to out-of-pocket health spending in India (Ghosh 2010). Adopting the methodology proposed by Wagstaff and van Doorslaer (2003), Ghosh (2010) defined catastrophic payments as out-of-pocket health payments in excess of 10 percent of total household spending. The results showed that out-of-pocket health expenditure increased over the study period, and the relationship between the share of out-of-pocket health spending in total expenditure and per capita state domestic product was positive.

The incidence of catastrophic health payments increased 2.3 percentage points during the study period but was likely to be concentrated more among the better-off households, and approximately 4.4 percent of the total population fell below the poverty line due to out-of-pocket health expenditure. These findings highlight that broad-based risk pooling and prepayment are likely to be a better health financing strategy for Indian households because they limit out-of-pocket health spending, reduce the likelihood of impoverishment and improve the utilization of health care services by the poor, especially the poorest.

Kagarura, Bruno and Ddumba-Ssentamu (2014) used the 2005–06 Uganda National Household Survey data to examine the effect of catastrophic payments on household poverty (Kagarura et al.). Having defined catastrophic payments as out-of-pocket health spending that exceeded 10 percent of total household income/expenditure, the study found that the incidence of catastrophic payments amounted to 19 percent and tended to occur among all socio-economic groups, but more in rural areas and among the non-poor. Out-of-pocket health spending was likely to increase poverty by 5.8 percent. The authors argued that the government might need to provide free health care for all or to establish prepaid schemes at all levels to protect against catastrophic expenditure should it be unable to expedite the National Social Health Insurance Scheme.

Van Doorslaer et al. conducted a comprehensive study on catastrophic payments and their impoverishment effects in 14 Asian

countries—Bangladesh, China, Hong Kong, India, Indonesia, Republic of Korea, Kyrgyz Republic, Malaysia, Nepal, Philippines, Sri Lanka, Thailand and Vietnam—that together account for 81 percent of the Asian population (Van Doorslaer et al. 2007). They revealed that rich households in the majority of low and middle-income countries are more likely to spend a large proportion of total household income on health care, catastrophic payments tend to concentrate in better-off households in most low-income countries, and out-of-pocket health spending is still the primary cause of poverty.

Unlike other studies that simply measured catastrophic payments and their impoverishment effects, O’ Donnell et al. (2005) attempted to identify the key determinants of the incidence of catastrophic payments in Bangladesh, Hong Kong, India, Sri Lanka, Thailand and Vietnam by using probit regression (O’ Donnell et al. 2005). In general, they found that households with more members or higher per capita consumption were more likely to incur catastrophic payments, and the incidence was higher in rural areas and among households without sanitary toilets and safe drinking water. This evidence suggested a need to develop risk pooling of health financing in rural areas, and that public sanitation interventions can be effective in addressing the high incidence of catastrophic payments.

In terms of catastrophic thresholds(z), two kinds of catastrophic thresholds(z) generally have been widely used to define CHE: 1) out-of-pocket healthcare expenditure (OOP) that

comprise $\geq 10\%$ of total household expenditures (O'Donnell et al. 2005); and 2) out-of-pocket healthcare expenditure that comprise $\geq 40\%$ of non-food household expenditures (Xu 2005). By deducting food expenses, the latter indicator can partly avoid measurement deviation that poor households which cannot afford to meet catastrophic payments are ignored (Wagstaff and Doorslaer 2003). However, in 2014, WHO and the World Bank have lately redefined catastrophic expenditure as any spending that is more than 25% of post-subsistence expenditure (WHO and Bank 2014).

2.5. Determinants of catastrophic health expenditures

Different studies imply various factors affecting fair financial contribution mostly viewed as social, quality and socio-economic variables (Mataria et al. 2010).

A high incidence rate of catastrophic health expenditures reveals the inadequacies of medical social security systems in achieving their goal of protecting household finances (Etienne et al. 2010). Therefore, for Korea to attain its goal of medical social security, greater understanding of catastrophic health expenditures is needed. Accordingly, a number of studies on catastrophic health expenditures in Korea have been undertaken: previous studies have mainly provided evidence for the incidence of household catastrophic health expenditures, factors influencing the recurrence of household catastrophic health expenditures, analysis of private health insurance on catastrophic health expenditures among

households with a cancer patient, impact of the benefit extension policy on catastrophic health care expenditure, relationship between catastrophic health expenditures and household income, and expenditure patterns in South Korea(Choi et al. 2015).

Meanwhile, few studies have investigated the association between chronic diseases and catastrophic health expenditures. Medical costs differ in terms of amount and health outcome, depending on the type of chronic disease present. Some diseases result in a high financial burden concentrated within a short time period, whereas other diseases result in costs that are both steady and high over the life of a patient. Studying the effect of different types of chronic diseases upon catastrophic health expenditures may aid in strengthening disease-dependent benefit coverage(Choi et al. 2015). Thus, this paper attempted to describe the rate of catastrophic health expenditures, identify factors associated therewith, and characterize the burden of catastrophic health expenditures due to the kinds of chronic diseases.

Chapter 3. Methodology

3.1. Data source and research sample

3.1.1. Data source

This study used data collected from the Korea Health Panel Survey (KHPS) in 2011 and 2012, which comprises nationally representative data and are publicly available.

The reason why this study selected 2011 and 2012 KHPS is as follows. In order to calculate catastrophic health expenditures, this study used non-food living expenditure as an annual total household expenditure. However, KHPS started survey with the questionnaire for food expenditure since 2011. Furthermore, as of December 2015, the available data to the public is those from 2008 to 2012. Therefore, the 2011 and 2012 KHPS could be chosen to be the available data for this study.

Meanwhile, KHPS was established by Korea Institute for Health and Social Affairs (KIHSA) and Korea National Health Insurance Corporation (KNHIC), starting collection data for a total of 7,866 households in 2008, with a response rate of 94.1%.

KHP survey

In terms of sampling research subjects, it is based on 90% complete enumeration data of National Population and Housing Census 2005 and extracted by probability proportionate two-stage cluster sampling using stratified variables which are

comprised with region (16 metropolitan cities) and town (2 spot).

Even though the original sample size was 7,866 households and 24,616 household members, it is reduced to 5,856 households and 17,417 household members at the 7th survey conducted in 2012. In order to fix the problem, additional samples with about 2500 households were extracted and included into the 8th survey in 2013 (Table 2).

Table 2. Korea health panel survey (KHPS) current status

Wave		1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Survey year		2008	2008	2009	2010	2010	2011	2012	2013	2014
Original sample	Household	7,866	7201	6798	6433	6283	6041	5850	5521	5284
	Household members	24,616	22,546	21,125	19,842	19,163	18,257	17,417	16,247	15,263
Additional sample	Household	–	–	–	–	–	–	–	2,222	2,055
	Household members	–	–	–	–	–	–	–	6,454	5,955
Total survey sample	Household	7,866	7201	6798	6433	6283	6041	5850	7743	7339
	Household members	24,616	22,546	21,125	19,842	19,163	18,257	17,417	22,701	21,218

KHP survey method and contents

The survey data are collected annually via self-report questionnaires and in-person interviews using CAPI system (Computer-Assisted Personal Interviewing).

The KHPS questionnaires comprise general information part and additional questions for adult household members. They encompass information about demographic and socioeconomic characteristics of individuals and households, each event of

health care utilization and expenditure, and details on chronic status, including the type of chronic disease.

The KHPS mitigated recall bias problems by using household financial record books or receipts of health care spending.

In terms of the KHPS disease code, KHPS performed recoding disease code by surveyors in the survey field using Korea Health Panel Disease Code. For the accuracy of the disease code, the need of experts' surveillance was brought up and conducted from the data in 2012 KHPS. In spite of this kind of effort, Korea Health Panel Disease Code has limitation that is classified by comprehensive level or middle level index.

3.1.2. Research sample

This study used and analyzed the data available from the KHP of the year 2011, with a total 5654 households and the KHP of the year 2012, with a total 5358 households.

3.1.2.1. Entire KHP in 2011 and 2012 sample

First of all, for the use of reference parameter, missing data and outlier were disposed or imputed with average value and the 5654 households' data from 2011 KHP and 5358 households' data from 2012 KHP were extracted for this study.

For the process of calculation catastrophic health expenditure (CHE), data imputation process for the missing data

and outlier, was needed and implemented as follows.

- In the case of nonresponse of total medical expenditure, mean value was substituted.
- When the total household expenditure was the same with the food expenditure, it means there is no money for medical expenditure, and needs another interpretation for it, so it is removed in the analysis.
- If household medical expenditure exceeds the total household expenditure, it is regarded as the outlier and removed in this study.

3.1.2.2. Subject sample

Definition of multiple chronic conditions (MCC) group

In this study, the subject group is the households containing at least one member who is ‘20 years old or over’ , who is in multiple chronic conditions(MCC), and whose each chronic conditions should last more than one year.

This study is based on the definition of multiple chronic conditions (MCC) addressed by OASH (Office of the Assistant Secretary of Health in the USA). There are many kinds of definition and measurement for multiple chronic conditions (MCC), but they have been constrained by lack of consistency in definitions and diagnostic classification schemes and heterogeneity in data systems and methods of data collection. To analyze Multiple chronic conditions(MCC), OASH (Office of the Assistant Secretary of Health in the USA) organized MCC

working group and addressed the definition of chronic illnesses are “conditions that last a year or more and require ongoing medical attention and/or limit activities of daily living” (such as physical medical conditions, behavioral health problems, and developmental disabilities) (Goodman et al. 2013). They produced the OASH list with 20 kinds of chronic conditions, the working group applied this definition and related criteria to sets of conditions used in 3 sources: 1) the CMS Chronic Condition Data Warehouse; 2) the list of Priority Conditions” identified by the Agency for Healthcare Research and Quality’s Effective Health Care Program; and 3) the Robert Wood Johnson Foundation chart book, Chronic Care: Making the Case for Ongoing Care. The CMS Beneficiary Claims Data File uses valid ICD–9 codes from Medicare claims data.

