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Physical activity reduced hypertension in the elderly and cost-effective

Robert D. Gandasentana* and Rina K. Kusumaratna**

ABSTRACT

*Department of Anatomy Pathology, Faculty of Medicine. Trisakti University
**Department of Community Medicine, Faculty of Medicine, Trisakti University

Correspondence
Dr. Robert D. Gandasentana, dr, MS
Department of Anatomy Pathology,
Medical Faculty,
Trisakti University
Jalan Kyai Tapa no. 260, Grogol
Jakarta Barat – 11440
Phone: 021-5672731 ext.2703
Email: robsentana@yahoo.com

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Sedentary lifestyle gives rise to important health problems in the world, such as cardiovascular disorders and hypertension. Hypertension is an important modifiable risk factor for cardiovascular disease and is the most significant risk factor for stroke. There is mounting evidence that physical activity is beneficial for the elderly, and may have positive effects on chronic disorders, such as hypertension. The purpose of the present study was to assess the effectiveness of physical activity for reducing hypertension and the healthcare costs of hypertension in the elderly. This cross-sectional study, conducted from August to October 2009, involved 237 community-dwelling elderly in one district of South Jakarta, comprising 86 males and 151 females aged 66.4 ± 6.3 years. Data on background characteristics were collected using a validated questionnaire, while physical activity was assessed using the short version of the International Physical Activity Questionnaire. Results showed that 32.9% elderly was physically active and 67.1 % less physically active. The overall prevalence of hypertension was 18.6%, while there was no significant difference of hypertension between male and female elderly (p=0.737). The risk for hypertension in the physically active group was 0.40 times lower than that in the less physically active group (OR = 0.40; 95% C.I. 0.16 – 0.97), leading to annual healthcare cost savings in the physically active group of 60%. In conclusion, physical activity reduces hypertension and the associated healthcare expenditure among community-dwelling elderly.

Key words : Physical activity, hypertension, cost-effectiveness analysis, elderly

INTRODUCTION

The aging individual is subject to a reduction in musculoskeletal mass, which is largely due to physical inactivity, as most elderly are commonly unemployed or retired and generally pay less attention to their physical health. In addition, the elderly frequently suffer from chronic diseases, particularly hypertension and other cardiovascular disorders. A World Health Organization (WHO) report estimated that 80% of adults aged 65

years and older has more than one chronic health condition and that 50% has more than two chronic health conditions.[1] Hypertension is an independent and powerful prognostic indicator for cardiovascular and renal disease, whereas it is significantly associated with the increased morbidity and mortality from cerebrovascular disease, myocardial infarction, congestive heart failure and renal insufficiency.[2,3] Arterial hypertension is highly prevalent in the elderly, and according to the National Health and Nutrition Examination Survey III Study, its prevalence rate for subjects >60 years old (white non-Spanish speaking Americans) is estimated to be >60%.[4] Hypertension prevalence increases with advancing age and is higher in men than in women until the age of 55 years, but is slightly higher in postmenopausal women.[5] Hypertension is the major risk factor for stroke, heart failure, and coronary artery disease in older adults, while all of these disorders are important contributors to mortality and functional disability. Hypertension is defined as a systolic blood pressure of 140 mmHg or greater and/or a diastolic blood pressure of 90 mmHg or greater. Isolated systolic hypertension is defined as a systolic pressure of 140 mmHg or greater with a diastolic pressure of less than 90 mmHg.[6] According to the most recent National American Guidelines for Hypertension, values of 120-139 mm Hg and 80-89 mmHg, for systolic and diastolic blood pressure respectively, are characterized as a precursor stage of hypertension, since these values are being associated with increased risk of hypertension development compared to lower values of arterial pressure.[7] Sedentary lifestyle is a major risk factor for cardiovascular disease and being physically active reduces risk by 40%.[8]

