CVDs risk factors and survival of the older persons in Thailand: three years follow-up from National Health Examination Survey III

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Abstract

This study aimed to compare the survivorship of the older Thais (aged 60+) with and without risk factors of cardiovascular diseases (CVDs). The data from National Health Examination Survey III (NHES III) conducted in 2004 were linked to 2004 – 2006 death records from vital registration. The older persons died from all causes except accidents and assault with complete information of CVDs risk factors only (*n* = 15 964) were analyzed by sex, using Cox proportional hazard regression. The findings indicated that independent factors associated with increased risk of mortality for both sexes included diabetes, BMI ≥ 25 kg/m^2 and physically inactive. For men, the hazard was also greater in those who consumed fruit and vegetable < 7.5 cups/day; whereas, for women, the increased hazard was found in those who were current and regular smokers. This study suggested the important role of CVDs risk factors in survivorship among older Thais.

Introduction

According to the epidemiologic transition during the last century, morbidity and mortality from infectious diseases worldwide as the major causes are now changed. Nowadays, the important causes of both morbidity and mortality are from degenerative diseases[1,2]. It can be said that this transition is related to the demographic transition which many countries, especially currently developed countries, have experienced and its causes were from socioeconomic and health development. Both transitions prolong human lifespan. At the same time, there is increasing morbidity from more degenerative diseases in population as well. Now, the disease which accounts for the major cause of death regardless of countries income is cardiovascular diseases (CVDs), a group of disorders of the heart and blood vessels[3,4,5]. Besides the major cause of death, CVDs contribute as the first and the third rank of burden of disease among high-income and low-and-middle income countries, respectively[6]. This

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burden will persist if people still have unhealthy behaviours such as consuming high fat or low fiber diet, lack of physical activities, smoking or drinking. It is estimated that morbidity and mortality from CVDs will increase to 17% during 2005 – 2015 if those countries do nothing[7].

For Thailand, it may say that the demographic situation is changing from young to ageing society as well as the mortality is changing from communicable to non-communicable causes. In 1980s, the major cause of death in Thailand was changed from infectious diseases to non-communicable diseases. Recently, CVDs and cancer are the major causes[8]. According to these changes, the studies of non-communicable diseases were interesting to many researchers. However, most of recent studies were the studies of prevalence or the association between risk factors and morbidity only[9-12]. One study explored the CVDs mortality differential among the older persons using aggregate data from vital registration[13]. Furthermore, a cohort study which having followed up health status of a group of people for 12 years had been ever done[14]. Nevertheless, subjects in this study did not represent the general population. Since the Ministry of Public Health conducted a national health examination survey which covered the entire population during 2003 - 2004, it will be very useful to study from this data. So, this study aimed to analyze the survivorship of the older persons who were the most risky population to CVDs morbidity, comparing between those who had and did not have risk factors of CVDs.

Methods

Study population

This paper analyses data from the National Health Examination Survey III (NHES III), a population-based survey conducted by Health System Research Institute (HSRI) and Bureau of Policy and Strategy (BPS), Ministry of Public Health during January 15 – April 15, 2004. A three-stage stratified probability sampling was adopted for this survey. The primary, secondary, and tertiary sampling units were provinces, election units for in-municipal / villages for out-municipal, and individuals aged 15 and over respectively. Sample sizes which were nationally representative are 39 290. For health assessment, people were interviewed through structural questionnaire which general questions were adapted from the health state description questions used in the WHO Multi-Country Survey Study on Health and Responsiveness 2000-2001[15]. Five physical exams i.e. general appearance, weight and height, waist and hip circumference, brachial blood pressure, and pulse, were examined. Furthermore, blood sample of each individual was drawn for fasting blood sugar and total cholesterol.