The result of this process was an aggregate set of 20 conditions: arthritis, asthma, autism spectrum disorder, cancer, cardiac arrhythmias, chronic kidney disease, chronic obstructive pulmonary disease (COPD), congestive heart failure, coronary artery disease, dementia, depression, diabetes, hepatitis, human immunodeficiency virus (HIV) infection, hyperlipidemia, hypertension, osteoporosis, schizophrenia, stroke, and substance abuse disorders.

To clear up the definition of multiple chronic conditions in this study, it is summarized as following three things.

④ Chronic condition is defined as one of 20 Chronic conditions

in OASH list: (it is regarded that the characteristics of the chronic condition such as, requiring ongoing medical attention and/or limiting activities of daily living” defined by OASH working group is already involved in the OASH list chronic disease.)

- ⑤ Multiple chronic conditions is at least two chronic conditions
- ⑥ Each conditions last a year or more

Disease codes in Korea health panel are classified by comprehensive level or middle level index. With this limitation, when ICD9 code in OASH list is translated into Korea Health Panel 2011, 2012, the variation can be found in the process.

The disease code translation process is displayed in the **Table 3.**

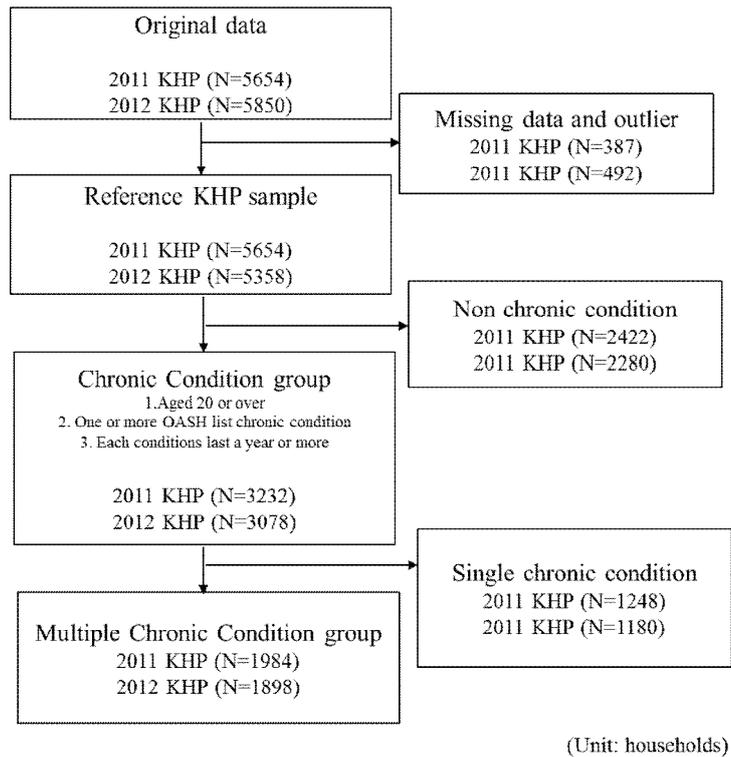


Figure 2. Sampling flow diagram

As shown in **Figure 2**, selecting sample process can be summarized as followings.

First of all, this study excluded and did amputation process with the missing data and outliers.

Second, among them, this study picked up the household having members aged 20 years old or over and who have one or more chronic conditions addressed by OASH list, and who have the condition last a year or more. The reason to extract single chronic condition group was to compare with multiple chronic conditions group.

Lastly, multiple condition groups were extracted from them who have at least two chronic condition members in a household.

Table 3. Disease code translation from OASH (Office of the Assistant Secretary of Health in the USA) list to KHP (Korea Health Panel)

OASH (Office of the Assistant Secretary of Health in the USA) list			KHP (Korea Health Panel)	
OASH List of Chronic Conditions	Name of Condition in Data Collection System	Term or Code Used	KHP 2012	KHP 2011
1. Hypertension	Hypertension /high blood pressure	401.0, 401.1, 401.9, 402.00, 402.01, 402.10, 402.11, 402.90, 402.91, 403.00, 403.01, 403.10, 403.11, 403.90, 403.91, 404.00, 404.01, 404.02, 404.03, 404.10, 404.11, 404.12, 404.13, 404.90, 404.91, 404.92, 404.93, 405.01, 405.09, 405.11, 405.19, 405.91, 405.99, 362.11, 437.2	I10~I15	19031
2. Congestive heart failure	Congestive heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.03, 404.13, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9	I50	19081, 19021
3. Coronary artery disease	Coronary artery Disease Coronary heart Disease Ischemic heart disease	410.00, 410.01, 410.02, 410.10, 410.11, 410.12, 410.20, 410.21, 410.22, 410.30, 410.31, 410.32, 410.40, 410.41, 410.42, 410.50, 410.51, 410.52, 410.60, 410.61, 410.62, 410.70, 410.71, 410.72, 410.80, 410.81, 410.82, 410.90, 410.91, 410.92, 411.0, 411.1, 411.81, 411.89, 412, 413.0, 413.1, 413.9, 414.00, 414.01, 414.02, 414.03,	I20~I25	19050, 19051, 19041

		414.04, 414.05, 414.06, 414.07, 414.12, 414.2, 414.3, 414.8, 414.9		
4. Cardiac arrhythmias	Cardiac arrhythmias	427.31	I49	19071
5. Hyperlipidemia	Hyperlipidemia	272.0, 272.1, 272.2, 272.3, 272.4	E78	14081, 14082
6. Stroke	Stroke, Cerebrovascular disease (stroke or transient ischemic attack)	430, 431, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.00, 434.01, 434.10, 434.11, 434.90, 434.91, 435.0, 435.1, 435.3, 435.8, 435.9, 436, 997.02	I60 ~I69	19121, 19101, 19111
7. Arthritis	Arthritis	714.0, 714.1, 714.2, 714.30, 714.31, 714.32, 714.33, 715.00, 715.04, 715.09, 715.10, 715.11, 715.12, 715.13, 715.14, 715.15, 715.16, 715.17, 715.18, 715.20, 715.21, 715.22, 715.23, 715.24, 715.25, 715.26, 715.27, 715.28, 715.30, 715.31, 715.32, 715.33, 715.34, 715.35, 715.36, 715.37, 715.38, 715.80, 715.89, 715.90, 715.91, 715.92, 715.93, 715.94, 715.95, 715.96, 715.97, 715.98, 720.0, 721.0, 721.1, 721.2, 721.3, 721.90, 721.91	M05, M06, M08, M10, M13, M15, M17, M18, M19, M45, M47, R29	23011, 23012, 23021, 23022, 23076
8. Asthma	Asthma	493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.81, 493.82, 493.90, 493.91, 493.92	J45	20121
9. Autism spectrum disorder	Autism	Not applicable	F84	15074

				12010, 12011, 12012, 12013, 12014, 12021, 12031, 12041, 12051, 12052, 12053, 12061, 12062, 12063, 12071, 12080, 12081, 12091, 12101, 12111, 12121, 12131,
10. Cancer	Cancer (all except nonmelanoma skin)	Female breast cancer: 174.0, 174.1, 174.2, 174.3, 174.4, 174.5, 174.6, 174.8, 174.9, 175.0, 175.9, 233.0, V10.3. Colorectal cancer: 154.0, 154.1, 153.0, 153.1, 153.2, 153.3, 153.4, 153.5, 153.6, 153.7, 153.8, 153.9, 230.3, 230.4, V10.05. Prostate cancer: 185, 233.4, V10.46. Lung cancer: 162.2, 162.3, 162.4, 162.5, 162.8, 162.9, 231.2, V10.11.	C00 ~ C97 D00 ~ D09	12132, 12141, 12151, 12161, 12162, 12170, 12171, 12181, 12190, 12191, 12201, 12202, 12211, 12221, 12231, 12241, 12250, 12251, 12261, 12271, 12281, 12290, 12291, 12292, 12301

		016.00, 016.01, 016.02, 016.03, 016.04, 016.05, 016.06, 095.4, 189.0, 189.9, 223.0, 236.91, 249.40, 249.41, 250.40, 250.41, 250.42, 250.43, 271.4, 274.10, 283.11, 403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 440.1, 442.1, 572.4, 580.0, 580.4, 580.81, 580.89, 580.9, 581.0, 581.1, 581.2, 581.3, 581.81, 581.89, 581.9, 582.0, 582.1, 582.2, 582.4, 582.81, 582.89, 582.9, 583.0, 583.1, 583.2, 583.4, 583.6, 583.7, 583.81, 583.89, 583.9, 584.5, 584.6, 584.7, 584.8, 584.9, 585, 585.1, 585.2, 585.3, 585.4, 585.5, 585.6, 585.9, 586, 587, 588.0, 588.1, 588.81, 588.89, 588.9, 591, 753.12, 753.13, 753.14, 753.15, 753.16, 753.17, 753.19, 753.20, 753.21, 753.22, 753.23, 753.29, 794.4	N10, N05.9, N00-08, N10-N16, N17~N19	24011 24012 24020 24021 24031 24041
11. Chronic kidney disease	Chronic kidney disease			
12. Chronic obstructive pulmonary disease	Chronic obstructive pulmonary disease	490, 491.0, 491.1, 491.20, 491.21, 491.22, 491.8, 491.9, 492.0, 492.8, 494.0, 494.1, 496	J40, J41, J42, J43, J44, J47	20110, 20111, 20112, 20113, 20131
13. Dementia (including Alzheimer' s and other senile dementias)	Dementia	331.0, 331.1, 331.11, 331.19, 331.2, 331.7, 290.0, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.40, 290.41, 290.42, 290.43, 294.0, 294.10, 294.11, 294.8, 797	G30, F03	16031 15011

14. Depression	Depression	296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 2 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.89, 298.0, 300.4, 309.1, 311	F31–F33	15051, 15052
15. Diabetes	Diabetes (all non–gestational)	249.00, 249.01, 249.10, 249.11, 249.20, 249.21, 249.30, 249.31, 249.40, 249.41, 249.50, 249.51, 249.60, 249.61, 249.70, 249.71, 249.80, 249.81, 249.90, 249.91, 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93, 357.2, 362.01, 362.02, 366.41	E10~E14	14021
16. Hepatitis	Hepatitis	Not applicable	K73, B18, B19	11252, 11250
17. HIV/AIDS ³	HIV	Not applicable	B20–B24	11261
18. Osteoporosis	Osteoporosis	733.00, 733.01, 733.02, 733.03, 733.09	M81.9 (M81)	23091

19. Schizophrenia	Schizophrenia	Not applicable	F20	15043
20. Substance abuse	Substance use	Not applicable	F10–F19	15021, 15030, 15031

3.2. Data analysis method

3.2.1. Model formula

This study measured CHE (catastrophic health expenditures) according to the proportion of out-of-pocket health expenditure to non-food household expenditures. CHE incidence and intensity were measured using the indicators reported by Wagstaff et al. (Wagstaff and Doorslaer 2003). Then, associated factors of CHE were estimated using ordinary least square and logistic regression modeling (2). Every data analysis was performed using SAS ver. 9.4 (SAS Institute Inc., Cary, NC, USA).

