

Effects of Physical Activity on the Frequency of and Medical Expenses Incurred for Treating Diabetes and Hypertension in Japan

Masakazu Furukawa*

Graduate School of Agricultural and Life Sciences, The University of Tokyo, 1-1-1, Yayoi, Bunkyo-ku, Tokyo, 113-8657, Japan

Abstract

Increasing of obesity people is a global health problem in a lot of countries including Japan. Promoting policies to increase the awareness of and changed attitudes toward physical activity and encouraging greater participation from people in such an activity is important from the perspective of sound financing policies for health care in Japan. This paper's purpose is to test the hypothesis that physical activity affects the frequency of and the medical expenses incurred for treating diabetes and hypertension in a prefecture.

This study's data were taken from the Family Income and Expenditure Survey, Patient Surveys, the Survey of Physicians, Dentists and Pharmacists, the Report on Health Center Activities and Health Services for the Aged, and Social Indicators by Prefecture. The method is least-squares regression analysis with prefectural data. Physical activity is defined by sports-related expenses as a proxy variable. The variable of medical expenses incurred for treating hypertension and diabetes is defined as the money spent on medical treatment for each household. The frequency of diabetes and hypertension is defined as data per 100,000 people.

The results showed that sports-related expenses were negatively related to the frequency of and the medical expenses incurred for treating diabetes and hypertension. The coefficients of the following factors are as given medical expenses incurred for the treatment of diabetes and hypertension: -0.00585 , coefficient of the frequency of diabetes: -0.4942 , and coefficient of the frequency of hypertension: -0.1005 . Since all the three factors are negative values, it shows that physical activity has the possibility to reduce both medical expenses incurred for treating of diabetes and hypertension and frequency of diabetes and hypertension.

Keywords: Sports-related expenses; Physical activity; Medical expenses; Diabetes; Hypertension

Introduction

Increasing of obesity people is a global health problem in a lot of countries including Japan. Obesity is associated with a variety of health problems. For improvement and prevention of obesity, physical activity is important. The Japanese government is promoting policies to increase the awareness and changed attitudes toward physical activity and is encouraging greater participation from people in such an activity. With the vital nature of such policies from the perspective of sound financing policies for health care, several countries are already engaged in research of the relationship between medical expenses incurred by people and their level of physical activity that they involve themselves in. Shephard [1] made analyzes of exercise programs for senior citizens in Canada. He also estimated the medical savings possible if cardiopulmonary functions are maintained and raised by 20% through cardio-respiratory exercise programs for senior citizens. The Hillary Commission [2] estimates that yearly medical expenditures can be reduced by \$4,800 per capita if the percentage of those who do not exercise is reduced from 31% to 21%. The Canadian Fitness and Lifestyle Research Institute [3] estimated the amount saved on direct medical expenses for cardiovascular disease by a 1% reduction of the number of Canadian citizens not actively involved in regular exercise. The Institute also reported that the increase in the number of people involved in exercise equivalent to walking over an hour a day from 21% of the population in 1981 to 37% in 1995 saved \$700 million (Canadian). In Australia, Daset [4] made calculations about the savings in medical expenses and estimated that a 5% drop in cardiovascular disease and lower back pain could be gained through physical exercise. Colditz [5] indicated that increased medical expenses due to lack of exercise stand at US \$24.3 billion, equivalent to approximately 2.4% of total medical expenditures. Pratt et al. [6] calculated the yearly direct

medical expenses for men and women over the age of fifteen in the United States. Expenses for those who exercise regularly are \$1,019, but \$1,349 for those who do not exercise, showing the possibility of reduced medical expenditure through improving a regime of physical exercise. In Canada, Katzmarzyk et al. [7] estimated the economic costs of physical inactivity. The study indicated that the economic burden of physical inactivity was \$5.3 billion and represented 2.6% of the total health care costs in Canada. Oldridge [8] indicated that physical inactivity was associated with considerable economic burden in developed countries. Zhang et al. [9] estimated the total economic burden of physical inactivity in China, and indicated that physical inactivity was imposing a substantial economic burden on the country. Bueno et al. [10] described the annual drug expenditures for the hypertensive and diabetic Brazilian, and analyzed the association with physical activity level and engagement in walking. The study showed that the annual expenditures of the use of medicines for controlling hypertension and diabetes of Brazilian elderly were inversely associated with physical activity level and engagement in walking.

