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Relationship between Levels of Daily Activity and Physical Fitness in Women Clerks

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The purpose of this study was to investigate the relationship between levels of physical activity in a day and physical fitness in physically active and inactive women clerks. Eight subjects were divided into two groups on the basis of the mean of step scores in a day measured by a pedometer. The means of step scores were 13300 in the active group and 6400 in the inactive. Each group had four subjects. Heart rate was recorded for 24 hours by a heart rate memory device. The energy expenditure in a day was calculated individually from the $\dot{V}O_2$-HR relations obtained from bicycle exercise. As indices of physical fitness, maximal oxygen uptake ($\dot{V}O_2$max) was determined by treadmill exercise and muscular strength (hand grip and back strength) was measured.

The results were as follows;

1) The average of the total energy expenditure in a day of the eight women clerks was 1813±304 kcal, which corresponded to 1.26 kcal/min. Energy expenditure in working time for eight hours was 637±89 kcal. According to the report from The Welfare Ministry, Japan (Nutrition Requirements of the Japanese, 1984), the level of activities of this energy expenditure was ranked as "light". The average of the total energy expenditure in a day was 1975±328 kcal in the active group and 1651±194 kcal in the inactive.

2) The active group spent 54±30 minutes on activities of over 3.0 kcal/min. It amounted to 276±183 kcal (109-531 kcal) in a day. The inactive group scarcely had the time of activities of over 3.0 kcal/min. Three subjects in the active group had a daily habit of exercise, such as jogging and gymnastics.

3) The mean values of $\dot{V}O_2$max, hand grip strength, back strength and the percentage of body fat were 42.9±1.9 ml/min/kg, 30.8±5.0kg, 106.5±21.4kg and 15.7±2.3% in the active group, and 33.2±2.8 ml/min/kg, 19.1±4.9kg, 54.8±10.7kg and 23.9±3.3% in the inactive, respectively.

In conclusion, the higher value in $\dot{V}O_2$max and muscular strength observed in the active group seems to relate to more active life style compared to that of the inactive.

Introduction

In modern highly industrial society, we have less and less opportunities for physical activities in daily life.[6),16),25),26)] It is generally observed that daily inactiveness causes hypokinetic diseases.[11),13)]

On the other hand, it is reported that individuals in physically active society have a greater aerobic capacity than those from a sedentary culture.[1),2),3),9),10),23)] This fact might suggest that physical fitness related to the difference in daily physical activity among individuals. There have been few papers that select working women as subjects and investigate the influence of life pattern on physical fitness by calculating energy expenditure for 24 hours.[17)~22)]

The purpose of this study was to investigate the relationship between level of physical fitness and daily physical activity of middle-aged women clerks.

Method

1. Classification of subjects into the active group and inactive one

In the previous study, we measured the daily pedometer step scores of 35 men and women clerks for one week. The average of pedometer step scores of 35 clerks was 8900. In the present

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Table 1. The physical characteristics, %Fat of the subjects.

	Subj.	Age (YR)	Height (CM)	Weight (KG)	%Fat (%)
INACTIVE GROUP	T.N	46	148.0	48.5	28.7
	N.H	45	155.0	46.5	21.9
	J.B	43	152.0	46.5	21.9
	K.K	38	153.0	53.5	23.3
	mean	43.0	152.0	48.8	24.0
	(SD)	(3.6)	(2.9)	(3.3)	(3.2)
ACTIVE GROUP	M.I	42	151.6	46.5	18.1
	A.N	39	153.0	47.0	13.0
	Y.S	36	153.0	51.0	16.2
	A.Y	32	166.5	57.3	15.1
	mean	37.3	156.0	50.5	15.6
	(SD)	(4.3)	(7.0)	(5.0)	(2.1)

study, we measured the daily pedometer step scores of 8 women clerks for a week. Figure 1 shows a histogram of the pedometer step scores for 35 clerks and the position of 8 clerks (arrow symbols). We classified the subjects into two groups, namely, active group and inactive group. Members of active group have over 8900 in pedometer step scores and members of inactive one have less than 8900 in pedometer step scores. In the present study, 4 women clerks were selected as subjects from active and inactive groups, respectively. Table 1 shows characteristics of each subject.

