RELATIONSHIP BETWEEN DYSLIPIDEMIA AND HYPERTENSION: FOLLOW-UP OF MEDICAL RECORD DATA IN DYSLIPIDEMIA PATIENTS

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ABSTRACT:

Background: Dyslipidemia is associated with atherosclerosis and hypertension. Hyperlipidemia leads to the formation of atherosclerotic plaque and decreases the lumen diameter, whilst increasing the arterial wall resistance and contributing to hypertension. The aim of study was to examine the association between demographic factors, biochemistry factors and hypertension.

Methods: The sample consisted of 203 dyslipidemia patients. Data were collected from the medical records of dyslipidemia patients who visited the Golden Jubilee Medical Center, Mahidol University from 2006-2009. All patients' follow-ups were based on medical record data through 31 December 2013, looking at survival time of hypertension among dyslipidemia patients.

Results: The results showed that an increase in age corresponded to a fasting blood sugar increase. The body mass index was not related to the total cholesterol level. The increasing body mass index was associated with a HDL-C decrease and a triglyceride and fasting blood sugar increase. The follow-up study was 91.73 months showed that dyslipidemia (at 64%), dyslipidemia and hypertension (at 16.7%), dyslipidemia and impaired fasting blood glucose (at 9.4%), dyslipidemia, hypertension and impaired fasting blood glucose (at 9.9%) all increased. Using a Kaplan Meier analysis of the median survival time of hypertension among dyslipidemia patients (the amount of time after which 50% of the dyslipidemia patients have hypertension), it was found that only the age variable was statistically significant (p=0.001). The median survival time of hypertension among dyslipidemia patients aged ≥ 55 years olds was 64.10 months shorter than in patients aged < 55 years old.

Conclusions: Age was significantly associated with survival time of hypertension among dyslipidemia patients. Policy makers and health promotion campaigns need to address the early screening of dyslipidemia patients, especially the aging population. The general public also needs to be aware of the consequences of the risks after dyslipidemia, such as hypertension and diabetes mellitus.

Keywords: Dyslipidemia, Hypertension, Kaplan Meier, Medical record

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INTRODUCTION

Dyslipidemia, associated with atherosclerosis, causes cardiovascular disease (e.g., coronary artery disease and cerebrovascular disease); atherosclerosis is also related to hypertension. Hyperlipidemia leads to the formation of atherosclerotic plaque and decreases the lumen diameter, with increases in arterial wall resistance and it contributes to hypertension [1]. The Framingham risk score was used for estimating the 10-year risk of developing coronary heart disease; based on age, gender, cholesterol levels, high density lipoprotein cholesterol (HDL-C) levels, smoking, and systolic blood pressure factors [2]. The World Health Organisation (WHO) reported that the prevalence of blood pressure increases among males and females (≥ 25 years) was 24.6%, and 20.2 %, respectively [3]. The study of the prevalence of dyslipidemia in Thailand found that 6.8% of samples, aged 20 years old and over, had a combination of three lipid abnormalities (low HDL-C, high LDL-C, and high TG). About 14.4% of samples at the age of 20 years old and over had a combination of low HDL-C and high LDL-C, 7% had a combination of low HDL-C and high

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triglycerides, and 2.7% had a combination of high LDL-C and high TG. Overall, 70.7% of the samples at the age of 20 years old and over had dyslipidemia and 29.3% had no dyslipidemia. 71.7% of females had dyslipidemia and 61.3% of males had dyslipidemia [4]. Dyslipidemias may lead to the subsequent development of hypertension. A previous cohort study in men found that the highest TC, non-HDL-C, and TC/HDL-C ratio had increased risks of developing hypertension of 23%, 39%, and 54%, respectively [5]. Serum cholesterol was strongly correlated among hypertensive patients [6]. Age, body mass index, waist-to-hip ratio, fasting insulin and triglyceride levels predicted the development of hypertension [7].

The majority of studies were based on cross-sectional designs and surveys that could not investigate the causes or effects of dyslipidemia and hypertension or cardiovascular disease [4, 8]. Many patients, who visit the hospital with multiple diagnoses such as dyslipidemia, hypertension, and diabetes, were not able to clarify which symptoms appeared first or haven't used any preventative measures to ward off any damaging effects. A few studies have prospectively explored the relationship between dyslipidemia and the future development of hypertension. Survival time studies of hypertension risk among dyslipidemia patients are rare because of the longitudinal data requirement. The research question involves the duration time of the hypertension risk of patients who have dyslipidemia. The study's aim was to examine the association between demographic factors, biochemistry factors and hypertension. The median survival time of hypertension was investigated among dyslipidemia patients.