In comparison with the research made in these countries, there is very little research on medical expenses and physical activity for Japanese people. One of the few studies is by Tsuji et al. [11]. That

*Corresponding author: Masakazu Furukawa, Graduate School of Agricultural and Life Sciences, The University of Tokyo, 1-1-1, Yayoi, Bunkyo-ku, Tokyo, 113-8657, Japan, Tel: +81-3-58418182; E-mail: furukawamasakazu@gmail.com

Received February 26, 2018; Accepted March 19, 2018; Published March 26, 2018

Citation: Furukawa M (2018) Effects of Physical Activity on the Frequency of and Medical Expenses Incurred for Treating Diabetes and Hypertension in Japan. Health Econ Outcome Res Open Access 4: 151. doi: [10.4172/2471-268X/1000151](https://doi.org/10.4172/2471-268X/1000151)

Copyright: © 2018 Furukawa M. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

study indicated that time spent walking was significantly associated with lower medical costs. Nagai [12] showed that people who spend more time walking require a lower lifetime medical expenditure from 40 years of age.

This study used household sports-related expenses as a proxy variable of physical activity. Having clarified the relationship between physical activity and medical expenses through least-squares regression analysis with prefectural data, the aim of this research is to contribute to reducing medical expenses. In addition, this research intends to shed light on the relationship between physical activity and the incidence of diabetes and hypertension for Japanese people, following in the steps of studies showing a higher degree of diabetes and hypertension for those not engaged in physical activity [13,14]. It is also hoped this research will have implications for future policies on health improvement.

Methods

Data and hypothesis

The data used in this study were taken from the Family Income and Expenditure Survey, Patient Surveys, the Survey of Physicians, Dentists and Pharmacists, the Report on Health Center Activities and Health Services for the Aged, and Social Indicators by Prefecture. Data were used in principle with prefectures as the base units. Data from the Family Income and Expenditure Survey were taken from the prefectural capital.

From the Family Income and Expenditure Survey, we used the spending of medical treatment for each household, hereinafter referred to as medical expenses. The total amount spent in a single household on physical activity or sports equipment (such as golf equipment), sports clubs or use of sports or training facilities gave us sports-related expenses. The Patient Surveys allowed us to make use of data on the frequency of diabetes and hypertension per 100,000 people. The Survey of Physicians, Dentists and Pharmacists gave us the number of physicians by region for every 100,000 people. This is henceforth referred to as the number of physicians. The Report on Health Center Activities and Health Services for the Aged allowed us to calculate the ratio of those over the age of 40, using data on the numbers of those who have had basic health checkups. This will be referred to as the medical checkup percentage. Also, using data on the number of group health education events allowed us to calculate the number of events for every 100,000 people over the age of 40. This is referred to as the frequency of medical education. Social Indicators by Prefecture allowed us to use data acquired on the percentage of those over 65, the population density per 1 km² of arable land and per capita income. These are hence referred to as the ratio of elder citizens, population density and citizen income.

The available data is for the years 2000 and 2001. However, the 2000 and 2001 values for frequency of diabetes and hypertension were calculated linearly with the use of data from the Patient Surveys for 1999 and 2002. This is because the Patient Surveys are held once every three years. The number of physicians in 2001 was similarly calculated linearly on a graph using 2000 and 2002 data for similar reasons, because the Survey of Physicians, Dentists and Pharmacists is taken every two years.

Method and hypothesis

Firstly, the purpose of this study is to clarify the relationship between medical expenses and physical activity. The dependent variable is medical expenses. The independent variables are sports-

related expenses, population density, number of physicians, percentage of medical checkups, frequency of medical education, income and the ratio of elder citizens. The amount of sports-related expenses is a proxy variable of physical activity. This is based on the assumption that households with the high expenses on sports-related activities will have a higher frequency of daily physical activity. Factors of medical supply and demand that are considered to have a great impact in general on medical expenses have been selected as the other independent variables. As an example, the ratio of elder citizens was used to reflect the factor of increasing medical expenses due to the worsening of health accompanying old age. The number of physicians is used as a variable for access to treatment. The differences in population and size of each prefecture have been adjusted by the use of population density as a variable. Percentage of checkups has been used as a variable showing short-term increases in medical expenses by early detection of disease with checkups. Frequency of medical education is used to reflect the impact on medical expenses of the prevention of disease encouraged by medical education. Income is used for factors showing price changes in medical services and production factors and general price fluctuations. All variables were converted to logarithmic scale.

We used the method of least-squares regression for quantitative analysis. This method provides the rationale to determine the best fit line that explains the relationship between an independent variable and a dependent variable. For the analysis, prefectural data for 2000 and 2001 are used. This analysis with panel data is able to control the differences among the prefectures we cannot predict. A year dummy variable was also added in the analysis to control the unobservable factors, such as revision of medical treatment fees. The optimum model was chosen through the use of F-tests and the Hausman Test.