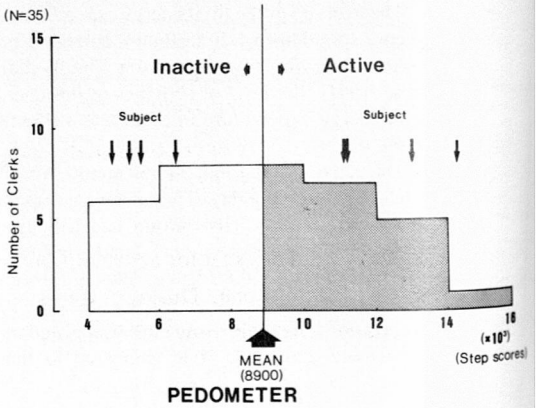

Fig. 1. Daily Pedometer step scores for 35 clerks and the position of 8 subjects (arrow symbols).

2. Heart rate recorder for 24 hours

Heart rate was recorded for 24 hours by heart rate memory device (Takei Kiki Company).

3. Energy expenditure in 24 hours and during working time

To calculate the energy expenditure from heart rate level, the relationship between heart rate and energy expenditure was investigated for each subject. Each subject exercised on a bicycle ergometer for 14 minutes in an incremental work load from 0 kp to 2.5 kp.[22]

Figure 2 shows two relations of heart rate and

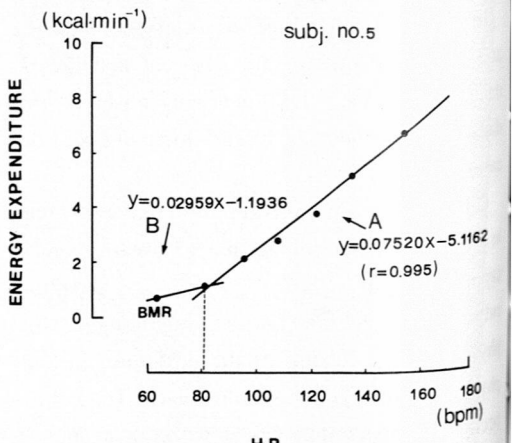

Fig. 2. Two relations (line "A" and line "B") of heart rate and energy expenditure from oxygen uptake.

energy expenditure calculated from oxygen uptake for one example. Line "A" was relation obtained individually from bicycle exercise. Line "B" was obtained from Basal Metabolic Rate (BMR) and heart rate at the starting point of pedalling. Energy expenditure for 24 hours was calculated from these relations for each subject. During sleep, the value of 90% of BMR was used.

4. Maximal oxygen uptake and muscle strength

Maximal oxygen uptake was measured by treadmill running method. Maximal back strength and hand grip strength were measured by dynamometer, respectively. All measurements were made between October, 1983 and October, 1985.

Results

1. Energy expenditure and pedometer step scores for 24 hours and during working time

Table 2 shows the average of energy expenditure and pedometer step scores for 24 hours and during working time. The daily average of total energy expenditure was 1975 kcal for active group and 1651 kcal for inactive one. During 8 hours working time, energy expenditure was 599 kcal in active group and 675 kcal in inactive one. The daily average of weekly pedometer step scores was 13300 for active group and 6400 for inactive one. During working time, the average was 3500 for active group and 3800 for inactive one.

Figure 3 shows the average of energy expenditure for 24 hours, during working time and off working time in active group and inactive one. Energy expenditure off working time was 1376 kcal for active group and 976 kcal for inactive one. The active group spent 400 kcal more than inactive one.