Several studies support the important role of physical activity for both primary and secondary prevention of cardiovascular diseases,[9] and according to epidemiological evidence there exist positive associations between regular physical activity and health benefits.[10] The WHO recommends at least 30 minutes of regular, moderate-intensity physical activity on most days of the week to reduce the risk of diseases.[10] To change physical activity behavior and promote regular physical exercise among community-dwelling elderly, there is a need for cost-effectiveness analyses using standardized methods to determine the costs and benefits of participation in physical activity.[11]

Outside of Indonesia, a large number of interventions have been conducted to promote physical activity, ranging from individual counseling by general practitioners to mass-media campaigns. The cost-effectiveness of several interventions have been evaluated using various methodologies. Cobiac et al.[8] performed cost-effectiveness analyses on six intervention programs, and concluded that all six could lead to substantial improvement in population health at a cost saving to the health sector.

Cobiac and colleagues modelled the costs and health outcomes associated with interventions to improve physical activity in the population, and identify specific interventions that are likely to be cost-saving. Rubinstein et al.[12] used generalized cost-effectiveness (GCE) analysis, a WHO-designed methodology, to evaluate a CVD reduction intervention package in Buenos Aires.

Despite the high prevalence of hypertension in older adults, it should not be considered a normal consequence of aging. Primary hypertension is the result of multiple conditions, such as genetic, nutritional, psychosocial, and life style factors. One of the life style factors leading to hypertension is obesity, which is usually related to a sedentary life style and inadequate physical activity. Therefore one way to prevent hypertension or at least decrease the risk of hypertension is to perform habitual physical activity (exercise), including work-related activity and activities of daily living.

In general, cost-effectiveness analysis has been used by governments and international

organizations for analyzing the efficiency of alternative programs, including healthcare intervention programs, such as promotion of physical activity among population groups.

However, the principles of cost-effectiveness analysis are presumably universal, and may therefore be applied at the level of the individual, especially where large healthcare expenditures are to be borne by the individual concerned. This is particularly true for most of the middle- to low-income groups of Indonesian elderly, as many, if not all, of them have no health insurance cover, apart from free but extremely restricted health insurance for the poorest, provided by the provincial governments.

In view of the foregoing, the aim of the present study was to conduct a cost effectiveness analysis of physical activity in relation to primary hypertension in community-dwelling elderly, in order to provide evidence of the economic benefits of physical activity in hypertensive individuals.

METHODS

Research design

The study was an observational cross-sectional study to determine the cost-effectiveness of physical activity among community-dwelling elderly with hypertension, conducted from August to October 2009.

Study subjects

The population under study comprised community-dwelling elderly residing in the vicinity of a primary community health center in South Jakarta. Inclusion criteria were: age 60 years and older, male or female gender, mobile and independent, able to verbally communicate, and apparently healthy. The participants' health status was determined by self-reported medical history and by physical examination during recruitment, and cross-checked with their medical record at the heath center. The sample size was determined to be around 229 subjects, based on a power of 95% and expected dropout of 20%. The subjects were recruited from a district in South Jakarta with a relatively high number of elderly persons of low to medium socioeconomic status among the permanent residents, as indicated by official data from the District Health Office *(Sudinkes)*. Cluster random sampling was used to determine the participating villages in the district and the numbers of hamlets (*RW)* and *RT* required to yield the calculated sample size. In Indonesia, *RT*s are the smallest administrative units comprising around 20 households, similar to neighborhood associations. The study sample consisted of community dwelling elderly selected from each *RT* in five villages by proportionate simple random sampling. The subjects meeting the inclusion and exclusion criteria gave written informed consent, confirmed by signature for the literate and by thumbprint for the illiterate.

Physical activity assessment

Physical activity among the participants was evaluated by a modification of the Short Format International Physical Activity Questionnaire (SF-IPAQ), recommended by the WHO to measure physical activity among adults from 15–69 years.[13] As a consequence, this study could assess only the physical activity status of elderly aged 60–69 years. The 9-item short form assesses time spent on different activities. The short form of IPAQ records four types of physical activity: vigorous activity such as aerobics; moderate-intensity activity such as leisure cycling; walking; and sitting. The IPAQ-SF contains questions on the frequency (number of days per week), duration (total time spent in physical activity per day), and intensity of physical activity over the previous week (light, moderate, and vigorous). After assessment of physical activity, the subjects were assigned to two groups, i.e. one group with moderate to high levels of physical activity, and one group with low levels of physical activity, designated in the present study as the physically active group and the less physically active group, respectively.

