Study on the Effects of Muscle Training by Community Inhabitants on Medical Economy

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We researched the medical expenditure of the elderly who participated in exercise group (aerobic exercise and muscle exercise), comparing control subjects who matched sex and birth year with exercise groups in 2 cities and 2 towns. We calculated the cumulative medical expenditures from the previous years. In result, yearly cumulative medical costs of control subjects increased more than exercise groups in all test areas. Similar tendencies were shown in medical costs of each year's May in 2 cities. In another town we compared medical expenditures of elderly people between 3 different types of exercise groups: muscle exercise using their own body weight, quoits, and Swiss ball exercise. Medical costs of muscle exercise group increased less although not significantly. In conclusion, cumulative medical costs are useful for evaluating effects of exercise on medical economy, and the exercise, especially muscle exercise using their own body weight, might reduce the medical costs among the elderly.

Keywords: muscle exercise, medical economy, universality

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1. Introduction

In recent years, the development of medical and pharmaceutical science and the spread of the medical care system have prolonged the average life expectancy in Japan. According to the abridged life tables for Japan 2003 released by the Ministry of Health, Labour and Welfare, life expectancy at age 0 is 78.36 years for males and 85.33 years for females. Japan now has the longest average life expectancy. In addition, the proportion of elderly population has increased annually combined with the downward trend in the birthrate. The proportion is 19.0% in 2003 [Health and Welfare Statistics Association (2004)]. With the aging population and the spread of medical care, medical costs have also increased

annually in Japan. In 2003, the costs exceeded 31 trillion yen and the Ministry of Health, Labour and Welfare estimates that it will exceed 60 trillion yen in 2025. Japanese government has so far promoted secondary prevention measures, which focus on the early detection and rapid cure of diseases, as counter measures against increasing life-style related diseases including diabetes and heart disease. In most cases, health assessments for elderly people are conducted in each individual medical institution recently, especially in urban areas. Although this is effective in improving the convenience for residents and in making a family doctor accessible to them, health assessments link directly to the treatment within the existing medical cost system which is based on the actual cost of treatment. In consequence, the increase

in medical costs is inevitable from a viewpoint of medical economy.

Asymptomatic diseases such as life-style related diseases are increasing today and health assessments are a meaningful tool. However, it has not yet been studied in detail whether secondary prevention measures control the increase in medical costs except for a few partial reports. [Kawaguchi, et al., (1995), Koyanagi, et al., (1997)].

The Ministry of Health, Labour and Welfare is now examining new measures to promote health for Japanese people including the prevention of nursing care, by inaugurating the Health Frontier Strategies in 2005. That is, the nation has taken measures to tackle the problem of increasing medical costs by increasing burden on patients as beneficiaries and by promoting the effective structure in offering medical care through the systematic medical care such as the Community Health Project. Nevertheless, when discussing future policy, it would be difficult to increase the burden on patients more and place an excessive burden on each medical institution in terms of securing public healthcare. In this circumstance, Japanese government has decided to promote and enforce primary prevention measures to prevent diseases and reduce the need for nursing care as well as early detection and rapid cure of disease. Japanese government has also started to address the formulation of the Health Promotion Law [Otani et al., (2002)] and implementation of nursing care prevention programs and the health promotion programs by the National Health Insurance system lead by the health insurance societies since fiscal 2005 [Ministry of Health, Labour and Welfare (2004)].

Still, it is important to elucidate the effect of the primary preventive project on the medical economy in order to disseminate these projects and to motivate local governments and health insurance societies in positively addressing them. Reports on the assessment of resistance training, which targets middle aged and older people and is promoted recently by local governments in particular, in terms of medical economy are rarely seen.

It has been well known that enhanced physical activities generates good results on health, including prevention of diseases and increased endurance [Kuno (2004)]. Several studies examined this process, advocating that the cardiopulmonary function improves or the immune function improves

due to exercise [Koizumi, et al., (2003), Sunamoto (1983)]. Yet it is necessary to advance the research further in future because some part of this process needs further clarification. There are some studies which have reported on the effect of the program of resistance training in clinical practices, conducted in order to recuperate the respiratory and circulatory function [Kakura, et al., (2003), Suzuki, et al., (2000), Kawamata, et al., (2000)].