To focus on the older persons, we selected subjects who aged 60 years and older (n = 19 372). The records of the interviewed individuals had been linked using a unique person identifier (not all records had person identifier) to vital registration data for the years 2004 to 2006, which percent completeness of vital registration was greater than 90[16,17]. According to the completion of person identifier, only 17 458 from total older persons (90.1%) could be used to link to vital registration. From this linkage, older persons who died from accidents and assault and those without information of health risk or protective behaviours were excluded. The final number of subjects left in this analysis were 15 964 (men = 7 729, women = 8 235).

Measures

In this study, the dependent variable which we focused on was mortality of older persons. Survival time was calculated as the interval between interview date and date of death or until the date of December 31, 2006 if those older persons did not die.

For independent variables, five major risk factors of cardiovascular diseases; i.e. current and regular smoker, hypertension, hypercholesterolemia, diabetes, and overweight were variables of our interest. We obtained these variables from the data of physical and blood exams. A current and regular smoker meant a person who smoked 100 or more cigarettes during his/her life time and still smoking while being interviewed. A hypertensive person was defined as the one whose systolic blood pressure >= 140 mm Hg and diastolic blood pressure >= 90 mm Hg or receiving antihypertensive drugs. For a person who was defined as having hypercholesterolemia, his/her total blood cholesterol was >= 240 mg/dl (5.7 mmol/l) or receiving lowering hypercholesterolemia drugs. A person who had diabetes, his/her fasting blood sugar was >= 126 mg/dl or receiving lowering hyperglycemic drugs or insulin. Body Mass Index (BMI) which was greater than 25 kg/m^2 was a criterion for overweight. By these definitions, the samples were evaluated whether they did or did not have each risk factor (0 'no', 1 'yes').

Besides risk factors of CVDs, two protective health behaviours were also put into our consideration. The first one was fruit and vegetable consumption and the second one was the behaviour of having physical activities. We assigned data of fruit and vegetable daily intake which were 7-day recall into 3 groups: 1 'less than 5 cups per day (1 cup = 150 ml)', 2 '5 cups or more but less than 7.5 cups per day' and 3 '7.5 cups or more per day'. For having physical activities, people were asked about whether their general activities were sitting, standing, and less than 10 minutes walking. We defined people who answered 'yes' to this question as 'inactive' and 'active' for those who answered 'no'.

Concerning about confounding variables, we took age in 2004, marital status, area of residence, geographical area, education, and living arrangement into account for controlling variables in our analysis. We categorized age in 2004 as follows: 1 '60-69', 2 '70-79' and 3 '80+'. Marital status was categorized into 3 groups: 1 'single', 2 'married' and 3 'widow/divorced/separated'. There were 2 areas of residence: 1 'in-municipality' and 2 'out-municipality'. Geographical area was classified into 5 regions: 1 'central (excluding Bangkok)', 2 'northeast', 3 'north', 4 'south' and 5 'Bangkok'. For education , we used the highest level of education attainment in this analysis. There were 3 categories of education level: 0 'no education', 1 'elementary level' and 2 'secondary level or higher'. Living arrangement, the last controlled variable, was classified into 5 groups: 1 'living alone', 2 'living with spouse only', 3 'living in 2-generation household', 4 'living in 3-generation household' and 5 'living with others'

Data analyses

In the initial analysis, mortality rate by health risks or protective behaviours were explored separately between older men and women as the risk of mortality of men and women were different. Then, the association between these variables with mortality was analyzed by using Cox proportional hazard model[18]. In this model, the hazard of death during 3 years of follow-up was a function of health risks/protective behaviours and a set of covariates. We performed 4 models to assess the ability of health risks/protective behaviours to predictive mortality. The first or based model was composed of health behaviour variables only. We also added the interaction between hypertension and diabetes whether hypertension affected different diabetes group. We found no interaction between them. So, the interaction term was dropped from model 1. Model 2 was the model which age in 2004, marital status, area of residence and geographical area variables were added to based model. In model 3, education variable which implied socioeconomic status was added on top of model 2. For the last model, living arrangement variable was added on top of model 3. These subsequent analyses were carried out in order to control the spurious association caused by these confounding factors.