3.2.2. Variable definition

① **Dependent variable: catastrophic health expenditure (CHE)**

CHE incidence and intensity were measured using the indicators reported by Wagstaff et al. (Wagstaff and Doorslaer 2003). In the formula (1), the indicator, Y_i , was calculated to determine whether CHE occurred: Where T_i is the OOP expenditure for healthcare by household i ; X_i is the total expenditures of household i ; fx_i is the food expenditure of a household i ; and Z is the given catastrophic threshold 0.25 and 0.4.

$$Y_i = \begin{cases} Y_i = 0 & \text{if, } \frac{T_i}{X_i - fx_i} < Z \\ Y_i = 1 & \text{if, } \frac{T_i}{X_i - fx_i} \geq Z \end{cases} \quad (1)$$

$i = 1, 2, \dots, N,$

N : number of households

$N=5654$ for the year of 2011 KHP, 5358 for the year of 2012 KHP

X_i : the total expenditures of household i

fx_i : the food expenditure of a household i

T_i : the OOP expenditure for healthcare by household i

$Z=0.25, 0.4$

The incidence and intensity of catastrophic health expenditure (CHE) were estimated as (2) –(4) formulas.

$$\text{Headcount (H)} = \frac{1}{N} \sum_{i=1}^N Y_i \quad (2)$$

$$\text{Overshoot (O)} = \frac{1}{N} \sum_{i=1}^N Y_i \left\{ \left(\frac{T_i}{X_i - fx_i} \right) - Z \right\} \quad (3)$$

$$\text{MPO} = \frac{O}{H} \quad (\text{MPO: mean positive overshoot}) \quad (4)$$

$i = 1, 2, \dots, N,$

N : number of households

$N=5654$ for the year of 2011 KHP, 5358 for the year of 2012 KHP

X_i : the total expenditures of household i

fx_i : the food expenditure of a household i

T_i : the OOP expenditure for healthcare by household i

$Z=0.25, 0.4$

In Formulas (2) –(4), N is the sample size. CHE incidence was estimated by performing a headcount. Headcount is the percentage of households whose OOP healthcare expenditures, as a fraction of nonfood household expenditures, exceeded a particular threshold (Z). CHE intensity was calculated using overshoot and mean

positive overshoot (MPO). Overshoot measures the degree by which an average OOP health expenditure crosses the given catastrophic threshold of the entire sample, and MPO indicates the degree by which the average OOP health expenditure of a household exceeded the given threshold.

In terms of catastrophic threshold (Z), this study defined it as 25% and 40% of non-food household expenditure. 25% is lately redefined standard by WHO and World bank and 40% is the value which has been widely used since the concept of CHE was introduced.

This study used 'non-food household expenditure' instead of total household expenditure as the denominator in order to calculate CHE, and thereby partly avoid measurement deviations that are often ignored in poor households.

KHPS investigates 'living expenditure' and 'food expenditure'. In this study, 'non-food household expenditure' was calculated by deducting 'food expenditure' from 'living expenditure'.

In the case of "Out of pocket medical expenditure", KHPS conveys various part of medical expenditure, but this study adopted only direct medical payment. The items included into the "Out of pocket medical expenditure" were as followings: emergency medical expenditure, hospitalization medical expenditure, outpatient medical expenditure, emergency prescription drugs fee, hospitalization prescription drugs fee, outpatient prescription drugs fee, Over the counter (OTC) medicine and medical supplies

② Independent variable: CHE determinants

In the logistic regression formula (5), this study defines x_{ki} as related factors to CHE, and the linear regression model of CHE. This study used logistic regression modeling to estimate the related factors of “CHE incidence” because “CHE incidence” is a binary variable here.

[Linear logistic regression model of CHE]

$$Y_i = \beta_0 + \sum_k \beta_k X_{ki} + \varepsilon_i \quad (5)$$

Independent variables, which are related factors to “CHE incidence” in this study, were demographic parameter, socioeconomic factor, and chronic condition factors. To check out which factors determines catastrophic health expenditures in the level of household, 6 kinds of factors were adopted: ‘Proportion of female in a household’, ‘Proportion of 65years old or over member in a household’, ‘Health coverage type’, ‘Number of the total people with MCC in a household’, ‘Household income adjusted by Equivalence Scale’ and ‘20 kinds of chronic condition listed by OASH’.

To expose the household’s demographic characteristic, gender and age were turned up with proportion in a household.

‘Health coverage type’ was divided by 3 items: Medical care assistance (type 1 and type2), Health Insurance (company insured person and locally insured person), and others(men of national merit, not joined, not qualified, suspension of payment).

‘Number of people with MCC in a household’ means the members in a household with two or more chronic conditions, which are listed by the OASH and it was categorized with ‘one MCC person in a household’ , ‘2 MCC people in a household’ , and ‘3 MCC people in a household’ .

In the case of ‘Household income adjusted by Equivalence Scale’ , first of all, ‘the number of the household members’ was adjusted by Equivalence Scale addressed by O’ Donnell et al in 2008. Recently, equivalence scale was recommended from 0.75 to 0.5 (square root scale). Therefore, equivalence scale was applied by “(number of Adults + 0.5* children)^{0.5}” . Then, the value was translated into natural log (**Table 4**).

Table 4. Comparing equivalence scales (OECD)

Household size	Equivalence scale				
	per-capita income	"Oxford" scale ("Old OECD scale")	"OECD-modified" scale	Square root scale	Household income
1 adult	1	1	1	1	1
2 adult	2	1.7	1.5	1.4	1
2 adults, 1 child	3	2.2	1.8	1.7	1
2 adults, 2 children	4	2.7	2.1	2.0	1
2 adults, 3 children	5	3.2	2.4	2.2	1
Elasticity ¹⁾	1	0.73	0.53	0.50	0

1) Using household size as the determinant, equivalence scales can be expressed through an “equivalence elasticity” , i.e. the power by which economic needs change with household size. The equivalence elasticity can range from 0 (when unadjusted household disposable income is taken as the income measure) to 1 (when per capita household income is used). The smaller the value for this elasticity, the higher the economics of scale in consumption.

In terms of '20 kinds of chronic condition listed by OASH' , it is to inspect which kind of chronic condition was contributed to the incidence of catastrophic health expenditures. It is followed for 20 kinds of chronic conditions by OASH list (Office of the Assistant Secretary of Health in the USA): arthritis, asthma, autism spectrum disorder, cancer, cardiac arrhythmias, chronic kidney disease, chronic obstructive pulmonary disease (COPD), congestive heart failure, coronary artery disease, dementia, depression, diabetes, hepatitis, human immunodeficiency virus (HIV) infection, hyperlipidemia, hypertension, osteoporosis, schizophrenia, stroke, and substance abuse disorders.

This study carried out Pearson correlation analysis with independent variables to check out the model' s suitability. Correlation coefficient with over 0.7 was regarded as improper variable, for it might be a signal of multi-collinearity (and other model problems) and it is generally recommended that researchers should pay careful attention to them(Grewal et al. 2004).

Table 5. Variable description

	Variable	Measure
Dependent variable	Catastrophic expenditure	Yes:1, No:2
Explanatory variable	Proportion of female in a household	continuous variable
	Proportion of 65yr or over member in a household	continuous variable
	Health coverage type	Medical care assistance: 1 Health Insurance: 2 Others: 3
	Household income adjusted by Equivalence Scale	log(Ordinary income)
	Number of people with MCC ¹⁾ in a household	0, 1, 2, 3
	Disease retention in a household or not?	
	Hypertension	No:0, Yes:1
	Congestive heart failure	No:0, Yes:1
	Coronary artery disease	No:0, Yes:1
	Cardiac arrhythmias	No:0, Yes:1
	Hyperlipidemia	No:0, Yes:1
	Stroke	No:0, Yes:1
	Arthritis	No:0, Yes:1
	Asthma	No:0, Yes:1
Autism spectrum disorder	No:0, Yes:1	
Cancer	No:0, Yes:1	
Chronic kidney disease	No:0, Yes:1	
Chronic obstructive pulmonary disease	No:0, Yes:1	
Dementia	No:0, Yes:1	
Depression	No:0, Yes:1	
Diabetes	No:0, Yes:1	
Hepatitis	No:0, Yes:1	
HIV/AIDS	No:0, Yes:1	
Osteoporosis	No:0, Yes:1	
Schizophrenia	No:0, Yes:1	
Substance abuse	No:0, Yes:1	

1)MCC: multiple chronic condition

Chapter 4. Results

4.1. General feature of analysis subject

4.1.1. Demographic characteristics

This study is for analysis of multiple chronic conditions (MCC) group compared with entire group and single chronic condition group.

Chronic condition is defined as 20 chronic diseases followed by “OASH list (US Office of the Assistant Secretary of Health list)” and the condition should be lasted 1yr or over. In addition, the person with the chronic condition should be 20yrs old or over.