A study also reported that improvement in musculature was observed during resistance training in some work places in Japan. All of these studies investigated the enhancement of physical functions including the improvement of muscle strength, while the reports on the medical economics are less in number. Positive effects in the treatment of social withdrawal has been reported with the use of muscle training, targeting the local residents in particular [Okuno et al., (2004)], while a study of the effect on medical economy has rarely been seen. We have reported the study results concerning the effect on the medical economy of muscle exercise, which was conducted in Taiyo Village in Ibaraki Prefecture in collaboration with Kuno, et al., [Kamiyama, et al., (2004)]. In this study, we will report on the examination of the effects on medical economics resulting from muscle exercise, which has been conducted in several municipalities in Japan.

2. Methodology

Figure 1 shows the basic concept of this study. In each municipality, the information on life-style including exercise and the information on medical costs of an individual are integrated in record linkage, then the relationships between the life-style including exercise and the medical costs are analyzed. Thus aiming at more effective health promotion, it intends to prevent life-style related diseases and to reduce medical costs.

The annual medical expenses and the medical costs in May were followed targeting the participants of exercise classes. The classes were held in a municipality which requested the Tsukuba Wellness Research co., Ltd to teach exercises to elderly people and to analyze its effects. The participants were contributors to the national health insurance for 3 years in a preliminary period before starting the exercise. The study also included non-participants as a control group matching sex and birth year with

Figure 1 Basic concepts of analysis

the participants (3 people of control group for 1 participant). In one city where the record of medical costs could not be collected from 3 years before the exercise, the medical cost of the contributor was followed from the year before starting the exercise.

The individual program was provided in the exercise class [Nishijima, et al., (2003)] and the exercise in the class (aerobic exercise using a bicycle ergometer, muscle exercise and stretching) was carried out 1~2 times per week, Instructions for training at home (muscle exercise, stretching) and daily walking were given to the participants. The muscle exercises were carried out using one's own body weight or exercise tube or dumbbell. Relating to the control group, people who match sex and birth year with participants were chosen among contributors of the national health insurance and 3 people of control group were selected for one participant according to the closeness of their birthday to the participant, or in order of the number in the national health insurance, or randomly. When the candidates were less than three, the control group for the participant consisted of no more than two.

When people of control groups participated in the exercise classes, or quitted contribution to the national health insurance, or moved out from the municipality, or died, they were removed from the control groups.

The annual medical cost was calculated each year starting from the same month when the exercise started. For instance, when the exercise started in Sep. 2002, the medical cost from Sep. 2002 to Aug. 2003 was defined as the annual medical cost of 2002. The average annual medical cost of 3 years in the preliminary period before starting the exercise was calculated and then the figure was added to the annual medical cost after starting the exercise, to sum up the cumulative

medical cost. In a city where the medical cost could be calculated only from the year before the start of exercise, the cumulative medical cost was calculated by adding the medical cost after starting the exercise to the medical cost of the previous year. In a similar way, the cumulative medical cost in May was calculated. The U test, which is a nonparametric test, was applied as the statistical test to compare the exercise group and the control group. In consideration of the fact that the U test is a rank-sum test and not an average value test, the consistency between magnitude correlations of the average value and the U statistic was confirmed when significant differences were observed. Written consents stating to cooperate with the study were obtained from individuals in the exercise group. The medical costs of control group were anonymized in each municipality. The medical cost of the national health insurance was presented through the collaboration of the relevant municipalities.

Department of Public Health of School of Medicine of Showa University planned and instructed the exercise, supported by Tsukuba University

Table 1 Exercise and yearly cumulative medical costs in A city.

(yen/person)

	Total Costs			Outpatients			Inpatients	
	pre	2002		pre	2002		pre	2002
controls	436,380	855,978	controls	323,155	528,717	controls	113,225	327,262
exercises	213,127	360,830	exercises	177,138	316,647	exercises	35,989	44,183

Figure 2 Exercise and yearly cumulative medical costs in A city.

Exercises: n=74 (male30, female44) 65.7 years old (average age at 1/12/2002); Controls: n=210 (male88, female122) 65.6 years old (average age at 1/12/2002).