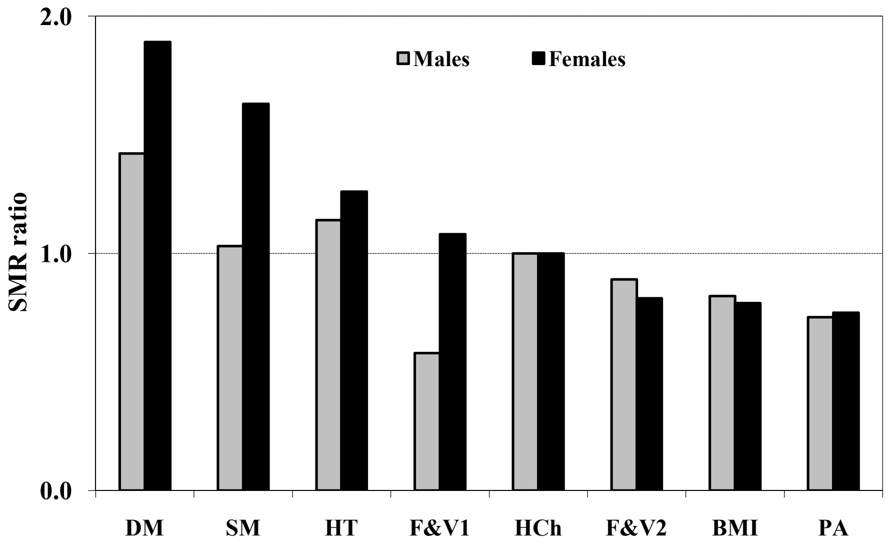
Results

Of the 15 964 older persons at baseline, 56.7% were age 60 – 69 years, 36.6% were age 70 – 79 years, and 6.7% were age 80 years and older. According to 3 years of follow-up, of the total, 845 subjects (649 men and 444 women) were died (6.8%). Among those who died, the mean survival time was 1.63 years (95% CI = 1.58 – 1.68). By each independent variable, mortality was different between subcategories of each of them. Older men and women almost had similar pattern of mortality. Mortality of them who exposed to health risks, except BMI and hypercholesterolemia for both sexes and smoking for men, was higher than those who did not. In addition, mortality among those who had protective behaviours was lower than the counterpart (Table 1). The standardized mortality rate (SMR) ratios of subcategories of each independent variable were in range of 0.6 – 1.4 for men and 0.7 – 1.9 for women, respectively (Figure 1).

Table 1 Age-adjusted mortality rate (per 1 000 person-years) and 95% confidence intervals of mortality rate by health risk characteristics and sex among older Thais in NHES III after 3 years of follow-up, 2004 – 2006

Health risk/protective behaviour	**Males**				**Females**			
	Person-year	Deaths	Mortality*		Person-year	Deaths	Mortality*	
			Rate	95% CI			Rate	95% CI
BMI								
<= 25 kg/m^2	16 990.8	538	30.7	28.4– 32.9	15 438.6	328	20.3	18.4– 22.2
> 25 kg/m^2	5 009.9	111	25.3	21.2– 29.4	8 357.0	116	16.1	13.5– 18.7
Diabetes								
No	18 960.8	536	27.9	25.7– 30.1	19 491.1	322	16.3	14.7– 17.9
Yes	3 039.9	113	39.6	33.3–45.9	4 304.5	122	30.8	26.0– 35.5
Hypertension								
No	10 239.3	274	27.5	24.6– 30.5	10 972.2	172	16.4	14.2– 18.6
Yes	11 761.4	375	31.2	28.3– 34.1	12 823.4	272	20.6	18.4– 22.9
Hypercholesterolemia								
No	17 306.0	517	29.4	27.0– 31.7	15 342.2	294	18.7	16.8– 20.7
Yes	4 694.7	132	29.4	25.0– 33.8	8 453.4	150	18.7	16.0– 21.3
Current, regular smoker								
No	13 997.4	418	29.0	26.4– 31.6	22 509.7	408	18.1	16.5– 19.8
Yes	8 003.3	231	29.9	26.4– 33.4	1 285.9	36	29.5	22.1– 36.9
Fruit & vegetable consumption per day								
<5 cups	18 828.6	576	30.2	27.9– 32.6	19 949.1	385	19.1	17.4– 20.9
>=5 & < 7.5 cups	2 474.6	63	26.9	21.4– 32.3	2 993.4	43	15.5	11.8– 19.2
>=7.5 cups	697.4	10	17.7	10.1– 25.3	853.1	16	20.7	13.6– 27.7
Physical activity								
Inactive	6 873.9	264	35.7	31.8– 39.7	9 393.2	222	22.0	19.d3– 24.6
Active	15 126.8	385	26.2	23.8– 28.6	14 402.4	222	16.4	14.5– 18.4