Table 3 shows time and energy expenditure spent in activities more than 2.2 kcal/min. In the present study, physical activities more than 3.0 kcal/min are classified into moderate intensity, according to Japanese Welfare Ministry Report.[24]

Figure 4 shows the percentage of energy expenditure in activities more than 3.0 kcal/min to the total energy expenditure in a day. The average was 13.9% to total energy expenditure for active group, 0% for inactive one.

2. Maximal oxygen uptake and muscle strength

Table 4 and Figure 5 show the physical fitness

Table 2. Energy expenditure and pedometer step scores for 24 hours and during working time.

	Subj.	Energy expenditure		The mean of weekly pedometer step scores	
		in a day (kcal)	during working time (kcal/kg·min)	in a day	during working time
INACTIVE GROUP	T.N	1703	0.0245	5842 ± 1615	3545 ± 64
	N.H	1573	0.0235	5333 ± 153	2630 ± 1796
	J.B	1436	0.0215	8617 ± 673	4483 ± 501
	K.K	1891	0.0245	5920 ± 3500	3489 ± 572
		mean 1651	0.0235	6428	3537
		(SD) (194)	(0.00139)	(1482)	(757)
ACTIVE GROUP	M.I	1657	0.0247	11833 ± 1601	3360 ± 233
	A.N	1732	0.0256	14267 ± 1104	3800 ± 424
	Y.S	2306	0.0314	9600 ± 834	3205 ± 985
	A.Y	2207	0.0267	15533 ± 1124	4700 ± 1153
		mean 1975	0.0271	13296	3766
		(SD) (328)	(0.00299)	(2312)	(672)

Table 3. Total time and energy expenditure in activities more than 2.20 kcal/min.

	Subj.	Physical activities (over 2.20 kcal)		
		Total time (min)	Energy expenditure (kcal)	(kcal/min)
INACTIVE GROUP	T.N	15	44.8	2.99
	N.H	35	78.3	2.24
	J.B	20	44.8	2.24
	K.K	0	0	0
		mean 18	42.0	1.87
		(SD) (14)	(32.0)	(1.29)
ACTIVE GROUP	M.I	62	188.7	3.04
	A.N	44	272.5	6.19
	Y.S	90	531.4	5.90
	A.Y	18	108.7	6.04
		mean 54	275	5.29
		(SD) (30)	(183)	(1.51)

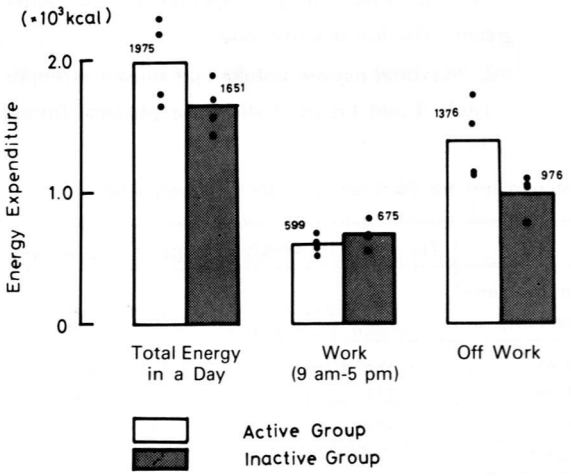

Fig. 3. The average of energy expenditure for 24 hours, during working time and off working time.

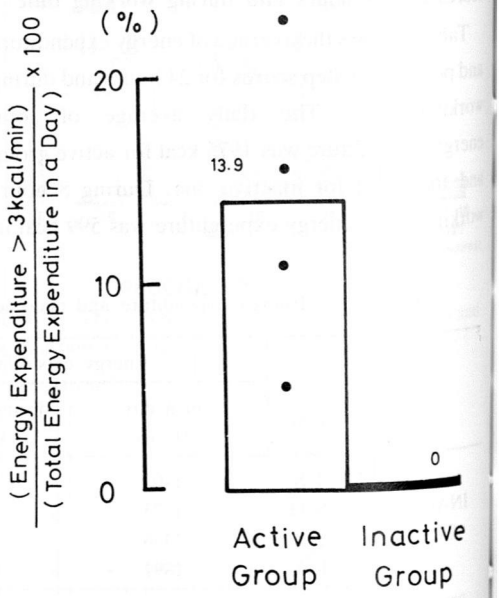

Fig. 4. The percentage of energy expenditure in activities more than 3.0 kcal/min to the total energy expenditure in a day.