※ Average of 3 years in preliminary period. The values of 2002 mean sum of Average of 3 years in the preliminary period and costs of 2002. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (U test)

and Waseda University concerning the following area. The study was acknowledged by the Medical Moral Committee of School of Medicine of Showa University and a written consent was obtained from individual subjects.

In one town, elderly people who participated in one exercise among three; muscle exercise using their own body weight without machine, Swiss ball exercise and quoits. The subjects were contributors to the national health insurance and consented to participate in the investigation. The control group, who were arbitrarily chosen from the Basic Residents Record matching sex and birth year with participants (one in the control group for one participant), were contributors to the national health insurance and consented to the investigation. Their medical costs in May and Nov. each year from the year before starting the muscle exercise were investigated. The medical cost for each person was calculated and the transition was observed. Relating to the muscle exercise using their own body weight, a training class was held 28 times during 3 years and the exercise at home was encouraged based on the "Chokin-tsucho: muscle bank book" [Fukunaga, et al., (2002)]. The class started from Aug. 2002. The Swiss ball exercise was

performed in the class held 1~4 times a month using an exercise ball of enough size for one person to sit on, to do endurance exercise and muscle training. As for the quoits, 9 target sticks were used in competing the point and exercise and games were performed 1~4 times per month. In order to clarify the total increase and decrease of medical cost, the cumulative medical cost was calculated by adding the average medical cost of May, Nov. 2001 and May 2002 before starting the exercise to the medical cost thereafter and the transition was observed. The Kurskal-Wallis test which is a nonparametric test was used for the statistical test to compare between 4 groups.

3. Results

3.1. Assessment of medical cost in each municipality

3.1.1. Exercise and medical cost transition in A city

The transition of annual medical expense of the exercise group (endurance training + muscle training) and the control group is shown as the average cost of 3 years in the preliminary period before starting the exercise and the cumulative medical cost thereafter

Table 2 Exercise and cumulative medical costs in each year's May in A city. (yen/person)

	Total Costs				Outpatients				Inpatients		
	pre	May-03	May-04		pre	May-03	May-04		pre	May-03	May-04
controls	39,187	79,408	114,045	controls	22,281	37,941	51,268	controls	16,906	41,467	62,777
exercises	30,785	42,123	54,602	exercises	12,333	23,671	31,504	exercises	18,452	18,452	23,098

Figure 3 Exercise and cumulative medical costs in each year's May in A city. Persons were same in Figure 2. ※ Average medical costs of 3 months in preliminary periods (each year's May from 2000 to 2002). The values of May 2003 mean sum of average medical costs of 3 months in the preliminary period and costs of May 2003. The values of May 2004 mean the sum of the values of May2003 and costs of May 2004. * $p<0.05$ (U test)

in **Table 1** and **Figure 2**. It was observed that the difference widened in the medical cost between the control group and the exercise group after starting the exercise. Significant difference was observed in the hospital expense between before and after the exercise and in the total medical cost after starting the exercise. The magnitude correlation of the average value was consistent to the magnitude correlation of the U statistic. All the other results showed the consistency of the magnitude correlation between the average value and the U statistic when the significant difference was observed. Thus it was not noted in particular.

Table 2 and **Figure 3** show the transition of the medical cost in May in the form of cumulative medical costs. In A city, the difference in the medical costs between the exercise group and the control group increases after starting the exercise even in terms of the medical costs only in May, as in the annual medical cost. Significant difference was observed in the cumulative total medical cost and the hospital expense in particular.

3.1.2. Exercise and medical cost transition in B city

The medical costs of the exercise group (endurance exercise + muscle training) and the control group are shown as the annual cumulative medical cost

in **Table 3** and **Figure 4**. Those of the cumulative medical cost in May are shown in **Table 4** and **Figure 5**. It was difficult to calculate the medical cost of 3 years in preliminary period before starting exercise in B city so that the previous year of starting exercise was determined to be the point of starting for calculating the cumulative medical cost. Similar to A city, it was observed that the difference increased in the annual medical cost and the medical cost in May between the exercise group and the control group after starting the exercise and significant difference was observed in the annual hospital expenses.

3.1.3. Exercise and medical cost transition in C town

Table 5 and **Figure 6** show the annual cumulative medical costs of the exercise group (endurance exercise + muscle training) and the control group from the periods before starting the exercise in C town. It is observed that the difference increased in the medical cost between the exercise group and the control group.