Note: Standardized by total older persons age structure.



Note: DM, SM, HT, HCh were SMR ratios of 'Yes' to 'No' category of diabetes, smoking, hypertension, and hypercholesterolemia respectively. F&V1 and F&V2 were SMR ratios of consuming fruit and vegetables ≥7.5 and ≥5&<7.5 cups per day to <5 cups per day, respectively. BMI was SMR ratio of BMI>25 kg/m^2 to BMI≤25 kg/m^2. PA was SMR ratio of physically active to inactive.

Figure 1 Standardized mortality rate (SMR) ratio by health risk characteristics and sex among older Thais in NHES III after 3 years of follow-up, 2004 – 2006

To assess the relationship of health risks to survival of older persons, four Cox proportional hazard models were tested and presented in Table 2. This table showed that the most fitted model considering from the lowest Akaike's information criterion (AIC) statistic was model 3 for males and model 2 for females. From fitted model of males (model 3), the older men who had BMI >= 25 kg/m^2, consumed fruit and vegetables >= 7.5 cups/day and still active were 25.2% (95% CI =7.4 – 39.4), 48.2% (95% CI = 3.0 – 72.3) and 25.6% (95% CI = 12.8 – 36.6) less likely to die than the counterpart who did have BMI < 25 kg/m^2, ate fruit and vegetables < 5 cups/day and were inactive, respectively. Furthermore, the hazard of the older men who had diabetes were 51.4% (95% CI = 1.2 – 1.9) higher than those who did not have diabetes. In women, the fitted model (model 2) showed that hazard of the older who had BMI >= 25 kg/m^2 and were active was 28.6% (95% CI = 24.8 – 31.3) and 27.8% (95% CI = 11.6 – 44.6) lower than hazard of the one who had BMI < 25 kg/m^2 and were not active, respectively. Moreover, the older women who had diabetes, hypertension and were current and regular smoker were 1.9 (95% CI = 1.6 – 3.2), 1.3 (95% CI = 1.2 – 1.9) and 1.7 (95% CI = 1.1 – 2.2) times more likely to die than those who did not have diabetes, hypertension and were not current and regular smoker, respectively. In comparison with the reference category of each predictive variable, these hazard ratios among the older women were obviously greater than among the older men.

Table 2 Cox proportional hazard ratios for survival time among older Thais in NHES III after 3 years of follow-up, 2004 – 2006