The next step is to clarify the relationship between the frequency of diabetes and hypertension and physical activity. The dependent variables are the frequency of diabetes and hypertension. The independent variables are sports-related expenses, population density, number of physicians, percentage of checkups, frequency of medical education, citizen income and the ratio of elder citizens. These are also subject to the least-squares regression analysis with prefectural data for 2000 and 2001. The optimum model was chosen through the use of F-tests and the Hausman Test.

Our hypotheses are as follows. Sports-related expenses are significantly negatively related to medical expenses and the frequency of diabetes and hypertension. Accordingly, physical activity suppresses the increase of medical expenses and reduces the incidence of diabetes and hypertension.

Results

The descriptive statistics are shown in Table 1.

The data in Table 1 are not yet transformed into logarithms. As a result of the F-test and the Hausman Test, the fixed effect models were adopted in all equations, and the necessity of estimates in consideration of fixed effects was recognized. And as a result of the White Test, the hypothesis of homoscedasticity was rejected. Hence, a White correction for heteroscedasticity has been made in response to this problem. The estimated results of the fixed effect models are shown in the Tables 2 and 3.

Table 2 shows the estimated result with medical expenses as a dependent variable. Sports-related expenses, which is a proxy variable of physical activity, was significantly related to medical expenses. The

	Mean	Standard deviation	Minimum	Maximum
Medical Expenses (yen)	37103.78	5101.01	28664	53467
Diabetes (person)	168.38	34.65	90	282.67
Hypertension (person)	536.36	100.38	307.67	732
Sports (yen)	60512.06	11315.35	36517	102919
Dens (person)	1363.4	1621.02	259.3	8696.1
Physician (person)	207.27	36.52	121.7	272.65
Check (%)	15.48	5.5	5.41	29.14
Education (times)	530.05	205.51	30.68	962.21
Income (thousand yen)	2802.41	361.67	2067	4319
Elder (%)	19.46	2.92	12.8	25.5

Note: The number of samples is 94. The values are before transformation of logarithms.

Table 1: Descriptive statistics.

Fixed Effect Model			
	Equation (1)	Equation (2)	Equation (3)
Dependent Variable	Medical Expenses		
Independent Variables			
Sports	-0.00585**	-0.00779*	-0.00880**
Dens	0.93838	1.63044	0.51389
Physician	2.11823**	1.84103**	2.31247**
Check	0.21406*	0.32271***	
Education	0.36498*		0.42653**
Income	-0.96168	-0.94579	-1.01675
Elder	0.8398	0.38407	0.84887
Adjusted R2	0.37112	0.36972	0.3809
Number of samples	94	94	94

Note: p<0.01; ***, p<0.05; **, p<0.1; *

Table 2: Estimated results of the fixed effect models with medical expenses as a dependent variable.

Fixed Effect Model		
Dependent Variable	Equation (4)	Equation (5)
Independent Variables	Diabetes	Hypertension
Sports	-0.04942**	-0.01005**
Dens	-2.36449**	-1.08111
Physician	1.81921***	0.64756
Check	0.17761**	0.03048
Education	0.17702**	0.09593
Income	-0.45913**	-0.31081*
Elder	0.78916**	0.74553**
Adjusted R2	0.46987	0.4753
Number of samples	94	94

Note: p<0.01; ***, p<0.05; **, p<0.1; *

Table 3: Estimated results of the fixed effect models with the frequency of diabetes and the frequency of hypertension as a dependent variable.

coefficient was a negative value of -0.00585 . This means that a 10% rise in sports-related expenses would bring about a 0.0585% reduction of medical expenses. This outcome backs up the hypothesis that physical activity reduces medical expenses. All other independent variables also showed significant relation to medical expenses.

Table 3 shows the estimated result with the frequency of diabetes as a dependent variable. Sports-related expenses, which is a proxy variable of physical activity, was significantly related to the frequency of diabetes. The coefficient was a negative value of -0.4942 . This means that a 10% rise in sports-related expenses would bring about a 0.4942% reduction in the frequency of diabetes. This outcome backs up the

hypothesis that physical activity reduces the frequency of diabetes. All other independent variables also showed significant readings, with the exception of population density.

The estimated result with the frequency of hypertension as the dependent variable was significant for sports-related expenses, the coefficient being a negative value of -0.01005 . This means that a 10% rise in sports-related expenses would bring about a 0.1005% reduction in the frequency of hypertension. This outcome backs up the hypothesis that physical activity reduces the frequency of hypertension. Citizen income and the ratio of elder citizens were also significant.