level of two groups. Maximal oxygen uptake measured by treadmill running method was 42.9 ml/kg/min for active group and 33.2 ml/kg/min for inactive one. Maximal back strength was 106.5kg for active group and 54.8kg for inactive one. Maximal hand grip strength was 32.2kg for active

Table 4. $\dot{V}O_2$max, hand grip and back strength of two groups

	Subj.	$\dot{V}O_2$max (ml/kg·min)	Hand grip strength		Back strength (kg)
			Right (kg)	Left (kg)	
INACTIVE GROUP	T.N	36.4	12.0	12.0	41.0
	N.H	30.6	21.0	18.0	52.0
	J.B	34.6	23.5	20.0	65.0
	K.K	31.0	25.5	21.0	61.0
	mean	33.2	20.5	17.8	54.8
	(SD)	(2.8)	(6.0)	(4.0)	(10.7)
ACTIVE GROUP	M.I	44.4	27.0	22.0	77.0
	A.N	43.3	30.0	28.0	105.0
	Y.S	43.7	37.0	35.0	125.0
	A.Y	40.1	35.0	32.0	119.0
	mean	42.9	32.2	29.3	106.5
	(SD)	(1.9)	(46)	(5.6)	(21.4)

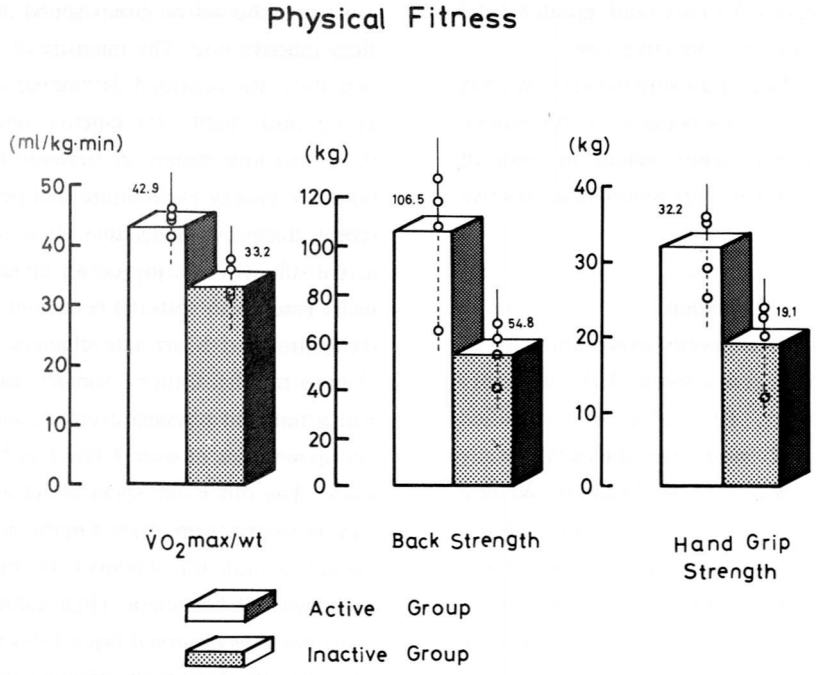

Fig. 5. Maximal oxygen uptake, maximal bach strength and hand grip strength of two groups.

group and 19.1kg for inactive one. In each case, active group shows higher value than inactive one.