Multiple chronic conditions are defined as the person who has two or more chronic condition. “MCC person” means the household member who has multiple chronic conditions. In this study, the total number with MCC people was 2,409 people in 2011 KHPS, 2,464 people in 2012 KHPS.

In terms of age, 65 years old or over people in MCC group was 1,428 (59.3%) in 2011, 1,529 (62.1%) in 2012, which are about three times higher proportions than in the entire group. Even when compared with the single chronic condition group, the proportion of MCC people who were 65 years old or over was about 10% higher than them. As in the previous researches, old people aged 65 years old or over are more susceptible to MCC than other age groups.

As for the proportion of female, female was fewer than male in the entire group, with the figure 45.5% in 2011, 45.8% in 2012.

However, in the both of chronic and MCC groups, female was more than male with the figures that chronic condition female was 54.1% in 2011, 54.9% in 2012 and MCC female was 57.3% in 2011, 57.6% in 2012.

In the case of insurance type, medical assistance type in 2011, 2011 respectively accounts for 5.0%, 4.8% in entire people, 7.8%, 7.5% in single chronic condition group, 10.1%, 10.0% in the MCC group. Chronic condition was defined as the “conditions that last a year or more and require ongoing medical attention and/or limit activities of daily living” (such as physical medical conditions, behavioral health problems, and developmental disabilities) (Goodman et al. 2013). That is to say, MCC group tend to be economical vulnerable for the activity limitation resulted from the chronic condition. Even though medical coverage is large in MCC group, it needs to examine whether this amount of coverage is enough or not.

Table 6. Characteristics of Study Sample

Variable	Entire people		Single chronic condition people ¹⁾		MCC people ²⁾			
	N	(%)	N	(%)	N	(%)		
2011	Age group	<20 yr	2,943	(21.9)	0	(0)	0	(0)
		20–44 yr	4,115	(30.6)	1,000	(21.0)	285	(11.8)
		45–64 yr	3,589	(26.7)	1,564	(32.8)	696	(28.9)
		≥65 yr	2,811	(20.9)	2,200	(46.2)	1,428	(59.3)
		Total	13,458	(100)	4,764	(100)	2,409	(100)
	Gender	Male	7,331	(54.5)	2,189	(46.0)	1,028	(42.7)
		Female	6,127	(45.5)	2,575	(54.1)	1,381	(57.3)
		Total	13,458	(100)	4,764	(100)	2,409	(100)
	Insurance type	Medical care assistance	666	(5.0)	373	(7.8)	244	(10.1)
		Health Insurance	12,727	(94.5)	4,351	(91.4)	2,137	(88.7)
Others		65	(0.5)	40	(0.8)	28	(1.2)	
Total		13,458	(100)	4,764	(100)	2,409	(100)	
2012	Age group	<20 yr	2,667	(21.1)	0	(0)	0	(0)
		20–44 yr	3,755	(29.6)	955	(20.2)	267	(10.8)
		45–64 yr	3,411	(26.9)	1,512	(32.0)	668	(27.1)
		≥65 yr	2,839	(22.4)	2,270	(48.0)	1,529	(62.1)
		Total	12,672	(100)	4,737	(100)	2,464	(100)
	Gender	Male	6,862	(54.2)	2,138	(45.1)	1,046	(42.5)
		Female	5,810	(45.8)	2,599	(54.9)	1,418	(57.6)
		Total	12,672	(100)	4,737	(100)	2,464	(100)
	Insurance type	Medical care assistance	612	(4.8)	356	(7.5)	246	(10.0)
		Health Insurance	11,999	(94.7)	4,337	(91.6)	2,190	(88.9)
Others		62	(0.5)	44	(0.9)	28	(1.1)	
Total		12,672	(100)	4,737	(100)	2,464	(100)	

1) Chronic condition is defined as 20 chronic diseases followed by “OASH list (US Office of the Assistant Secretary of Health list)” and the condition should be lasted 1yr or over. In addition, the person with the chronic condition should be 20yrs old or over.

2) MCC is the abbreviation for multiple chronic conditions. MCC person is defined as the one who has two or more chronic conditions.

4.1.2. Chronic condition characteristics

In respect of chronic condition, first of all, this study looked over for the prevalence of chronic disease applied by OASH list, then 8766 chronic illness cases in 2011 KHPS and 9,000 cases in 2012 KHPS were found.

Frequent chronic disease was hypertension 30.56%, 19.20%, Arthritis 18.89%, 19.32% and Diabetes 11.01%, 11.47% in 2011 KHPS and 2012 KHPS respectively. The ratio of Hypertension decreased rapidly from 2011 to 2012, and it is supposed that KHPS disease code system between 2011 and 2012 were not the same and it could influence this results.

In KHPS questionnaire, disease prevalence time is inquired. Chronic diseases with long prevent period were Schizophrenia with average 15.47 years, 16.54 years, Hepatitis with average 13.40 years, 13.71 years and Asthma with average 11.33 years, 11.39 years in 2011 and 2012 respectively.

As for the chronic disease distribution in a household, this study analyzed them according to “the number of chronic disease in a household” and “the number of MCC members in a household” . The number of chronic disease was categorized from 0 to 5 or more diseases in a household. “The number of MCC members in a household” was distributed from 0 to 3 people in a household. The results were presented with ‘2×2 table’ in **Table 7** and **Table 8**.

Table 7. Summary of Chronic Disease Prevalence in Korea Health Panel 2011

Chronic disease ¹⁾ distribution		(total 8,766 diseases events)			
Chronic disease ¹⁾ name	Distribution	Disease duration (yr)			
	N (%)	Mean	SD	(min, max)	
Hypertension	2,679(30.56)	8.21	6.66	(1, 51)	
Congestive heart failure	20(0.23)	8.50	6.63	(1, 23)	
Coronary artery disease	298(3.40)	7.76	6.95	(1, 40)	
Cardiac arrhythmias	67(0.76)	6.70	7.23	(1, 32)	
Hyperlipidemia	890(10.15)	5.12	4.83	(1, 41)	
Stroke	326(3.72)	7.32	6.01	(1, 39)	
Arthritis	1,656(18.89)	8.63	7.77	(1, 52)	
Asthma	221(2.52)	11.33	12.26	(1, 76)	
Autism spectrum disorder	–	–	–	–	
Cancer	409(4.67)	5.23	4.58	(1, 32)	
Chronic kidney disease	78(0.89)	8.27	8.21	(1, 47)	
Chronic obstructive pulmonary disease	111(1.27)	6.93	6.42	(1, 32)	
Dementia	62(0.71)	3.58	3.35	(1, 18)	
Depression	189(2.16)	6.26	6.35	(1, 38)	
Diabetes	965(11.01)	9.45	7.63	(1, 47)	
Hepatitis	92(1.05)	13.40	9.57	(1, 40)	
HIV/AIDS	–	–	–	–	
Osteoporosis	656(7.48)	5.46	5.13	(1, 36)	
Schizophrenia	32(0.37)	15.47	9.96	(2, 42)	
Substance abuse	15(0.17)	8.93	8.21	(2, 31)	

Chronic disease ¹⁾ distribution in a household		(total: 5654 households)				
		The number of MCC members ²⁾ in a household				
		0	1	2	3	Total
The number of chronic disease ¹⁾ in a household	0	2422	–	–	–	2422
	1	905	–	–	–	905
	2	295	600	–	–	895
	3	32	614	–	–	646
	4	13	281	87	–	381
	5 ↑	3	145	249	8	405
	Total	3670	1640	336	8	5654

1) The term, “chronic disease” is used as the same meaning with the chronic condition, which defined as 20 illnesses followed by “OASH list (US Office of the Assistant Secretary of Health list)” and the condition should be lasted 1yr or over. In addition, the person with the chronic disease should be 20yrs old or over.

2) MCC is the abbreviation for multiple chronic conditions. MCC person is defined as the one who has two or more chronic conditions. MCC member means the household member who has multiple chronic conditions.

Table 8. Summary of Chronic Disease Prevalence in Korea Health Panel 2012

Chronic disease ¹⁾ distribution		(total 9,000 diseases events)			
Chronic disease ¹⁾ name	Distribution	Disease duration (yr)			
	N (%)	Mean	SD	(min, max)	
Hypertension	2628(19.20)	8.60	6.62	(1, 48)	
Congestive heart failure	22(0.24)	9.59	6.57	(1, 24)	
Coronary artery disease	326(3.62)	7.58	6.88	(1, 41)	
Cardiac arrhythmias	74(0.82)	6.81	7.05	(1, 33)	
Hyperlipidemia	931(10.34)	5.44	4.61	(1, 37)	
Stroke	333(3.70)	7.60	6.44	(1, 40)	
Arthritis	1739(19.32)	8.93	7.75	(1, 53)	
Asthma	227(2.52)	11.39	11.91	(1, 77)	
Autism spectrum disorder	–	–	–	–	
Cancer	423(4.70)	5.41	4.29	(1, 33)	
Chronic kidney disease	79(0.88)	7.51	7.70	(1, 48)	
Chronic obstructive pulmonary disease	96(1.07)	7.00	6.02	(1, 33)	
Dementia	67(0.74)	3.84	3.68	(1, 19)	
Depression	200(2.22)	6.37	6.21	(1, 38)	
Diabetes	1032(11.47)	9.16	7.60	(1, 48)	
Hepatitis	90(1.00)	13.71	9.54	(1, 41)	
HIV/AIDS	–	–	–	–	
Osteoporosis	691(7.68)	5.81	5.06	(1, 37)	
Schizophrenia	28(0.31)	16.54	10.29	(3, 43)	
Substance abuse	14(0.16)	9.50	8.64	(2, 32)	

Chronic disease ¹⁾ distribution in a household		(total: 5,358 households)				
		The number of MCC members ²⁾ in a household				
		0	1	2	3	Total
The number of chronic disease ¹⁾ in a household	0	2280	–	–	–	2280
	1	864	–	–	–	864
	2	280	574	–	–	854
	3	23	578	–	–	601
	4	11	265	87	–	363
	5 ↑	2	151	238	6	397
Total		3470	1568	325	6	

1) The term, “chronic disease” is used as the same meaning with the chronic condition, which defined as 20 illnesses followed by “OASH list (US Office of the Assistant Secretary of Health list)” and the condition should be lasted 1yr or over. In addition, the person with the chronic disease should be 20yrs old or over.