MATERIAL AND METHODS

The sample consisted of 203 dyslipidemia patients. Data were collected from the medical records of dyslipidemia patients who visited the Golden Jubilee Medical Center (Kanchanaphisek Medical Center), Mahidol University from 2006-2009. Patients with only dyslipidemia, exhibiting no signs of hypertension, diabetes, or heart diseases and who had not received treatment prior to their first diagnosis are included in the present study, looking at timing of high blood pressure increases. All patients' follow-ups were based on medical record data through 31 December 2013. The present study was submitted for approval to the ethical committee of Faculty of Social Sciences and Humanities, Mahidol University Institutional Review Board (IRB). The author was allowed to use secondary medical records data from the director of the Golden Jubilee Medical Center. The data was handled appropriately to ensure the confidentially of the research subjects. When the results of the present study are published, individual names and other personally identifiable information will not be used.

Dyslipidemia includes patients who have total cholesterol (LDL-C, HDL-C) or triglyceride level abnormalities. Hypertension, in the present study, means patients' that have a systolic blood pressure of 140/90 mmHg and over based on the diagnosis in the medical record data. An impaired fasting blood glucose diagnosis is a condition in which the blood sugar levels are higher than normal, but not as high as it is in diabetes (fasting blood sugar levels of 100-110 mg/dl). Independent variables consisted of demographics and biochemistry data; such as age, gender, marital status, occupation, birth place, body mass index (BMI), total cholesterol levels, LDL-C, HDL-C, triglyceride, fasting blood sugar levels, electrocardiogram examinations and whether they had received drug treatments. The dependent variable was the duration time of hypertension occurrence, which was followed up at the beginning of the diagnosis date of dyslipidemia to the end of the follow-up time in December 2013. Descriptive statistics data used percentages, based on gender, marital status, occupation, birth place, and last diagnosis, as well as the mean, median, and standard deviation on variables such as systolic blood pressure, diastolic blood pressure, BMI, total cholesterol, LDL-C, HDL-C, triglyceride, fasting blood sugar, and the duration time of the follow up. Univariate analysis was used to test the relationships between the age at diagnosis, BMI, total cholesterol levels, LDL-C, HDL-C, triglyceride, fasting blood sugar levels and gender by using a chi-square test. Correlation testing of age at diagnosis, BMI, total cholesterol levels, LDL-C, HDL-C, triglyceride, and fasting blood sugar levels were used to determine the correlation metric. The median survival time of hypertension was analyzed by using Kaplan-Meier and Log Rank tests. Statistical analysis was conducted using SPSS version 18 (Mahidol University) for Windows.

RESULTS

The samples in the present study consisted of 203 individuals, who were diagnosed with dyslipidemia from the baseline data. Most of samples were female, married, retired, with a birth place outside Bangkok, and with a normal BMI. Baseline data showed the mean total cholesterol, LDL-C, HDL-C, triglyceride, and fasting blood sugar levels were 252.46 (mg/dl), 174.96 (mg/dl), 59.75 (mg/dl), 141.83 (mg/dl), and 92.85 (mg/dl),

Table 1 The characteristics of included subjects

Characteristic	N	%
Gender		
Males	60	29.6
Females	143	70.4
Total	203	100.0
Age at diagnosis		
Min 34.68, Max 72.48, Mean (SD) = 53.91(7.76), Median 54.15		
Marital status		
Single/Widowed/Divorced/separated	55	27.1
Married	148	72.9
Total	203	100.0
Occupation		
Farmer	7	3.4
Self employed	15	7.4
Entrepreneur	27	13.3
Retired	124	61.1
Unemployed	30	14.8
Total	203	100.0
Birth place		
Bangkok	76	37.4
Others	127	62.6
Total	203	100.0
Last diagnosis at the end of followed up		
Dyslipidemia	130	64.0
Dyslipidemia, hypertension	34	16.7
Dyslipidemia, impaired fasting blood glucose	19	9.4
Dyslipidemia, hypertension, impaired fasting blood glucose	20	9.9
Total	203	100.0
Mean systolic blood pressure 123 mmHg (Baseline)		
Mean diastolic blood pressure 77 mmHg (Baseline)		
BMI (kg/m^2)*		
Min 16.21, Max 33.58, Mean (SD) = 23.83 (3.19), Median 23.61		
Total cholesterol (mg/dl)		
Min 131, Max 352, Mean (SD)= 252.46 (39), Median 252		
LDL-C (mg/dl)		
Min 63, Max 317, Mean (SD)= 174.96 (39), Median 172		
HDL-C (mg/dl)		
Min 27, Max 106, Mean (SD)= 59.75 (15.9), Median 57		
Triglyceride (mg/dl)		
Min 43, Max 678, Mean (SD)= 141.83 (93.8), Median 114		
Fasting blood sugar (FBS) (mg/dl)		
Min 77, Max 111, Mean (SD)= 92.85 (5.89), Median 93		
Duration time followed up (month)		
Min 1.87, Max 91.73, Mean (SD)= 47.08 (23.8), Median 48.07		