Blood pressure measurement

Two sitting blood pressure (BP) measurements were taken for all subjects and the mean value was used to determine BP status: hypertensive (systolic BP ≥140 mm Hg, diastolic BP ≥90 mm Hg, or not.

Body mass index

Height was measured with microtoise with a precision of 0.1 cm. Weight was measured with Sage portable scales with a precision of 0.1 kg. Body mass index (BMI) was calculated as the weight (kg) divided by the square of the height (m^2). For Asian populations, BMI is classified into the following categories: underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23.0–27.5 kg/m^2), and obese (> 27.6 kg/m^2).[14]

Cost-effectiveness analysis

Cost-effectiveness analysis (CEA) generally considers the costs and effects of adding new interventions to current practice or the cost of replacing an existing intervention with another targeting the same condition. The CEA in this study indicated that for hypertensive patients attending a health center (*Puskesmas*), the health care expenditure including medications was approximately Rp. 12,000 at the time of the study. Patients with hypertension are usually advised to visit their physician once weekly for follow-up, until their BP is adequately controlled, with a systolic BP of <140 mmHg and a diastolic BP of <90 mmHg.[15] Therefore the annual healthcare costs for regular follow-up at a health center is approximately Rp. 624,000.

Ethical clearance

Ethical clearance was issued by the Research Ethics Committee, Faculty of Medicine, Trisakti University.

Statistical analysis

The background characteristics were analyzed using descriptive statistics, after checking for normal distribution by the Kolmogorov-Smirnov test of normality. Cost-effectiveness of physical activity was analyzed using the odds ratio as a measure of the risk of hypertension among the physically active subjects as compared with the risk of hypertension in the less physically active subjects. The level of significance was set at $p<0.05$.

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RESULTS

Background characteristics of the elderly

A total of 237 elderly people aged 60–69 years from eight hamlets in the five sub-districts participated in the present study. The socio-economic status of the subjects consisted of education, history of employment, income sources, health services, history of occupation as well as their housing status. Regarding the distribution of socio-economic status of the study subjects, among the 237 elderly there were 138 (58.2%) in the age range of 60-64 years and 99 (41.8%) in the age range of 65-69 years. Overall mean age was 63.9 ± 2.6 years. With regard to gender, the subjects comprised 86 (36.3%) males and 151 (63.7%) females. The majority (77.2%) of the elderly had been educated and most of them in their youth had received their formal education at religious elementary schools. With regard to marital status, approximately half of them (55.7%) was widowed or unmarried. A total of 60.8% of the elderly did not have regular income for supporting their daily life and most of the income came from their children. Only 13.5% of the elderly had insurance and for access to health services, most of them had the *Kartu Miskin* (health services card for the poor). Around 80.6% of the elderly lived in their own house (Table 1). The prevalence of hypertension was 18.6%, while 32.9% was physical active (Table 2).

There was no significant difference in the prevalence of hypertension between males and females. Similar results were obtained for nutritional status and smoking habits. The results

Table 1. Socio-economic and demographic profile of the participants (n=273)

Variables	n (%)
Age	
60-64	138 (58.2)
65-69	99 (41.8)
Gender	
Male	86 (36.3)
Female	151 (63.7)
Education	
Illiterate	54 (22.8)
Educated	183 (77.2)
Marital status	
Married	105 (44.3)
Widowed/unmarried	132 (55.7)
Income sources	
Regular	93 (39.2)
Non-regular	144 (60.8)
Health services	
Insurance	32 (13.5)
Non-insurance	205 (86.5)
History of occupation	
Enterpreneur	25 (10.5)
Laborer	19 (8.0)
Goverment employee	19 (8.0)
Merchant	35 (14.8)
Unemployed	139 (58.6)
Housing status	
Own	191 (80.6)
Not own	46 (19.4)