2) MCC is the abbreviation for multiple chronic conditions. MCC person is defined as the one who has two or more chronic conditions. MCC member means the household member who has multiple chronic conditions.

4.1.3. Abilities of payment for out-of-pocket healthcare payments (OOP)

This study measured CHE (catastrophic health expenditures) according to the proportion of out-of-pocket health expenditure to non-food household expenditures.

Household living expenditure, food expenditure, and out-of-pocket healthcare payments (OOP) were presented in **Table 9**. Remarkable thing in the **Table9**, is that even though MCC group spends the largest money of “out-of-pocket healthcare payments (OOP)” with average 1,623,757 (KRW) in 2011 and average 1,744,524 (KRW) in 2012, household living expenditure shows the smallest money with average 20,116,875 (KRW) in 2011, average 20,390,011 (KRW) in 2012 compared with the other groups. In other words, although MCC group has to spend the largest money to medical expenditure, they have the smallest money for living expenditure. They have more probability of facing catastrophic expenditure. In terms of food expenditure, the group who spent the most money in food was “Single chronic condition group” . MCC group spend average 6,423,085 (KRW) in 2011 and average 6,424,615 (KRW) in 2012, while, “Single chronic condition group” spend average 7,852,699 (KRW) in 2011 and average 7,947,637 (KRW) in 2012.

Table 9. Household living expenditure, food expenditure, and out-of-pocket healthcare payments (OOP)

Household expenditure	Entire households ¹⁾		Single chronic condition group ²⁾		Entire MCC group ³⁾		
	(total 5654 in 2011 KHP, total 5358 in 2012 KHP)		(total 1248 in 2011 KHP, total 1180 in 2012 KHP)		(total 1984 in 2011 KHP, total 1898 in 2012 KHP)		
	Mean	Median	Mean	Median	Mean	Median	
2011 Korea Health Panel	Household living expenditure (x) ⁴⁾	25,760,587	24,000,000	26,327,981	24,000,000	20,116,875	15,900,000
	Food expenditure (fx) ⁵⁾	7,852,699	7,200,000	7,916,827	7,200,000	6,423,085	6,000,000
	Out-of-pocket healthcare payments (T) ⁶⁾	1,307,153	761,150	1,317,638	736,094	1,623,757	1,047,760
2012 Korea Health Panel	Household living expenditure (x) ⁴⁾	26,744,435	24,000,000	27,371,085	24,000,000	20,390,011	15,960,000
	Food expenditure (fx) ⁵⁾	7,947,637	7,200,000	8,143,220	7,200,000	6,424,615	6,000,000
	Out-of-pocket healthcare payments (T) ⁶⁾	1,425,317	824,700	1,422,135	780,850	1,744,524	1,121,935

(unit: KRW / household)

1) 'Entire households' mean the total households in Korea Health Panel in 2011 and 2012. 2) 'Single chronic condition group' means the household in which there is one with single chronic disease. Chronic disease is used as the same meaning with the chronic condition, which defined as 20 illnesses followed by "OASH list (US Office of the Assistant Secretary of Health list)" and the condition should be lasted 1yr or over and the person with the chronic disease should be 20yrs old or over. 3) 'MCC household' means the household in which there are household member with one or more MCC(multiple chronic conditions). MCC person is defined as the one who has two or more chronic disease presented by OASH list. 4) Household living expenditure(x): 12 times of household living expenditure in Korea Health Panel. This represents annual household total expenditure. 5) Food expenditure (fx): 12 times of food expenditure in Korea Health Panel. This represents sustenance expenditure. 6) Out-of-pocket healthcare payments(T): Annual out-of-pocket healthcare payments. Korea Health Panel conveys various part of medical expenditure, but this study adopted only direct medical payment. The items included into the "Out of pocket medical expenditure" were as followings: emergency medical expenditure, hospitalization medical expenditure, outpatient medical expenditure, emergency prescription drugs fee, hospitalization prescription drugs fee, outpatient prescription drugs fee, Over the count(OTC) medicine and medical supplies.

4.2. Incidence and intensity of catastrophic health expenditure

4.2.1. Incidence of CHE

This study measured the incidence and intensity of catastrophic health expenditures with various criteria,

At the very first, this study defined catastrophic threshold (z) as 25% and 40% of non-food household expenditure. 25% is lately redefined standard by WHO and World bank and 40% is the value which has been widely used since the concept of CHE was introduced.

There was missing data in the medical expenditure, and it was imputed with average value.

According to the OASH list, people with chronic condition are defined as the one who is 20 years old or over and his or her chronic diseases should be belonging to OASH list and they should last 1 year or more.

As shown in the “**Table 10** and **Table11**”, at the entire KHPS households, according to the CHE threshold 40%, 5.64%households in 2011, 5.78%households in 2012 faced catastrophic health expenditures. With the CHE threshold 25%, 11.45% households in 2011, 11.38% households in 2012 were at the risk of catastrophic health expenditures.

In the “Entire Chronic household” group, according to the CHE threshold 40%, 8.51% in 2011, 8.38% in 2012 households confronted catastrophic health expenditures. As in the CHE

threshold 25%, 16.74% households in 2011, 16.34% households in 2012 were at the catastrophic health expenditures.

This “Entire chronic household” group was divided by 4 groups based on the number of MCC member in a household: non MCC group, 1 MCC member in a household, 2 MCC members in a household, 3 MCC members in a household. Surely, the more the number of MCC member in a household, the bigger the incident size of Catastrophic health expenditures.

According to the CHE threshold 40% in 2011, Catastrophic health expenditures occurred 3.69% in non MCC group, 9.45% in 1 MCC group, 22.02% in 2 MCC group, and 0% in 3 MCC group. Even in the year of 2012, when according to the CHE threshold 40%, Catastrophic health expenditures occurred similarly to that of 2011, as followed 4.32% in non MCC group, 9.95% in 1 MCC group, 15.74% in 2 MCC group and 0% in 3 MCC group. Except 3 MCC group, the number of MCC members in a household was proportional to the incidence of catastrophic health expenditures.

As in the CHE threshold 25%, in 2011, catastrophic health expenditures took place 8.89% in non MCC group 19.02% in 1 MCC group 33.93% in 2 MCC group, and 50% in 3 MCC group.

As in the CHE threshold 25%, in 2012, 7.88% in non MCC group, 19.77% in 1 MCC group, 30.86% in 2 MCC group, 0% in 3 MCC group. Big difference exists between 2011 and 2012 in 3 MCC group, because 3 MCC group has too small sample size.

4.2.2. Intensity of CHE

As to the matter of intensity of catastrophic health expenditures, **'Figure 3'** and **'Figure4'** represents the total CHE intensity with the upper area chopped by the catastrophic threshold (z) horizontally. The total area shows the total excess burden of out of pocket healthcare money, namely **'total catastrophic overshoot'** (O'Donnell and Wagstaff 2008). As shown in the **'Figure 3'** and **'Figure4'**, MCC group have bigger area of **'total catastrophic overshoot'** than entire KHP group both in the 2011 and 2012. Specific intensity of catastrophic health expenditures was described in **"Table 10 and Table11"**.

The noticeable thing in the intensity of catastrophic health expenditures is that it is not proportional to the number of MCC member in a household. Rather, as in the 40% catastrophic health expenditures in 2011, MPO was fluctuated by the number of MCC member in a house from 20.2% in non MCC group to 19.78% in 1 MCC group, and 17.39% in 2 MCC group. In 2012, according to 40% catastrophic health expenditures, MPO was increased with 19.41% in non MCC, 24.56% in 1 MCC group, and 18.87% in 2 MCC group.

In the 25% catastrophic threshold in 2011, MPO was increased by the number of MCC member in a household with 19.01% in non MCC group, and 20.12% in 1 MCC group, and 23.55% in 2 MCC group, then dropped to 7% in 3 MCC group because of small number of the sample. In 2012, according to 25% catastrophic health expenditures, MPO was fluctuated that 22% in non MCC, 23.02% in 1 MCC group, 20.74% in 2 MCC group, and 0% in 3 MCC group.

Table 10. Incidence and intensity of catastrophic health payments*, 2011

Catastrophic payments measures, threshold budget share, z =25%						
	2011 KHP	Entire chronic households ¹⁾	Non- MCC household ²⁾	1 MCC member in a household ³⁾	2 MCC members in a household ⁴⁾	3 MCC members in a household ⁵⁾
Subject size (unit: household)	5654	3232	1248	1640	336	8
Number of CHE event (unit: household)	647	541	111	312	114	4
Headcount (H)	11.45%	16.74%	8.89%	19.02%	33.93%	50%
Standard error	0.42%	0.66%	0.81%	0.97%	2.59%	18.90%
Overshoot (O)	2.28%	3.43%	1.69%	3.83%	8.00%	3.50%
Standard error	0.12%	0.19%	0.21%	0.28%	0.81%	1.75%
Mean positive overshoot (MPO)	19.96%	20.52%	19.01%	20.12%	23.55%	7.00%
Catastrophic payments measures, threshold budget share, z =40%						
	2011 KHP	Entire chronic households ¹⁾	Non- MCC household ²⁾	1 MCC member in a household ³⁾	2 MCC members in a household ⁴⁾	3 MCC members in a household ⁵⁾
Subject size(unit: household)	5654	3232	1248	1640	336	8
Number of CHE event (unit: household)	319	275	46	155	74	0
Head count (H)	5.64%	8.51%	3.69%	9.45%	22.02%	0
Standard error	0.31%	0.49%	0.53%	0.72%	2.26%	–
Overshoot (O)	1.08%	1.63%	0.74%	1.87%	3.83%	0
Standard error	0.08%	0.12%	0.13%	0.19%	0.54%	–
Mean positive overshoot (MPO)	19.10%	19.21%	20.20%	19.78%	17.39%	–

*Defined with Nonfood Expenditure

1) “Entire chronic households” mean the households in which there are household member with one or more chronic disease presented by OASH list. They contain next 4 categories; “Non MCC household” , “1 MCC member in a household” , “2 MCC members in a household” , and “3 MCC members in a household” 2) “Non-MCC household” means the household in which there are household members with only one chronic disease presented by OASH list. They do not contain MCC members in the household. MCC person is defined as the one who has two or more chronic disease presented by OASH list. 3) “1 MCC member in a household” means the household in which there is only one member with multiple chronic conditions. 4) “2 MCC members in a household” means the household in which there are two members with multiple chronic conditions. 5) “3 MCC members in a household” means the household in which there are three members with multiple chronic conditions.