*BMI (Body mass index): body mass divided by the square of their height-with the value universally being given in units of kg/m^2

respectively. The last, or most recent diagnosis, which was performed at the end of study (31 December 2013), showed that dyslipidemia (at 64%), dyslipidemia and hypertension (at 16.7%), dyslipidemia and impaired fasting blood glucose (at 9.4%), dyslipidemia, hypertension and impaired fasting blood glucose (at 9.9%) all increased. The maximum time of the follow-up study was 91.73 months (7.6 years), Table 1.

An analysis of the age at the first diagnosis, showed that, of the patients coming into the hospital for check-ups, the number of males under the age of 55 years exceeded the numbers of females, but in those aged 55 years and over the number of females exceeded that of males. Overall, females had higher total cholesterol (≥ 240 mg/dl) levels than males. Male and female BMI, HDL-C, and triglyceride levels were different ($p<0.05$). The majority of males had a higher BMI than females (≥ 25 kg/m2) and males had a lower HDL-C (< 59 mg/dl) than

Table 2 Chi-square analysis for age, BMI, total cholesterol, LDL-C, HDL-C, triglyceride, classified by gender

	Male		Female		*p-value*
	N	**%**	**N**	**%**	
Age at first diagnosis (year)					*0.06*
< 55	40	66.7	75	52.4	
≥ 55	20	33.3	68	47.6	
Total	60	100.0	143	100.0	
BMI (kg/m^2)					*0.004*
< 25	31	51.7	104	72.7	
≥ 25	29	48.3	39	27.3	
Total	60	100.0	143	100.0	
Total cholesterol (mg/dl)					*0.07*
< 240	27	46.6	47	32.9	
≥ 240	31	53.4	96	67.1	
Total	58	100.0	143	100.0	
LDL-C (mg/dl)					*0.53*
< 160	24	40.7	51	35.9	
≥ 160	35	59.3	91	64.1	
Total	59	100.0	142	100.0	
HDL-C (mg/dl)					*0.001*
< 59	47	79.7	61	43.3	
≥ 59	12	20.3	80	56.7	
Total	59	100.0	141	100.0	
Triglyceride (mg/dl)					*0.001*
< 200	39	65.0	125	89.3	
≥ 200	21	35.0	15	10.7	
Total	60	100.0	140	100.0	

Table 3 Correlation metric of age, BMI, total cholesterol, LDL-C, HDL-C, triglyceride, and FBS at diagnosis

	Age	**BMI**	**Cholesterol**	**LDL**	**HDL**	**Triglyceride**	**FBS**
Age	1						
BMI	-.078	1					
Total cholesterol	.061	-.080	1				
LDL-C	.058	-.007	.892***	1			
HDL-C	.238***	-.377***	.253***	.043	1		
Triglyceride	-.121	.283***	-.090	-.155*	-.562***	1	
FBS	.182*	.410***	-.004	-.004	-.111	.193*	1

p-value: * < 0.05 ** 0.01 *** 0.001

females. Males also had higher triglyceride (≥ 200 mg/dl) levels than females (Table 2).

Median age scores at the first diagnosis of dyslipidemia among males and females were 51.7 and 54.6, respectively. The correlation metric showed that an increase in age corresponded to a fasting blood sugar increase. BMI was not related to the total cholesterol level. The increasing BMI was associated with a HDL-C decrease, and a triglyceride and fasting blood sugar increase (Table 3).

Kaplan Meier analysis, median survival time (the 50th percentile of the survival time distribution) of hypertension among dyslipidemia patients found that only the age variable was statistically significant (p=0.001). The median survival time of hypertension in those aged 55 years and over was 64.10 months shorter than in the groups of patients aged 55 years and below. In patients who had a BMI equal to 25 and over, the median survival time was 64.57 months shorter than in patients who had a BMI equal to 25 and below. The median survival time of hypertension among patients who had both dyslipidemia and impaired fasting blood glucose were 49.33 months shorter than in patients who did not have impaired fasting blood glucose levels. The median survival time of heart abnormalities, based on an abnormal electrocardiogram examination, was 64.10 months shorter than patients who had a normal electrocardiogram (Table 4).