Variables	**Males**				**Females**			
	Model 1 (n = 7 729)	**Model 2 (n = 7 729)**	**Model 3 (n = 7 729)**	**Model 4 (n = 7 729)**	**Model 1 (n = 8 235)**	**Model 2 (n = 8 235)**	**Model 3 (n = 8 235)**	**Model 4 (n = 8 235)**
BMI (Ref: <25 kg/m^2)								
>=25 kg/m^2	0.638(.069)***	0.735(.080)**	0.748(.082)**	0.746(.081)**	0.604(.067)***	0.714(.081)**	0.717(.081)**	0.717(.081)**
Diabetes (Ref: No)								
Yes	1.410(.150)**	1.489(.159)***	1.514(.162)***	1.511(.161)***	1.780(.193)***	1.942(.213)***	1.946(.213)***	1.948(.213)***
Hypertension (Ref: No)								
Yes	1.210(.098)*	1.132(.092)	1.136(.093)	1.141(.093)	1.386(.138)**	1.277(.128)*	1.277(.128)*	1.278(.128)*
Hyperchloresterolemia (Ref: No)								
Yes	0.931(.092)	1.030(.104)	1.046(.106)	1.054(.107)	0.934(.095)	1.009(.107)	1.021(.108)	1.018(.108)
Current, regular smoker (Ref: No)								
Yes	0.952(.080)	1.030(.087)	1.011(.086)	1.015(.086)	1.533(.269)*	1.681(.302)**	1.659 (.298)**	1.655 (.298)**
Fruit & vegetable consumption per day (Ref: <5 cups)								
>= 5 & < 7 cups	0.837(.111)	0.908(.121)	0.928(.124)	0.925(.124)	0.799(.129)	0.849(.138)	0.855(.139)	0.855(.139)
>= 7.5 cups	0.477(.152)*	0.510(.163)*	0.518(.166)*	0.518(.166)*	0.983(.251)	1.058(.273)	1.084(.280)	1.091(.281)
Physical activity (Ref: Inactive)								
Active	0.661(.053)***	0.741(.060)***	0.744(.060)***	0.743(.060)***	0.668(.064)***	0.722(.075)**	0.778(.076)**	0.779(.076)*
-2Log likelihood (no covariates)	5 782.35	5 782.35	5 782.35	5 782.35	3 991.02	3 991.02	3 991.02	3 991.02
-2Log likelihood (with covariates)	5 749.81***	5 672.27***	5 668.68***	5 665.44***	3 949.31***	3 889.60***	3 888.49***	3 887.83***
Df	8	17	19	23	8	17	19	23
AIC	11 515.62	11 378.53	11 375.37	11 376.89	7 914.61	7 813.19	7 814.98	7 821.66
Number of failures	649	649	649	649	444	444	444	444

Note: Standard errors are shown in parenthesis. *, **, *** denote significance at p <.05, .01 and .001 respectively

Model 1 was not controlled by other covariates.

Model 2 was controlled by age in 2004, marital status, area of residence and geographical area.

Model 3 was controlled by age in 2004, marital status, area of residence, geographical area and education level.

Model 4 was controlled by age in 2004, marital status, area of residence, geographical area, education level and living arrangement.

Discussion

It can say that this is the first population-based study where trying to explore the relationship between CVDs risk factors and survival among the older persons in Thailand. It takes the advantage of applying the linkages between two potential data sources, NHES III and vital registration, to follow-up surviving people. Most of results are as the expectation. Firstly, this study indicates that both diabetes and hypertension are positively associated to mortality in older men as well as in women. However, the capability to predict the risk of dying relatively to non-diabetic and non-hypertensive ones by these predictors is stronger in older women than in men. This finding is consistent with Barrett-Connor and Wingard's study[19]. The explanation is that persons who have developed diabetes usually have other risks including hypertension, hypercholesterolemia and or obese. Once women develop these conditions and survive until old age they will face a heavier risk burden and mortality effect than in older men[20]. Secondly, besides diabetes and hypertension, current and regular smoking behaviour is a strong mortality predictor for women but not for men. It can be explained that smoking is common for males but this study cannot capture those who quit smoking. Consequently, we cannot find the significant association between smoking and mortality in older men. Thirdly, alike another studies[21,22], the preventive effect of physical activity to mortality can be found in this study, both in men and women. Thus, the awareness of being a physically active person should be in everyone's consideration. Lastly, this study also displays higher risk of dying for both men and women with below normal weight, comparing to normal and above normal weight people. It may be because of these people had developed some organ failures which introduced to weight loss prior to be interviewed. Some studies explained that BMI was a poor measure of body fat in older persons[23,24] and suggested to use waist-hip ratio (WHR) instead[23]. Moreover, many studies demonstrate the reverse-J or U shape relationship between BMI where classified into <18.5, 18.5-24.9, 25-29.9, 30-34.9, and 35+ kg/m^2 group and mortality[25-29]. The BMI classifications like these are not performed in this study due to very few deaths existing in very low and high BMI groups, one limitation of this study.