Table 11. Incidence and intensity of catastrophic health payments*, 2012

Catastrophic payments measures, threshold budget share, z =25%						
	2012 KHP	Entire chronic households ¹⁾	Non- MCC household ²⁾	1 MCC member in a household ³⁾	2 MCC members in a household ⁴⁾	3 MCC members in a household ⁵⁾
Subject size(unit: household)	5358	3078	1180	1568	324	6
Number of CHE event (unit: household)	610	503	93	310	100	0
Headcount (H)	11.38%	16.34%	7.88%	19.77%	30.86%	0
Standard error	0.43%	0.67%	0.78%	1.00%	2.57%	0
Overshoot (O)	2.51%	3.66%	1.73%	4.55%	6.40%	0
Standard error	0.13%	0.21%	0.23%	0.33%	0.78%	0
Mean positive overshoot (MPO)	22.01%	22.38%	22.00%	23.02%	20.74%	0
Catastrophic payments measures, threshold budget share, z =40%						
	2012 KHP	Entire chronic households ¹⁾	Non- MCC household ²⁾	1 MCC member in a household ³⁾	2 MCC members in a household ⁴⁾	3 MCC members in a household ⁵⁾
Subject size(unit: household)	5358	3078	1180	1568	324	6
Number of CHE event (unit: household)	310	258	51	156	51	0
Headcount (H)	5.78%	8.38%	4.32%	9.95%	15.74%	0
Standard error	0.32%	0.50%	0.59%	0.76%	2.03%	0
Overshoot (O)	1.28%	1.87%	0.83%	2.44%	2.97%	0
Standard error	0.09%	0.14%	0.15%	0.23%	0.54%	0
Mean positive overshoot (MPO)	22.03%	22.42%	19.41%	24.56%	18.87%	0

*Defined with Nonfood Expenditure

1) “Entire chronic households” mean the households in which there are household member with one or more chronic disease presented by OASH list. They contain next 4 categories; “Non MCC household” , “1 MCC member in a household” , “2 MCC members in a household” , and “3 MCC members in a household” 2) “Non-MCC household” means the household in which there are household members with only one chronic disease presented by OASH list. They do not contain MCC members in the household. MCC person is defined as the one who has two or more chronic disease presented by OASH list. 3) “1 MCC member in a household” means the household in which there is only one member with multiple chronic conditions. 4) “2 MCC members in a household” means the household in which there are two members with multiple chronic conditions. 5) “3 MCC members in a household” means the household in which there are three members with multiple chronic conditions.

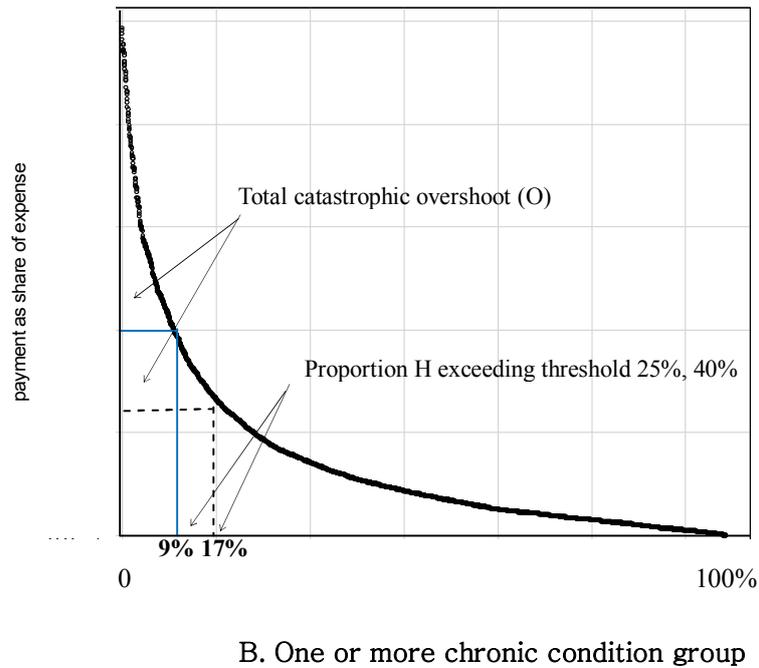
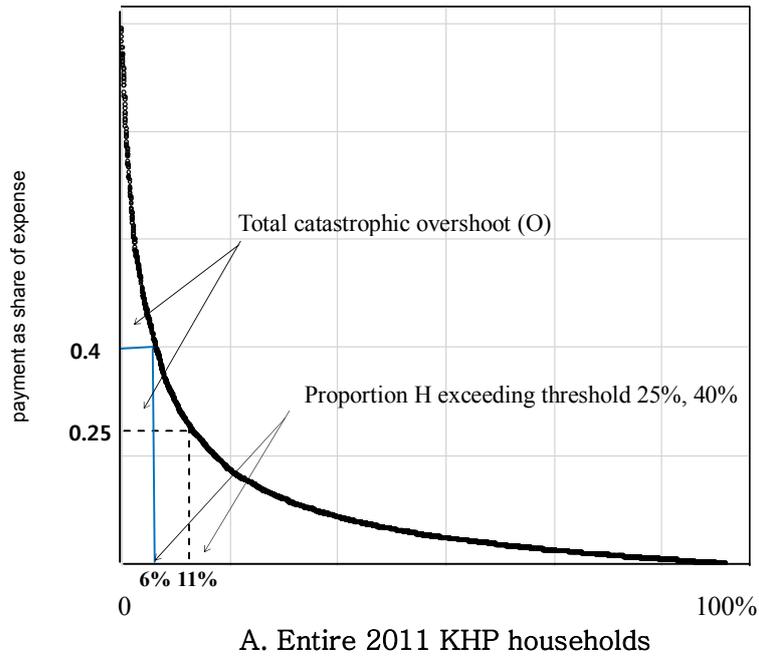
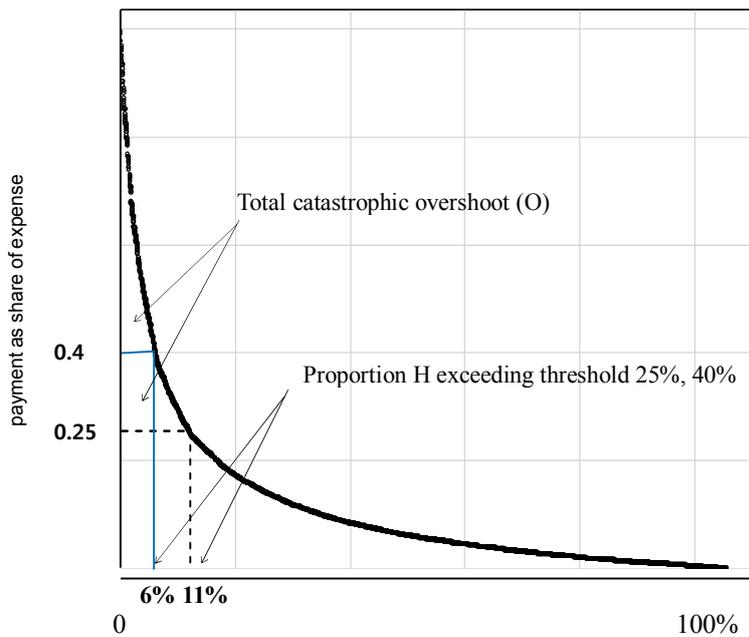
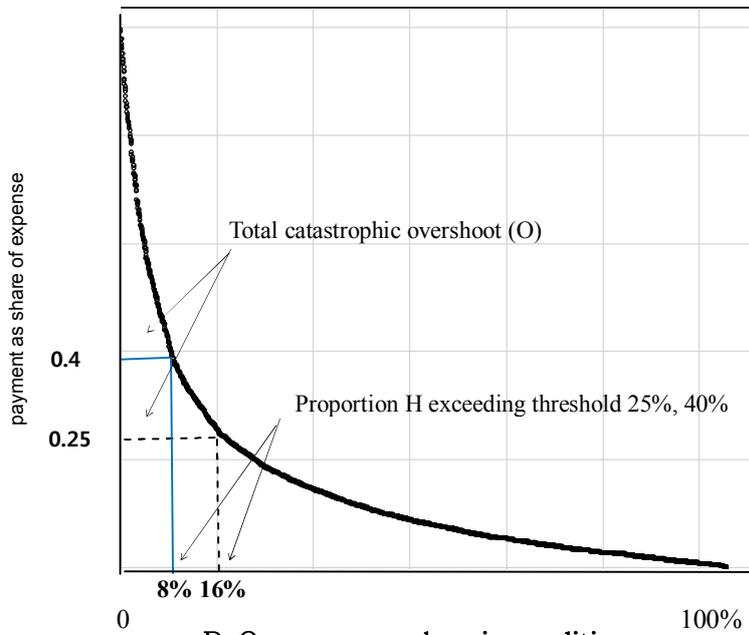