Table 2. Nutritional, health status, and physical activity of the elderly (n=273)

Variables	n (/%)
Nutritional status	
BMI* kg/m^2 (Mean ± SD)	21.80 ± 4.04
Underweight	55 (23.2)
Normal	95 (40.1)
Overweight	87 (36.7)
Health status	
Chronic	186 (78.1)
Non-chronic	51 (21.5)
Hypertension	
Yes	44 (18.6)
No	193 (81.4)
Physical activity	
Active	78 (32.9)
Les active	159 (67.1)

*BMI = Body Mass Index

indicated that for elderly with adequate physical activity, the risk of hypertension was 0.4 times lower, as compared with the less physically active elderly (O.R.=0.4; 95% Confidence Interval 0.16 – 0.97) (Table 3).

Cost-effectiveness of physical activity

Cost-effectiveness analysis was used to evaluate the impact of physical activity on hypertension, by assessing the risk of hypertension in the physically active group as compared to the risk of hypertension in the less physically active group.

The prevalence of elderly with hypertension was 10.3% in the physically active group and 22.0 % in the less physically active group. These data indicate that there were significantly more elderly with hypertension in the less physically active group than in the physically active group (p=0.027). The risk for hypertension in the physically active group was 0.40 times lower than that of the less physically active group as shown in Table 3. This signifies that the risk of suffering from hypertension among elderly who were physically active was significantly lower than in elderly who were less physically active.

From Table 4 it is apparent that the cost of a patient in the health center is Rp.12,000 per ambulatory visit, amounting to 52 x Rp.12,000 = Rp.624,000 per year. In subjects who are physically active, the risk of hypertension was 0.40 lower, such that the total cost per year amounts to Rp.249,600, yielding a 60% reduction in healthcare expenditure, compared to subjects who are less physical active.

DISCUSSION

For the 237 subjects of the present study, the prevalence of hypertension was 18.6%. A study in Costa Rica on elderly aged 60 to 80 years (mean age = 76 years) yielded differing results, the prevalence of hypertension being 65.0%.[16] This may have been due to the higher

Table 3. Risk factors of hypertension in the elderly (n=237)

Risk factors	Hypertension		p
	Yes (n= 44,/%)	No (n=193,/%)	
Gender			
Male	15 (17.4)	71 (82.6)	0.737
Female	29 (19.2)	122 (80.8)	
Age (years)			
60 – 64	25 (18.1)	113 (81.9)	0.934
65 – 69	18 (18.9)	77 (81.1)	
≥ 70	1 (25.0)	3 (75.0)	
Smoking			
Yes	8 (17.0)	39 (83.)	0.761
No	36 (18.9)	154 (81.1)	
Nutritional status			
Underweight	9 (16.4)	46 (83.6)	0.709
Normal	24 (18.0)	109 (82.0)	
Overweight	11 (22.4)	38 (77.6)	
Physical activity			
Active	8 (10.3)	70 (89.7)	0.027
Less active	35 (22.0)	124 (78.0)	O.R.* = 0.40 (95% C.I.=0.16-0.97)

* O.R.=odds ratio C.I.= confidence interval

age of the subjects, whereas the elderly in our study were relatively younger, with a mean age of 63.9 years.