Table 6 and **Figure 7** show the transition of the cumulative medical cost in May from the periods before starting the exercise. The difference was not observed in the outpatient treatment fee between the exercise group and the control group. The hospital expense and the total medical cost were higher in the

Table 3 Exercise and yearly cumulative medical costs in B city.

(yen/person)

	Total Costs			Outpatients			Inpatients	
	2001	2002		2001	2002		2001	2002
controls	175,814	364,787	controls	138,270	271,054	controls	37,544	93,732
exercises	113,777	237,643	exercises	108,975	231,733	exercises	4,802	5,909

Figure 4 Exercise and yearly cumulative medical costs in B city.

Exercises: n=79 (male25, female54) 65.9 years old (average age at 1/9/2002); Controls: n=232 (male74, female158) 66.0 years old (average age at 1/9/2002). The values of 2002 mean the sum of costs of 2001 and costs of 2002.

* $p < 0.05$ (U test)

Table 4 Exercise and cumulative medical costs in each year's May in B city.

(yen/person)

	Total Costs			Outpatients			Inpatients	
	May-02	May-03		May-02	May-03		May-02	May-03
controls	12,749	29,807	controls	11,840	24,524	controls	910	5,283
exercises	10,417	21,051	exercises	9,878	20,512	exercises	539	539

Figure 5 Exercise and cumulative medical costs in each year's May in B city.

Persons were same in Figure 4. The values of May 2003 mean the sum of costs of May 2002 and costs of May 2003.

Table 5 Exercise and yearly cumulative medical costs in C town. (yen/person)

	Total Costs			Outpatients			Inpatients	
	pre	2002		pre	2002		pre	2002
controls	320,837	707,823	controls	213,787	439,062	controls	107,050	268,761
exercises	256,575	519,069	exercises	232,311	469,766	exercises	24,264	49,302

Figure 6 Exercise and yearly cumulative medical costs in C town.
Exercises: n=41(male8, female33) 69.6 years old (average age at 1/12/2002); Contorls: n=120 (male24, female96) 69.6 years old (average age at 1/12/2002).
※ Average of 3 years in preliminary period. The values of 2002 mean the sum of Average of 3 years in preliminary periods and costs of 2002. * $p<0.05$ (U test).

Table 6 Exercise and cumulative medical costs in each year's May in C town. (yen/person)

	Total Costs			Outpatients			Inpatients	
	pre	May-03		pre	May-03		pre	May-03
controls	22,671	46,211	controls	17,810	36,067	controls	4,861	10,144
exercises	26,708	65,129	exercises	17,738	38,680	exercises	8,970	26,449

Figure 7 Exercise and cumulative medical costs in each year's May in C town.
Persons were same in **Figure 6**. ※ Average medical costs of 3 months in preliminary periods (each year's May from 2000 to 2002). The values of May 2003 mean sum of average medical costs of 3 months in preliminary period and costs of May 2003.

Table 7 Exercise and yearly cumulative medical costs in D town.

(yen/person)

	Total Costs			Outpatients			Inpatients	
	pre	2003		pre	2003		pre	2003
controls	511,393	1,062,443	controls	333,645	664,564	controls	177,748	397,879
exercises	258,023	473,668	exercises	142,841	336,707	exercises	115,182	136,961

Figure 8 Exercise and yearly cumulative medical costs in D town.

Exercises: n=20 (male4, female16) 68.2 years old (average age at 1/2/2003); Controls: n=60 (male12, female48) 68.1 years old (average age at 1/2/2003).

※ Average of 3 years in preliminary period. The values of 2003 mean sum of Average of 3 years in preliminary periods and costs of 2003.

exercise group, although the significant difference was not observed. The medical cost of the exercise group was higher than the control group at the starting point.

3.1.4. Exercise and medical cost transition in D town

Table 7 and Figure 8 show the transition of the cumulative medical cost from the periods before starting the exercise in the exercise group (endurance exercise + muscle training) and the control group in D town. Similar to the other municipalities, the increased difference in the medical cost between the exercise group and the control group was observed.