Figure 3. Health payments budget share against cumulative households ranked by decreasing budget share (A. Entire 2011KHP, B. One or more chronic condition group in 2011 KHP, KHP: Korea Health Panel, threshold budget share, $z = 25\%$, 40%)



A. Entire 2011 KHP households



B. One or more chronic condition group

Figure 4. Health payments budget share against cumulative households ranked by decreasing budget share (A. Entire 2012KHP, B. One or more chronic condition group in 2012 KHP, KHP: Korea Health Panel, threshold budget share, $z = 25\%$, 40%)

4.3. Determinants of catastrophic health expenditures

4.3.1. Correlation analysis

To check out if there is multi-collinearity in independent variables, Pearson correlation analysis with them was performed. Correlation coefficient with over 0.7 was regarded as improper variable, for it might be a signal of multi-collinearity (and other model problems) and it is recommended that researchers should pay careful attention to them (Grewal et al. 2004). In the Pearson correlation analysis using SAS 9.4, there was no variable with over 0.7 of Correlation coefficient. Even though it is confirmed that there is no multi-collinearity, additional analysis for reaffirmation of it was conveyed with tolerance and variance inflation factor (VIF) (O'Brien 2007)

The Variance Inflation Factor (VIF) and tolerance are both widely used measures of the degree of multi-collinearity of the i 'th independent variable with the other independent variables in a regression model. A VIF of 10 or even one as low as 4 (equivalent to a tolerance level of 0.10 or 0.25) have been used as rules of thumb to indicate excessive or serious multi-collinearity. Menard (1995: 66) states "A tolerance of less than 0.20 is cause for concern; a tolerance of less than 0.10 almost certainly indicates a serious collinearity problem." Since VIF is the inverse of tolerance a tolerance of 0.20 corresponds to the rule of 5 and a tolerance of 0.10 to the rule of 10. Neter et al. (1989: 409) state "A maximum VIF value in excess of 10 is often taken as an indication

that multi-collinearity may be unduly influencing the least square estimates.” Hair et al. (1995) suggest that a VIF of less than 10 are indicative of inconsequential collinearity. Marquardt (1970) uses a VIF greater than 10 as a guideline for serious multi-collinearity. Mason et al. (1989) cite a VIF of greater than 10 as reason for concern. The STATA manual (Stata Corp 1997: 390) notes: “However, most analysts rely on informal rules of thumb applied to VIF (see Chatterjee and Price 1991). According to these rules, there is evidence of multi-collinearity if 1) The largest VIF is greater than 10 (some chose the more conservative threshold value of 30). 2) The mean of all of the VIF’ s is considerably larger than 1.” Kennedy (1992:183) states that “for standardized data $VIF_i > 10$ indicates harmful collinearity.”

In this study, the values of variance of inflation (VIF) and tolerance for each variable, the tests of the extent of multi-collinearity and collinearity, indicated that there was no multi-collinearity in the model.

Table 12. Verification of multi-collinearity, 2011 KHP

Variable	Tolerance	VIF
Hypertension	0.72506	1.3792
Congestive heart failure	0.98986	1.01024
Coronary artery disease	0.93297	1.07185
Cardiac arrhythmias	0.97935	1.02108
Hyperlipidemia	0.82206	1.21645
Stroke	0.9225	1.08401
Arthritis	0.73792	1.35517
Asthma	0.94836	1.05445
Cancer	0.90819	1.10109
Chronic kidney disease	0.98187	1.01846
Chronic obstructive pulmonary disease	0.97529	1.02534
Dementia	0.96007	1.04159
Depression	0.95314	1.04916
Diabetes	0.81147	1.23234
Hepatitis	0.95731	1.0446
Osteoporosis	0.83135	1.20286
Schizophrenia	0.95822	1.04361
Substance abuse	0.97712	1.02341
Female proportion	0.5525	1.80995
65+member proportion	0.4827	2.07167
Health coverage type	0.89717	1.11462
Number of multi-morbidity household member in a house	0.39176	2.55256
Household income	0.49432	2.023

Table 13. Verification of multi-collinearity, 2012 KHP

Variable	Tolerance	VIF
Hypertension	0.7103	1.40786
Congestive heart failure	0.98821	1.01194
Coronary artery disease	0.93526	1.06922
Cardiac arrhythmias	0.97806	1.02243
Hyperlipidemia	0.81446	1.2278
Stroke	0.93153	1.07351
Arthritis	0.72537	1.37861
Asthma	0.95045	1.05213
Cancer	0.9072	1.10229
Chronic kidney disease	0.98142	1.01893
Chronic obstructive pulmonary disease	0.97164	1.02919
Dementia	0.96308	1.03833
Depression	0.95378	1.04846
Diabetes	0.80553	1.24141
Hepatitis	0.94014	1.06367
Osteoporosis	0.82178	1.21688
Schizophrenia	0.96745	1.03365
Substance abuse	0.97509	1.02555
Female proportion	0.54523	1.83409
65+member proportion	0.47604	2.10065
Health coverage type	0.89449	1.11796
Number of multi-morbidity household member in a house	0.38836	2.57492
Household income	0.48168	2.07606

4.3.2. Determinants of CHE

This study estimated the associated factors of CHE (Catastrophic health expenditures) using ordinary least square and logistic regression modeling. All of data analysis was performed using SAS ver. 9.4 (SAS Institute Inc., Cary, NC, USA).

From now on, this study mentioned the results in the order by the year of 2011 and 2012, and catastrophic threshold 25% and 40%.

Table 14 shows all associated factors of CHE in 25% catastrophic threshold, 2012 KHPS.

To check out which factors determines catastrophic health expenditures in the level of household, 6 kinds of factors were adopted: '20 kinds of chronic condition listed by OASH', 'Household income adjusted by Equivalence Scale', 'Number of the total people with MCC in a household', 'Proportion of 65years old or over member in a household', 'Health coverage type', and 'Proportion of female in a household'.

First of all, the results from '20 kinds of chronic condition listed by OASH' would be explained.

Evident chronic diseases significantly affecting CHE incidence in 2011 with 25% threshold were as follows; Chronic kidney disease (OR=4.4), substance abuse (OR=4.3), depression (OR=2.2), Cancer (OR=1.8), arthritis (OR=1.6), coronary artery disease (OR=1.6), osteoporosis (OR=1.6), asthma (OR=1.4), diabetes (OR=1.3), cardiac arrhythmias (OR=1.8),

hyperlipidemia(OR=1.1).

In 2012 with the same threshold 25%, chronic diseases significantly affecting CHE incidence threshold were as follows; Chronic kidney disease (OR=2.4), Cancer (OR=1.9), cardiac arrhythmias (OR=1.7), arthritis(OR=1.4), osteoporosis(OR=1.4), stroke(OR=1.4).

In 2011 with 40% threshold, chronic diseases significantly affecting CHE incidence were as follows; Substance abuse (OR=6.1), chronic kidney disease (OR=2.4), cardiac arrhythmias (OR=2.4), depression (OR=2.1), chronic obstructive pulmonary disease(OR=1.8), coronary artery disease (OR=1.6), osteoporosis(OR=1.6), arthritis(OR=1.4), diabetes(OR=1.4).

In 2012 with 40% threshold, chronic diseases significantly affecting CHE incidence were as follows; Chronic kidney disease (OR=2.2), cardiac arrhythmias (OR=2.1), cancer (OR=1.9), stroke (OR=1.6), osteoporosis(OR=1.5), arthritis(OR=1.3), diabetes(OR=1.3).

Regardless of catastrophic thresholds, 'chronic kidney disease' , 'cardiac arrhythmias' , 'cancer' , 'osteoporosis' , 'diabetes' , 'arthritis' significantly affected to the incidence of CHE.

Higher households' income showed reverse correlation with the occurrence of CHE.

Medical care assistance also showed reverse correlation with the occurrence of CHE with the value of OR 0.2~0.4 at different

levels. That is to say, medical care assistance was good source for a defense against catastrophic health expenditures.

Meaningful results were found in MCC criteria. At the threshold 25%, 2 MCC group confronted 1.8 times in 2011, 2.6 times in 2012 higher CHE incidence than non MCC group and 3 MCC group did 6.6 times higher CHE incidence than non MCC group in 2011.

Furthermore, at the threshold 40%, 2 MCC group confronted 3 times in 2011, 1.7times in 2012 higher CHE incidence than non MCC group. This represents that more number of multiple chronic condition(MCC) member of a household affect CHE incidence.

Lastly, "Female proportion in a household" did not significantly affect to the incidence of CHE.

Table 14. Determinant factors of catastrophic health expenditures in the entire chronic disease households

* : <0.1, ** : <0.05*** : <0.01

Variables (reference group)		2011 (N=3,232 households)				2012 (N=3,078 households)			
		Threshold 25%		Threshold 40%		Threshold 25%		Threshold 40%	
		OR	Coef.(SE)	OR	Coef.(SE)	OR	Coef.(SE)	OR	Coef.(SE)
Hypertension (no)	exist	1.1	0.10(0.13)	1.0	0.04(0.17)	1.2	0.17(0.13)	1.2	0.20(0.17)
Congestive heart failure (no)	exist	1.3	0.30(0.55)	1.5	0.39(0.66)	0.4	-0.85(0.77)	0.4	-0.85(1.06)
Coronary artery disease (no)	exist	1.6	0.49*** (0.16)	1.6	0.47** (0.19)	1.3	0.27(0.17)	1.3	0.24(0.22)
Cardiac arrhythmias (no)	exist	1.8	0.58* (0.30)	2.4	0.86** (0.34)	1.7	0.53* (0.31)	2.1	0.74** (0.36)
Hyperlipidem ia (no)	exist	1.1	0.08* (0.12)	0.9	-0.09(0.16)	1.0	0.04(0.12)	1.0	0.02(0.16)
Stroke (no)	exist	1.2	0.22(0.16)	1.2	0.16(0.21)	1.4	0.33** (0.16)	1.6	0.48** (0.20)
Arthritis (no)	exist	1.6	0.45*** (0.11)	1.4	0.31** (0.15)	1.4	0.34*** (0.12)	1.3	0.29* (0.16)
Asthma (no)	exist	1.4	0.33* (0.20)	1.5	0.40(0.24)	1.4	0.32(0.20)	2.3	0.83*** (0.23)