This study also has some other limitations which may affect to the results in this study. The first limitation is this study focuses only on all causes mortality. To find out more correct conclusions, deaths related to CVDs should be taken into account. Secondly, since the CVDs risky people usually have more than one CVDs risk factor, the interaction between each CVDs risk factor should be taken into account as well. The third limitation is that we cannot study all observations from NHES III due to inability of linking to death registration. We also face the limitation of not long enough follow-up. The replication of this study should be done again after longer duration of follow-up in order to confirm the ability of CVDs predictive risk factors in older Thai population. For policy implication, to make use of linking available data should be advocated to evaluate health status. In addition, this study underlines the importance of policy to control the cardiovascular risk factors especially the prevention and control of diabetes, hypertension and promote physical activity among Thai population.

Acknowledgements

We would like to acknowledge the National Health Examination Survey Office (NHESO) under Health System Research Institute (HSRI) and Bureau of Policy and Strategy (BPS) , Ministry of Public Health for providing us the NHES III and mortality data used in this study.

This study was approved by the Institute for the Development of Human Research Protections (IHRP), Ministry of Public Health, Thailand.

References

1. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. *Milbank Mem Fund Q* 1971; 49(4): 509 – 538.

2. Olshansky SJ, Ault AB. The fourth stage of the epidemiologic transition: the age of delayed degenerative diseases. *Milbank Q* 1986; 64(3): 355 – 391.

3. World Health Organization. The top ten causes of death. http://www.who.int/mediacentre/factsheets/fs310/en/index.html. Updated October 2008. Accessed Jan 12, 2009.

4. Yusuf S, Reddy S, Ôunpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. *Circulation* 2001; 104: 2746 – 2753.

5. Yusuf S, Reddy S, Ôunpuu S, Anand S. Global burden of cardiovascular diseases: part II: variations in cardiovascular disease by specific ethnic groups and geographic regions and prevention strategies. *Circulation* 2001; 104: 2855 – 2864.

6. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray C JL. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *Lancet* 2006; 367: 1747 – 1757.

7. World Health Organization and Public Health Agency of Canada. Preventing chronic diseases: a vital investment. Geneva: WHO; 2005.

8. Ministry of Public Heath. Public Health Statistics AD 2006. Nonthaburi: Bureau of Health Policy and Strategy; 2006.

9. Viseshakul D, Premwatana P, Chulrojanamontri V, Kewsiri D. The prevalence of three major risk factors of cardiovascular disease: (glucose intolerance, hypertension, hyperlipoproteinemia) in a sample of Thai social class 1. *J Med Assoc Thai* 1979; 62: 116 – 122.

10. Viseshakul D, Chaivatsu C, Soonthornsima P et al. Health screening survey to determine risk factors of cardiovascular diseases in a selected Thai population: a study in 1331 Thai government saving bank clerks. *J Med Assoc Thai* 1979; 62: 550 – 560.

11. Sitthi-Amorn C, Chandraprasert S, Bunnag SC, Plengvidhya CS. The prevalence and risk factors of hypertension in Klong Toey slum and Klong Toey government apartment houses. *Int J Epidemiol* 1989; 18(1): 89 – 94.

12. Tatsanavivat P, Klungboonkrong V, Chirawatkul A, Bhuripanyo K, Manmontri A. Chitanondh H, et al. Prevalence of coronary heart disease and major cardiovascular risk factors in Thailand. *Int J Epidemiol* 1998; 27(3): 405 – 409.