Our study showed that the risk for hypertension in the physically active group was 0.40 times lower than that of the less physically active group as shown in Table 3. Similar results were obtained in a prospective study of 27,055 apparently healthy women, where vigorous physical activity (1500 Kcal/week) led to a reduction in the incidence of hypertension (R.R. = 0.62;95% C.I. (0.51–0.74;p< 0.001).[17] A study in Australia showed similar results, in that the prevalence of poor physical activity was higher among the hypertensive elderly.[18]

Many epidemiologic observational studies have reported a consistent inverse association between physical activity and the risk of incident cardiovascular diseases.[19] Even at an advanced age, becoming more active still confers a reduction in coronary heart disease mortality.[20] The cardio-protective effect of physical activity may be related to its beneficial effects on body weight, blood pressure, serum cholesterol and glucose tolerance.[21]

Cobiac et al.[8] analysed cost-effectiveness of six physical activity intervention programs in community-dwelling frail elderly taken from a larger number of meta-analyses. Their analysis indicated that these interventions would be cost-

Table 4. Costs, effects and cost-effectiveness of physical activity on hypertension

Iitervention	Cost per ambulatory visit	Cost-effectiveness per year	Reduction
	HC*	HC*	HC*
Physical activity	12,000,-	374,400,-	60.0%

* HC : health center

saving to the health sector, leading to substantial improvements in health for the Australian population. Although the studies analyzed by Cobiac et al.[8] differed from the present study in South Jakarta in several respects, one of them being that their subjects were frail elderly, their findings were similar to the results of cost-effectiveness analysis of the present study regarding the cost-savings of physical activity in the elderly.

The pragmatic, single-blind randomized clinical trial conducted by McCarthy et al.,[22] showed that a home-based exercise program supplemented with an 8-week class-based exercise program yielded significantly better results even 12 months after cessation of the intervention, while their economic evaluation suggested that structured physical activity programs are likely to be cost-effective. The findings of the McCarthy study that elderly conducting regular physical activity have cost-savings in health care expenditure, therefore are consistent with the results of abovementioned study, although differing in study design.

The beneficial effect of regular exercise in hypertension is not limited to reduction of blood pressure only. It has also been shown to reduce left ventricular hypertrophy,[23] and improve exercise capacity and quality of life.[24] When combined with dietary alterations, regular exercise causes reduction of oxidative stress, increases nitric oxide availability and improves the overall metabolic profile.[25] Recently published large prospective epidemiological studies have reported physical inactivity as a predictor of not only cardiovascular but also total mortality in middle-aged men and women.[26,27] This association is strong, and independent of other major risk factors, and illustrates the enormous preventive potential of regular exercise, especially given the high prevalence of a sedentary lifestyle in most communities. It also implies that physical activity also has a protective effect on noncardiovascular mortality, although the beneficial mechanisms are not clearly understood.

In general, blood pressure rises with age, certainly up to the seventh decade. The rise is more marked for systolic pressure and is more pronounced in men. Hypertension needs life-long medical control. Once the subject has been diagnosed as suffering from hypertension, he or she is obliged to take antihypertensive medications for life, thus becoming a burden to the family and society. Ideally, the hypertension patient has to visit his or her physician for control of the disorder at regular intervals of one week.

For the calculation of cost of healthcare in health centers, the present study used the standard healthcare costs as determined by the Department of Health.[28] The cost savings for the physically active subjects in comparison to the less physically active subjects was 60%.

It is apparent that regular physical activity in older persons results in healthcare cost savings due to reduced risk of hypertension. The cost-effectiveness measured in the present study is seen from the viewpoint of the study subjects (on a micro scale), as most did not have health insurance and had to pay for health services out of their own pocket.

Several limitations of the present study should be taken into consideration. As physical activity was assessed by self-report, it is possible that more precise assessment of this factors may have resulted in a different contribution of this variable to the reduction in hypertension. We also did not have information on other variables that are favorably influenced by physical activity, such as those related to heart rate or autonomic balance, or insulin sensitivity, so we could not evaluate their contributions to the inverse relation between physical activity and hypertension risk.

CONCLUSIONS

The prevalence of hypertension in the elderly was 18.6%, while 67.1 % of the subjects was less physically active. The risk of hypertension among the elderly who were physically active was 0.4 lower compared to less physically active elderly. In the economic

evaluation the physically active group had higher annual healthcare cost savings of approximately 60%. Future randomized controlled studies will be needed to confirm the potential beneficial effect of physical activity on health status of the elderly and the attendant reduction in healthcare expenditure.

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