Cancer (no)	exist	1.8	0.60*** (0.16)	1.1	0.13(0.22)	1.9	0.64*** (0.17)	1.9	0.66*** (0.21)
Chronic kidney disease (no)	exist	4.4	1.49*** (0.28)	2.4	0.89** (0.37)	2.4	0.88*** (0.30)	2.2	0.80** (0.38)
Chronic obstructive pulmonary disease (no)	exist	1.2	0.17(0.28)	1.8	0.59* (0.31)	0.8	-0.26(0.33)	1.0	-0.004(0.40)
Dementia (no)	exist	1.1	0.08(0.34)	0.6	-0.45(0.50)	1.1	0.10(0.38)	1.9	0.64(0.44)
Depression (no)	exist	2.2	0.78*** (0.19)	2.1	0.73*** (0.23)	1.1	0.10(0.22)	0.8	-0.26(0.31)
Diabetes (no)	exist	1.3	0.24** (0.12)	1.4	0.30** (0.15)	1.2	0.16(0.12)	1.3	0.28* (0.16)
Hepatitis (no)	exist	0.9	-0.05(0.43)	0.8	-0.24(0.58)	1.1	0.07(0.45)	1.8	0.58(0.51)
Osteoporosis (no)	exist	1.6	0.47*** (0.12)	1.6	0.46*** (0.16)	1.4	0.31** (0.13)	1.5	0.38** (0.16)
Schizophrenia (no)	exist	0.6	-0.54(0.69)	<0.001	-13.34(584.60)	1.7	0.53(0.58)	1.0	-0.04(1.05)
Substance abuse (no)	exist	4.3	1.45** (0.63)	6.1	1.81** (0.73)	2.6	0.97(0.69)	1.9	0.66(1.07)
Female proportion		0.8	-0.25(0.18)	0.7	-0.37(0.23)	0.9	-0.11(0.18)	1.0	-0.01(0.23)
65+member proportion		1.6	0.47** (0.20)	1.9	0.64** (0.26)	0.9	-0.05(0.20)	1.0	-0.03(0.26)

Health coverage type (Health Insurance)	Medical care assistance	0.3	-1.08*** (0.20)	0.4	-1.05*** (0.27)	0.3	-1.13*** (0.21)	0.2	-2.00*** (0.32)
	others	0.8	-0.22 (0.48)	0.7	-0.38 (0.64)	0.6	-0.56 (0.56)	0.6	-0.53 (0.75)
Number of MCC members in a household	1 vs 0	1.1	0.14 (0.16)	1.3	0.30 (0.22)	1.6	0.46*** (0.16)	1.2	0.18 (0.22)
	2 vs 0	1.8	0.59** (0.24)	3.0	1.09*** (0.31)	2.6	0.95*** (0.25)	1.7	0.54* (0.32)
	3 vs 0	6.6	1.89** (0.82)	<0.001	-12.78 (1141.60)	<0.001	-11.68 (396.30)	<0.001	-11.49 (523.70)
Households income	log(x)	0.6	-0.47*** (0.06)	0.6	-0.51*** (0.08)	0.6	-0.59*** (0.07)	0.5	-0.62*** (0.09)
Likelihood Ratio		2551.250		1617.247		2427.209		1580.851	
Wald Chi-Square		311.3287***		221.9292***		261.8613***		168.7987***	

Chapter 5. Conclusion and discussion

This study analyzed Korea Health Panel data in 2011 and 2012, focusing on household members with multiple chronic conditions.

The purpose of this study was to estimate CHE determinants and check out whether multiple chronic conditions (MCC) attribute to the incidence and intensity of catastrophic health expenditures (CHE). With this purpose, incidence and intensity of catastrophic health expenditures (CHE) were measured divided by the number of MCC member in a household. The results were that household with more multiple chronic conditions (MCC) members showed more incidences of catastrophic health expenditures, but did not represented bigger intensity of catastrophic health expenditures (CHE). In addition, regardless of catastrophic thresholds, 'chronic kidney disease', 'cardiac arrhythmias', 'cancer', 'osteoporosis', 'diabetes', 'arthritis' significantly affected to the incidence of CHE.

Existing research suggested that female rather than male can affect CHE (Kim and Lee 2012), but female proportion in a household was non determinant factor for CHE in this study. Many studies showed that the number of disease of the number of chronic disease household member affect the CHE, but this study found that the intensity of CHE was not proportional to the number of chronic condition. Yuk et al. conducted catastrophic health expenditure study with Korea Health Panel Survey (KHPS) in 2008 and presented the chronic disease odds ratio affecting CHE (Yuk et

al. 2013). The results were that chronic kidney disease, neoplasm, cerebrovascular disease, ischemic heart disease, arthritis, hypertension can be the determinants for it and they were similar with these studies results.

However, the reason why the intensity of CHE was not proportional to the number of MCC in a household is not clear. This study excluded outliers with too high medical expenditure above their affordability, and it can make maximum limitation and affect these results.

This study found the trend that the more a household has MCC member in a household, the bigger there were CHE incidence. Insurance coverage on MCC group need to be considers in Health policy. Korea achieved universal health insurance coverage is low level paying quite high OOP payments. The proportion of total medical spending financed by the public sector is only 58%, which is lower than the OECD average (72%), and is the fourth lowest OECD level of spending after Chile (47%), Mexico (48%), and the USA (48%) (Jung et al. 2013).

This study has following limitations. Korea Health Panel Disease Code is classified by comprehensive level or middle level index. With this point, in the process of translation ICD9 code of OASH list into Korea Health Panel 2011, 2012, some diseases can be omitted and mistranslated.

In addition, the response of the KHPS could be incorrect such as at the total medical expenditure, income, living expenditure, or food expenditure.

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국문초록

복합만성질환 가구의 재난적의료비 분석 (2011,2012한국의료패널 이용)

최희정

보건학과 보건학전공

서울대학교 보건대학원

연구배경

복합만성질환에 대한 역학 및 의료비 부담 등에 관한 연구는 중요한 보건 문제로 향후 복합만성질환 유병률이 더욱 높아지는 고령화 시대에 대비하기 위해, 본 연구는, 대두된 복합만성질환으로 인한 질병 부담을 측정하고 그 원인이 되는 결정 요소를 파악하고자 한다. 특별히, 복합만성질환군은 의료비 부담이 높은 것으로 선행연구들이 밝히고 있으나, 의료비 부담을 측정하는 데 널리 사용하고 있는 재난적의료비(Catastrophic health expenditures, CHE)를 이용해서 그 발생과 강도를 측정한 연구는 찾아보기 힘들다. 또한, 복합만성질환의 분류가 연구들 간에 서로 일관성이 없어 질병 목록의 통일성이 필요한 상황인데, 2013년 미국보건복지부에서는 이에 대한 해결책을 위해 전문가들로 구성된 위원회를 통해 기준을 정하고 20가지의 만성병 목록인, OASH list 목록을 정한바 있다.

대상 및 방법

본 연구는, 자료원으로 2011, 2012년 한국의료패널조사 자료를 사용하였고, 만성질환에 대한 분류기준은 미국 보건부 Office of the Assistant Secretary of Health(OASH) 에서 제시한 표준화된 20개 만성질환 목록을 따라서 일반 인구군, 한 개 이상 만성질환을 가진 군, 복합만성질환 환자가 포함된 가구군으로 나누었다. 복합만성질환에 대한 정의는 OASH 분류상 만성질환 개수를 파악하여, 2개이상 만성질환을 가진 군을 복합만성질환군으로 정의하였다. 재난적의료비 선정을 위해 사용한 역치는, 가구의 전체 가계직접부담 의료비지출이 가구의 비 생계 총 지출액의 25%, 40% 이다. 마지막으로, 복합만성질환군과 재난적의료비 결정요인을 알아보기 위해 ordinary least square 과 logistic regression modeling을 사용하였다.

결과

한 가구 안의 전체 만성질환 수를 고정하고 관찰하였을 때, 복합만성질환자가 많을수록 재난적의료비 발생이 높아졌다. 40% 역치에서, 전체표본에서는 5.64%, 5.78%, 복합만성질환자가 없는 군에서 3.69%, 4.32%, 한 명의 복합만성질환자가 있는 군에서 9.45%, 9.95%, 2명의 복합만성질환자가 있는 군에서 22.02%, 15.74%를 나타내었다. 25% 역치의 경우, 전체표본에서는 11.45%, 11.38%, 복합만성질환자가 없는 군에서 8.89%, 7.88%, 한 명의 복합만성질환자가 있는 군에서 19.02%, 19.77%, 2명의 복합만성질환자가 있는 군에서 33.93%, 30.86% 를 나타내었다. 그러나, 복합만성질환의 강도는 복합만성질환자의 수가 증가하는 것과 연관성이 없는 것으로 나타났다. 또한 역치와 관계없이 다음과 같은 질환군이

가구내 존재하는 여부가 재난적의료비 발생에 결정요인으로 나왔다; ‘chronic kidney disease’, ‘cardiac arrhythmias’, ‘cancer’, ‘osteoporosis’, ‘diabetes’, ‘arthritis’

결론

본 연구는 복합만성질환군에서 재난적의료비 발생과 강도를 살펴본 연구이다. 한 가구 안의 전체 만성질환 수를 고정하고 관찰하였을 때, 복합만성질환자가 많을수록 재난적의료비 발생이 높아졌다. 그러나, 복합만성질환의 강도는 복합만성질환자의 수가 증가하는 것과 연관성이 없는 것으로 나타났다.

주요어: 복합만성질환, Multiple chronic conditions, Multimorbidity, 재난적의료비, 과부담의료비, Catastrophic health expenditures, Office of the Assistant secretary of Health, OASH

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