13. Petcharoen N, Prasartkul P, Gray R, Vapattanawong P. Adult mortality of cardiovascular disease by socioeconomic status in Thailand. *J Public Health Dev* 2006; 4(2): 61 – 72.

14. Sritara P, Cheepudomwit S, Chapman N, Woodward M, Kositchaiwat C, Tunlayadechanont S, et al. Twelve-year changes in vascular risk factors and their associations with mortality in a cohort of 3499 Thais: the Electricity Generating Authority of Thailand Study. *Int J Epidemiol* 2003; 32(3): 461 – 468.

15. Üstün TB, Chatterji S, Villanueva M, Bendib L, Çelik C, Sadana R, et al. WHO multi-country survey study on health and responsiveness 2000 – 2001. Geneva: World Health Organization; 2001 [cited 2008 Feb 9]. http://www.who.int/healthinfo/survey/whspaper37.pdf. Accessed Feb 9, 2009.

16. National Statistical Office. Report on the 1995 – 1996 Survey of Population Change. Bangkok: Statistical Data Bank and Information Dissemination Division; 1997.

17. National Statistical Office. Report on the 2005 – 2006 Survey of Population Change. Bangkok: Statistical Forecasting Bureau; 2007.

18. Cox DR, Oakes D. Analysis of survival data. London: Chapman & Hall; 1984.

19. Barrett-Connor E, Wingard D. Sex differential in ischemic heart disease mortality in diabetics: a prospective population-based study. *Am J Epidemiol*, 1983; 118(4): 489 – 496.

20. Juutilainen A, Kortelainen S, Lehto S, Rönnemaa T, Pyörälä K, Laakso M. Gender difference in the impact of type 2 diabetes on coronary heart disease risk. *Diabetes Care*, 2004; 27(12): 2898 – 2904.

21. Oguma Y, Sesso HD, Paffenbarger Jr RS, Lee I-M. Physical activity and all cause mortality in women: a review of the evidence. *Br J Sports Med*, 2002; 36(3): 162 – 172.

22. Newman AB, Simonsick EM, Naydeck BL, Boudreau RM, Kritchevsky SB, Nevitt MC, et.al. Association of long-distance corridor walk performance with mortality, cardiovascular disease, mobility limitation, and disability. *JAMA*, 2006; 295(17): 2018 – 2026.

23. Price GM, Uauy R, Breeze E, Bulpitt CL, Fletcher AE. Weight, shape and mortality risk in older persons: elevated waist-hip ratio, not high body mass index, is associated with a greater risk of death. *Am J Clin Nutr*, 2006; 84(2): 449 – 460.

24. Seidell JC, Visscher TL. Body weight and weight change and their health implications for the elderly. *Eur J Clin Nutr* , 2000; 54(suppl3): s33 – s39.

25. Breeze E, Clarke R, Shipley MJ, Marmot MG, Fletcher AE. Cause-specific mortality in old age in relation to body mass index in middle age and in old age: follow-up of the Whitehall cohort of male civil servants. *Int J Epidimiol*, 2006; 35(1): 169 – 178.

26. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. *JAMA*, 2005; 293(15): 1861 – 1867.

27. Katzmarzyk PT, Craig CL, Bouchard C. Original article underweight, overweight and obesity: relationships with mortality in the 13-year follow-up of the Canada Fitness Survey. *J Clin Epidemiol*, 2001; 54: 916 – 920.

28. Taylor DH, Østbye T. The effect of middle- and old-age body mass index on short-term mortality in older people. *JAGS*, 2001; 49(10): 1319 – 1326.

29. Strawbridge WJ, Wallhagen MI, Shema SJ. New NHLBI clinical guidelines for obesity and overweight: will they promote health? *Am J Public Health*, 2000; 90(3): 340 – 343.