DISCUSSION AND CONCLUSION

The present study showed that the majority of males with a BMI of ≥ 25 kg/m2 were higher than in females, the HDL-C levels (< 59 mg/dl) were lower in males than females, and the triglyceride scores (≥ 200 mg/dl) were higher in males than

Table 4 Median survival time of hypertension among dyslipidemia patients, using Kaplan Meier

Characteristic	n	Median survival time (months)	Log rank (*p-value*)
Gender (n=194)			
Male	59	74.33	*0.49*
Female	135	76.13	
Age (year) (n=194)			
< 55	109	89.27	*0.001*
≥ 55	85	64.10	
BMI (kg/m^2) (n=194)			
< 25	126	76.13	*0.97*
≥ 25	68	64.57	
Total cholesterol (mg/dl) (n=192)			
< 240	71	75.37	*0.87*
≥ 240	121	80.93	
Fasting blood sugar (mg/dl) (n=148)			
≤ 100	132	74.33	*0.07*
> 100	16	49.33	
ECG (n=194)			
Normal	170	76.13	*0.57*
Abnormal*	24	64.10	

* Abnormal electrocardiogram such as right bundle branch block, anterior ischemia, and T-wave abnormality

females. An increase in age corresponded to fasting blood sugar increases. BMI increases were associated with HDL-C decreases, while triglyceride and fasting blood sugar levels increased. In correspondence with previous studies, BMI had an inverse correlation to serum HDL cholesterol but, in contrast to the present study, BMI was related to total cholesterol levels and LDL-C in men [9, 10]. BMI was strongly associated with hypertension [11]. The present study showed the median survival time of hypertension, among dyslipidemia patients, revealed that the age variable was statistically significant (p=0.001). Similarly, a previous study found that age increases were more likely to present a risk of hypertension, with a relative risk of hypertension equal to 4.28 [12]. Generally, age and hypertension are major determinants of arterial stiffness [13]. Arterial stiffness has been demonstrated to lead to an increase in mild hypertension, especially in the elderly [14]. Dyslipidemia causes an endothelial dysfunction of the vascular system, which may lead to hypertension [15]. The present study showed that the median survival time of hypertension in those aged 55 years and over was 64.10 months shorter than in that group of patients aged 55 years and below. Median survival time of hypertension among patients who had both dyslipidemia and impaired fasting blood glucose levels were 49.33 months shorter than in patients who did not have an impaired fasting blood glucose levels. In theory, over time, a high blood sugar level can lead to increased plaque buildup in arteries. Having diabetes doubles the risk of coronary heart disease. If impaired fasting blood glucose patients don't take steps to manage it, they'll likely develop type 2 diabetes within 10 years. They're also at a higher risk of coronary heart disease [16]. Outcomes, corresponding with previous studies, found that the significant risk factors for hypertension included age and hypercholesterolemia [5, 12]. Similarly, a previous study in Thailand found that dyslipidemia increases with both age and high triglyceride levels in men. In contrast, dyslipidemia showed low HDL-C in women, but the present study showed higher HDL-C in women than in men [8]. The difference in results may be explained in terms of the study design and individual characteristics. The primary strength of the present study was the follow-up or longitudinal study of the medical records data and in analyzing the median survival time of hypertension. The limitations of the present study were:

1. An inadequate length of time to follow-up on hypertension. The sample size was small. In the future, research design should increase the number of hospitals involved and extend the follow-up time in the study.
2. Laboratory and blood pressure measurements depended on patients visiting or having a check-up or blood examination. Symptoms of diseases may appear long before visiting a medical facility/hospital.
3. The timing of hypertension occurrence may be under-estimated as a result of most patients receiving lipid management agents such as simvastatin drugs to reduce dyslipidemia.
4. Some patients did not have regular check-ups. The present study found that at the end of the

long term follow-up, some patients suffered from dyslipidemia and hypertension (17%); dyslipidemia and impaired fasting blood glucose (9%); and dyslipidemia, hypertension and impaired fasting blood glucose (10%). Similarly, a previous study found that the percentage of those suffering from impaired fasting blood glucose was 11% and those with impaired systolic blood pressure was 17% [17].

Policy makers and health promotion campaigns need to address early screening of dyslipidemia patients by encouraging the at-risk population to have regular check-ups, especially among the aging population. The general public also needs to be aware of the consequences of the risks after dyslipidemia, such as high blood pressure and cardiovascular diseases. In future research, the study should consider treatments and behavior risks (diet, exercise, alcohol, and smoking) for the prevention, control, and survival of non-communicable diseases such as dyslipidemia, hypertension, cardiovascular diseases and type 2 diabetes.

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