Discussion

There are a number of policies in place to encourage physical activity in Japan. The outcome of this study shows that physical activity is capable of reducing household medical expenses and of reducing the frequency of diabetes and hypertension. This certainly has implications for planning health improvement policies and for sound financial administration of medical insurance. A particular point here is that in research conducted on Japanese people up to now, the extent of the capability of physical activity to reduce medical expenses was unclear. Sports-related expenses for all households in Japan in 2001 were ¥61,125 per household, while payments by patients of Japanese national medical expenditure amounted to ¥4.4588 trillion. Though our calculations may be overly simplified, the result of this study's analyzes show that a 10% increase in sports-related expenses, meaning an increase of ¥6,112.5 worth of physical activity for each household, has the potential to reduce medical expenditure by ¥450 billion. The total amount spent in a single household on physical activity or sports equipment (such as golf equipment), sports clubs or use of sports or training facilities was used as a proxy variable of physical activity in this study's analyzes, but it may also serve as one guideline for policy planning. However, these expenses show the monetary involvement in physical activity but not the actual intensity of physical activity. It must be borne in mind that there will be differences in intensity of physical activity due to the type of physical activity, even with the same financial investment. There is also the possibility of differences in the family between those who provide the money for sports or physical activity and those actually involved in physical activity. In the future, more detailed research, such as analysis using individual data and analysis of the reductive effect on medical expenses of different kinds of physical activity, will be required for the implementation of effective health improvement projects.

The outcome of this study is highly significant in that it shows how the frequency of two different types of disease may be reduced through physical activity. The study concentrated on the frequency of diabetes and hypertension, a focus that offered the opportunity of gaining more data on the correlation between physical activity and obesity, which has been attracting increasing attention, and of gaining more data relevant to the findings of the Japan Society for the Study of Obesity that diabetes and hypertension are related to and caused by obesity, and obstruct weight loss [15]. Further clarification of the relationship between the frequency of diseases and medical expenses, analysis using long-term data, and minimization of those medical expenses through physical activity, is anticipated.

Conclusion

This study indicated that physical activity was capable of reducing household medical expenses and to reduce the frequency of diabetes and hypertension.

Acknowledgement

I am grateful to Dr. Shuzo Noshimura, Professor of Kyoto University, for useful discussions. I would also like to thank the members of Institute of Economic Research, Kyoto University. I would like to thank Enago for the English language review.

References

1. Shephard RJ (1979) *Physical activity and aging*. Croom Helm, London.
2. Hillary Commission for Sports, Fitness and Leisure (1993) *The business of sport and leisure*, summary report.
3. Canadian Fitness and Lifestyle Research Institute (1997) *Physical activity benchmarks, highlights reports*.
4. DASET (1998) Australian Department of the Arts, Sport, the Environment, Tourism and Territories, *The economic impact of sport and recreation, regular physical activity*. p: 2.
5. Colditz GA (1999) Economic costs of obesity and inactivit. *MSSE* 31: S663-S667.
6. Pratt M, Macera CA, Wang G (2000) Higher Direct Medical Costs Associated With Physical Inactivity. *Phys Sportsmed* 28: 63-70.
7. Katzmarzyk PT, Janssen I (2004) The Economic Costs Associated With Physical Inactivity and Obesity in Canada: An Update. *Can J Appl Physiol* 29: 90-115.
8. Oldridge NB (2008) Economic burden of physical inactivity: healthcare costs associated with cardiovascular disease. *Eur J Cardiovasc Prev R* 15: 130-139.
9. Zhang J, Chaaban J (2013) The economic cost of physical inactivity in China. *Prev Med* 56: 75-78.
10. Bueno DR, Marucci MDFN, Gobbo LA, de Almeida-Roediger M, de Oliveira Duarte YA, et al. (2017) Expenditures of medicine use in hypertensive/diabetic elderly and physical activity and engagement in walking: cross sectional analysis of SABE Survey. *BMC Geriatr* 17: 70.
11. Tsuji I, Takahashi K, Nishino Y, Ohkubo T, Kuriyama S, et al. (2003) Impact of walking upon medical care expenditure in Japan: the Ohsaki Cohort Study. *Int J Epidemiol* 32: 809-814.
12. Nagai M, Kuriyama S, Kakizaki M, Ohmori-Matsuda K, Sone T, et al. (2011) Impact of walking on life expectancy and lifetime medical expenditure: the Ohsaki Cohort Study. *BMJ Open* 1.
13. Paffenbarger Jr. RS, Wing AL, Hyde RT, Jung DL (1983) Physical activity and incidence of hypertension in college alumni. *Am J Epidemiol* 117: 245-257.
14. Manson JE, Nathan DM, Krolewski AS, Stampfer MJ, Willett WC, et al. (1992) A prospective study of exercise and incidence of diabetes among US male physicians. *JAMA* 268: 63-67.
15. Japan Society for the Study of Obesity. Examination committee for diagnostic standard of obesity (2000) New judgment of obesity and diagnostic standard of obesity. *Obes Res* 6: 18-28.