3.2. Comparison of medical cost change due to the type of exercise

Table 8 and Figure 9 show the comparison of the change in the medical cost among participants of the muscle exercise class and other exercise classes in E town. Focusing on the medical costs in May and Nov., the three different exercise groups; muscle exercise group, quoits group and Swiss ball exercise group, and the control group were compared. The total medical cost is shown in the left side and the

outpatient treatment cost was in the right side. The tendency for the medical cost increase to plateau is observed in the exercise group with muscle exercise in both sides. However, significant difference was not observed among these 4 groups except outpatient treatment costs of Nov.2002.

4. Some considerations

This study investigated the effect of muscle exercise on medical economy in 2 cities and 3 towns using the methods of analysis with which we proved the effect of muscle exercise on medical economy in Taiyo village in Ibaraki Prefecture.

At first we were concerned whether the difference could not be observed between the exercise group and the control group because of the variation of the medical cost in small groups and whether the difference would occur during the short period of time.

However, in the result of our investigation, the difference was clearly observed between the medical costs of exercise group and control group when tracing the figures in the form of cumulative medical cost in years. That is, in the same manner as the

Table 8 Comparing cumulative medical costs between muscle exercise, quoits, and ball exercise. (yen/person)

	Total Costs						Outpatients					
	pre	Nov-02	May-03	Nov-03	May-04	Nov-04	pre	Nov-02	May-03	Nov-03	May-04	Nov-04
muscle exercise	15,772	21,158	41,558	49,362	56,876	67,111	9,465	14,851	30,853	38,657	46,171	56,406
quoits	10,041	16,372	24,326	35,710	71,266	93,718	10,041	16,372	24,326	35,710	54,742	77,195
ball exercise	11,039	24,614	38,863	52,012	63,722	75,357	11,039	21,669	35,918	49,067	60,777	72,411
controls	19,980	38,705	81,621	104,400	133,233	158,540	19,980	38,705	57,422	80,202	99,188	117,135

Figure 9 Comparing cumulative medical costs between muscle exercise, quoits, and ball exercise. muscle exercise: n=16 (male5, female11) average 69.8 years old; quoits: n=8 (male6, female2) average 72.8 years old; ball exercise: n=23 (female23) average71.1 years old; controls: n=46 (male9, female37) average71.1 years old; the ages were those of 1/8/2002. ※ Average medical costs of 3 months in preliminary period (May-01, Nov-01, and May -02). The values of Nov-02 mean the sum of average medical costs of 3 months in preliminary period and costs of Nov-02. The values of May-03 mean the sum of the values of Nov-02 and costs of May -03. Other values were calculated in the same manner. * p<0.05 (Kruskal-Wallis test)

result in Taiyo village in Ibaraki Prefecture, the difference in the medical cost between the exercise group and the control group was observed, which suggests the increase in the difference year by year, in A city, B city, C town and D town. The transition of the cumulative medical cost of May in A city, where the medical cost after 2 years from starting the exercise was gained, indicates that the difference in the medical cost between the exercise group and the control group widens. At present, we are conducting follow-up reviews of the medical cost after 2 years from starting the exercise in other municipalities. It is really interesting whether the difference will widen in the medical cost when observing further on over the years hereafter. While the difference between the exercise group and the control group is observed in a part of outpatient treatment fee when observing the transition of the medical cost in these 2 cities and 2 towns, it is indicated that the difference is larger in the hospital cost. The most serious element in the increase in the national medical cost is the increase in the hospital expense. Therefore, if the muscle exercise is effective in restraining the

hospital expense as the primary prevention measures, it is meaningful to motivate local municipalities and health insurance unions to positively address these projects in future.

In comparing the medical costs in these cities and towns, the medical cost of the exercise group is lower than the control group even before starting the exercise. It is assumed that the exercise group selected by municipalities did not exactly start the exercise at this experiment but had been interested in the exercise and actually practiced it before the experiment and the effect has been kept through the experiment. The alternative view is that people who can do the exercise are healthy by nature. In this study, it is noticeable that the difference in the medical cost between the exercise group and the control group is widening. The fact that the difference in medical cost widens through continuing the exercise seems to suggest that there is a possibility of the effect of muscle exercise on the medical economy.