3. Daily physical activities and physical fitness

Figure 6 shows relationship between $\dot{V}O_2$max per body weight and total energy expenditure in a day. Four full circles show active subjects and four open circles, inactive subjects. Star marks indicate the average of four subjects in each group. Active

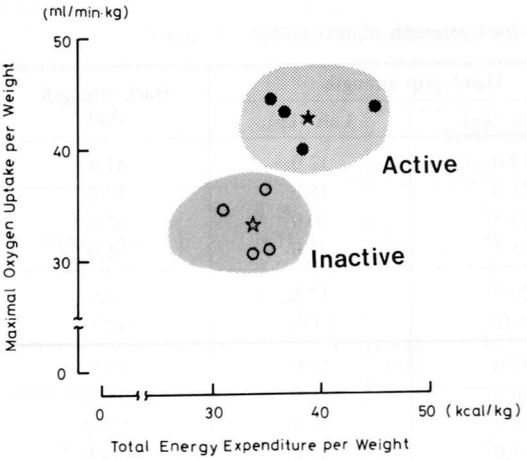

Fig. 6. The relationship between $\dot{V}o_2max$ per body weight and total energy expenditure in a day.

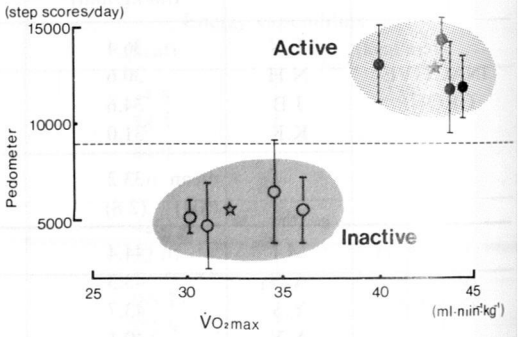

Fig. 7. The relationship between $\dot{V}o_2max$ per body weight and daily pedometer step scores.

group shows higher $\dot{V}o_2max$ and greater total energy expenditure than inactive one.

Figure 7 shows the realtionship between $\dot{V}o_2max$ per body weight and daily pedometer step scores. Active group shows higher values in both of $\dot{V}o_2max$ and pedometer step scores than inactive one.

Discussion

The average of total energy expenditure for 24 hours in 8 middle-aged women clerks was 1813 kcal (36.4 kcal/kg). The value was classified between "light" and "moderate" intensity of daily physical activity, according to Japanese Welfare Ministry Report.[24] The average energy expenditure during 8 hour-working time in 8 subjects was 639 kcal (0.0268 kcal/kg/min). The value had the same intensity as making an entry and computing on an electric calculator which are 0.0252 kcal/kg/min, and sewing and watching a conveyor belt which are 0.0269 kcal/kg/min.[12] So, during working time, activities of women clerks in present study could be regarded as a typical sedentary work in a typical modern society.

The average of total energy expenditure for 4 active women was 1975 kcal and 1651 kcal for 4 inactive. The active group spend 300 kcal more than inactive one. The intensity of daily physical activities was regarded as "moderate" for active group and "light" for inactive one. Therefore, there was little difference between two groups in both the energy expenditure and pedometer step scores during working time. It is found that an active subject A.N. jogged for about 25 min with heart rate up to 150-160 beats/min, according to the pattern of heart rate changes for 24 hours (Figure 8, left). Other 2 subjects in active group had a habitual physical exercise, such as jogging and gymnastics of over 3 kcal/min 5 or 6 times a week. The other one spent about an hour riding bicycle to and from office. On the other hand, the mean heart rate for 24 hours in the inactive subject K.K. was 69 beats/min. High value around 100 beats/min was observed twice a day when she was preparing the day's work after arriving at the office and when she was preparing evening meal. Peak value for 24 hours was only 115 beats/min (Figure 8, right). Other 3 subjects in inactive group had the life pattern similar to hers. Thus, the difference in daily energy expenditure by 300 kcal between active and inactive group is due to the level of physical activities off working time in which active

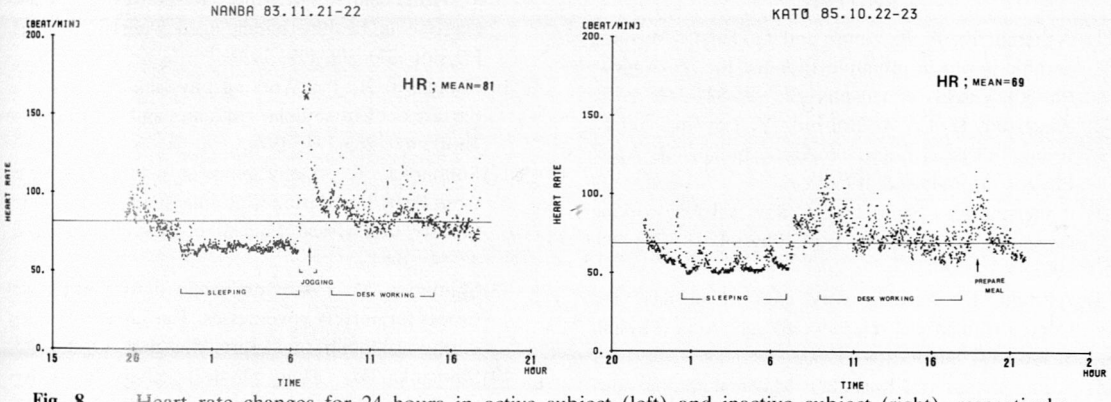

Fig. 8. Heart rate changes for 24 hours in active subject (left) and inactive subject (right), respectively.

group have a habitual physical exercise. The active group spent 54 min on activities of over 3 kcal/min which amounted to 275 kcal in a day. On the other hand, inactive subjects had no habitual physical exercise. The activities of 3-6 kcal/min were classified as "moderate"[24] and 3 of 4 active subjects showed activities of 5.7-6.2 kcal/min. It can be said that the active group have a relatively heavy habitual physical exercise. Compared with the active one, 3 of 4 subjects in inactive group have a habitual physical exercise only of "light" (2.20-2.99 kcal/min) such as walking and TV-gymnastic exercise. One subject, driving to office, scarcely had time even to walk. It is reported that people whose intensity of daily activities is "light" need 100-200 kcal of physical activities in order to keep health and increase physical fitness. Therefore, the active group had optimal activities[24] for healthy life.

The mean $\dot{V}o_2$max was 43 ml/kg/min for active group. The value of $\dot{V}o_2$max was classified "excellent", which might be equivalent to women athletes.[8] Hand grip strength was average, according to Japanese standards, and back strength was 2 SD superior to Japanese standards, while hand grip and back strength in inactive group were 2 SD and 1 SD below Japanese standards.[14] The present study agreed with the previous reports in which active group had higher $\dot{V}o_2$max than inactive one.[1),2),5)] $\dot{V}o_2$max, hand grip and back strength for active group were 29%, 61% and 95% higher than those for inactive one, respectively. The active group is 5.7 years younger than the inactive group. Even the decrease in $\dot{V}o_2$max due to advancing age (1.8 ml/kg/min in 6 years)[5] was considered, $\dot{V}o_2$max for active group was still 24% higher than inactive one. Though $\dot{V}o_2$max for inactive group proved inferior to active one in this study, the value of $\dot{V}o_2$max was higher than evaluation range of the same age group reported by Kobayashi[8] and Profant et al.[15] and approximately the same as was reported by Åstrand[4] and Kilbom.[7] The reason for this difference is not clear.

Judging from these results, the daily pedometer step scores and energy expenditure for active group were about 6000 and 300 kcal higher than inactive one, respectively. The active group spent more time on a habitual exercise and with higher intensity than inactive one. It was emphasized that the active group was superior to inactive one in $\dot{V}o_2$max and back strength.

The higher value in physical fitness observed in active group seems to relate to more active life style compared with that of physically inactive one.

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