We are now analyzing the relationship of the difference in life activities such as eating habits

and the difference in exercise adherence between people with the increased medical cost and those not increased in the exercise group based on the baseline data. Relating to the issue whether it can be said that the muscle exercise is effective given that the exercise group are presumably healthy by nature, a comparative review was performed on the change in the medical cost among three groups; the group of Chokin (saving money=muscle)-exercise invented by Fukunaga [Fukunaga, et al., (2002)], the group of Swiss ball exercise and the group of quoits. The result indicated that the increase in the medical cost of the muscle exercise group is less than the other two groups. It seems interesting whether the difference will widen or not in future and the observation and review are continuing at present. The Chokin exercise is easily performed at home as the base of muscle exercise. The measurement of physical fitness was performed once in six months using the new physical fitness test of the Ministry of Education, Culture, Sports, Science and Technology to prove the effectiveness.

The scope of medical costs was reviewed by comparing both the annual medical costs and the medical costs in May, when the individual notification is made on the identified disease, by year. The insurers of the national health insurance are notified of the medical cost of May individually in the system (insurers of the social insurance in June) and the data can be obtained easily if the subject agrees. In this study, while the medical cost in May showed the same tendency with the annual medical cost in a city and a town, the different result was seen between the medical cost in May and the annual medical cost in 1 municipal. It seems preferable to investigate the annual medical cost as far as possible when assessing the medical cost.

The proportion of the control group and the exercise group matching sex and birth year was determined 3 to 1 in comparing their medical costs. It is necessary to establish the control group who match sex and birth year in assessing the medical cost in terms of the exercise effect and comparing the transition of the annual medical cost. As shown in this study, the medical cost of exercise group is also increasing over the years in the similar way with the control group. Therefore, this study observed whether the difference in the increase gap widens or not between the exercise group and the control group. Conclusively, we acknowledged that there

is the gap in the medical cost between the exercise group and the control group and the increase in the gap is the problem. Moreover, by showing the cumulative medical cost the effect was easily noticed. The average medical cost of 3 years in preliminary period before starting the exercise was defined as the base line in analyzing to even out the medical cost at the starting point. It is generally difficult to grasp the medical cost of the control group compared to the exercise group. In addition, the information of exercise of the control group is also hard to grasp. Thus the number of subjects in control group was set three times more than the exercise group.

This study aimed to develop methods to prove the effects of physical activity on medical economy, which is most simple and persuasive and can be performed at any time in any municipality or health insurance union throughout in Japan. There are studies that report that the medical cost can be reduced by several hundred million dollars if blood pressure is lowered by 2mmHg, and that the medical cost decreases by some amount if the cholesterol is lowered by 10 mg/dl in Europe and the United States. Although similar reports have been published as well in Japan, their explanations are somewhat difficult to understand for the hygienist and residents in municipalities, regardless of the argument as the evidence-based medicine (EBM). We believe that this study has developed a universal method that can be easily applied in any municipality or health insurance union.

5. Conclusion

This study examined the medical economic effect of muscle exercise using the analyzing method of muscle exercise effect on medical economy, which has demonstrated its validity in Taiyo village in Ibaraki Prefecture, in 2 cities and 3 towns. The results are as follows;

1. It is observed that the difference in the medical cost between the exercise group and the control group increased year by year in 2 cities and 3 towns.
2. The difference in the hospital expense was large in terms of the difference in the medical cost.
3. When comparing the medical costs among three groups; a group of Chokin exercise based on the muscle exercise invented by Fukunaga, et al., [Fukunaga, et al., (2002)], a group of Swiss ball

exercise and a group of quoits, it was indicated that the medical cost increased less in the group of muscle exercise compared to the other two groups.

4. In demonstrating the validity of the effect on medical economy using the method which is easily implemented in any municipality, it is recommended to compare the transition of the medical cost in May and the annual medical cost defining the control group matching sex and birth year.

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1998- Researcher, Department of Public Health, School of Medicine, Showa University

1999- Received Ph.D at University of Tokyo

2004- Lecturer, Department of Public Health, School of Medicine, Showa University

Main Works:

- Effect of muscle exercise on reduction in medical expenditure among elderly. Jpn. J. Phys. Fitness Sports Med. 53:205-210, 2004. (in Japanese)

Membership in Learned Societies:

- Japanese Society of Health Education and Promotion
 - Japanese Society of Physical Fitness and Sports Medicine
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