A Comparative Epidemiological Study of the Effects of Regular Exercise on Health Level

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STUDY OBJECT: to reveal the relationship between regular exercise and physical fitness, lifestyle, mental health, and other cardiovascular risk factors among the Japanese. DESIGN: cross-sectional study. SUBJECTS: Three thousands, one hundred and thirty-two individuals (1,795 men and 1,336 women) over 40 years old who were examinees at one of seven centers for health promotion.

METHODS: a questionnaire survey on the lifestyle, a physical fitness tests and clinical laboratory tests were performed. RESULTS: Continuing regular exercise was associated with high levels of physical strength and their odds ratio (OR) was 2.09 (95% confidence interval(CI) 1.74 - 2.50). Many individuals in this group had good mental health: the OR for their sensation of fatigue (swift recovery) was 1.40(95%CI;1.17 - 1.68) and that for mood recovery (fast) was 1.44(95%CI;1.20 - 1.72). Thinness and obesity were scarce in this group. CONCLUSIONS: high physical fitness level, good mental health, standard body weight are more common in regular exercise group. J Epidemiol, 1998 ; 8 : 15-23.

During the past 50 years, life styles of the Japanese have undergone dramatic changes due to westernization. Their diets have changed to include large quantities of proteins and lipids, and a smaller quantity of fibers, while the total energy intake has increased. On the other hand, opportunities for physical exertion have been eliminated due to development of transportation systems, industrial machinery, and automated household equipment. In association with these changes in the lifestyle, the prevalence of obesity and hyperlipidemia has increased. However in the Japanese the mortality rate from ischemic heart disease (per one hundred thousand people) was 9.9 in 1950, and it is increasing till 1970, but it is only 41.4 in 1992. It is much lower than 196.7 in the United States and 287.5 in United Kingdom. In addition among the Japanese the prevalence of ischemic heart disease is not increasing.

Previous extensive investigations in the United States and European countries showed many risk factors of ischemic heart disease, and exercise or physical activity is one of them. It is associated to cardiopulmonary function, lipid metabolism, glucose metabolism, prohibition of aging of musculoskeletal system, and relaxation of mental strain. On the other hand, it is not clear that these facts suit Japanese.

This study deals with regular exercise as a risk factor, and the purpose is to show the relationship between regular exercise and physical fitness, lifestyle, mental health, and other cardiovascular risk factors among the Japanese.

METHODS

The subjects of the study were 3,132 individuals (1,795 men and 1,336 women) over 40 years old who were examinees at one of seven centers for health promotion (Hyogo Prefectural Center, Tottori Prefectural East Center, Tottori Prefectural West Center, Ehime Prefectural Center, Okinawa Prefectural General Center, Chiba City Center, and Takarazuka City Center). Centers for health promotion were established throughout Japan by local governments to promote and check the health of citizens. Examinees were given physical fitness tests, clinical laboratory tests and a questionnaire survey about lifestyle (including habit of exercise) and mental health under
The physical fitness tests comprised of six items: grip strength (average of right and left hands), side step, vertical jump, standing trunk flexion, sit-up, and Harvard step test, by which muscular strength, agility, power, flexibility, and endurance were measured. Each physical fitness test was judged using the physical fitness test scoring chart. The physical fitness test on which this score was based was performed with a standard protocol. From this score a comprehensive index was prepared. The comprehensive index was adjusted by sex and age, because we made scores using deviation from standard physical fitness levels. Each item was rated on a 5-level physical fitness scale shown below:

Criteria for physical fitness scale:

- **Score 1**: Low (less than M - 1.5 SD)
- **Score 2**: Slightly low (between M - 1.5 SD and M - 0.5 SD)
- **Score 3**: Normal (M±0.5 SD)
- **Score 4**: Slightly high (between M + 1.5 SD and M + 0.5 SD)
- **Score 5**: High (over M + 1.5 SD)

A comprehensive score was the sum of the six items. In the current study, this score was used as an index for the comprehensive physical fitness level. When one or two out of six test items were missing, the normal values (score 3) were given.

For the evaluation of the score for physical fitness, 19 or less was classified as "low", while 20 or higher was classified as "high". This classification generally divided the subject population into two halves. The clinical laboratory tests included subcutaneous fat on the back, blood sugar, total serum cholesterol, systolic blood pressure, diastolic blood pressure, height, and weight. Obesity was evaluated using following formula: a degree of obesity(%) = weight / standard weight * 100. Standard weight was obtained using modified Broca index. Persons with a degree of obesity above 120% were classified as obese. Persons with a degree of obesity under 90% were classified as thin. Persons with systolic blood pressure above 160 mmHg and with diastolic blood pressure above 95 mmHg were classified as hypertensive. Examinees were not requested to fast before blood was taken for clinical laboratory tests. The hematological tests were examined at multiple facilities by their own methods.

Each examinees was questioned about life style including exercise habit, smoking habit, alcohol drinking, and dietary habits. In determining whether a subject engaged in a regular exercise program, those who had maintained their habit of regular exercise from middle and high school days to the present i.e., those who responded that they participated in sport activities in middle and high schools and still engage in sports regularly or frequently constituted the regular exercise group, while the others were classified as the non-regular exercise group. Each examinees was asked following two questions: “Do you recover your fatigue sensation swiftly?” and “Do you recover your mood fast?” We thought these questions represented mental health.

The relationship between regular exercise and the physical fitness levels, mental health and clinical laboratory tests were evaluated. These relationships were examined comprehensively first, followed by classification by sex (2 groups) and age intervals (2 groups: 40 to 49 years and 50 or older).

To observe the relationship between the maintenance of regular exercise habits and each item, odds ratios and their 95% confidence intervals for the regular and non-regular exercise groups were calculated, using the unconditional logistic models. First, adjustments were made for sex and age, age only, and sex only; and odds ratios and the 95% confidence intervals were calculated for the entire group, and for the two sex- and age-classified groups. Next, the statistically significant items were selected and simultaneously incorporated into the model for an analysis using an unconditional logistic model to control any confounding factors.

### RESULTS

Table 1 shows the number of subjects classified according to sex, age intervals, and continuation of regular exercise. Of the entire group, 20.8% were rated with continued exercise group. When viewed in relation to sex, 25.5% of males and 14.4% of females are classified as continued exercise. In the male, mean age of not continued exercise group is 51.3 years old and that of continued exercise group is 50.5 years old. In the female, mean age of not continued exercise group is 51.6 years old and that of continued exercise group is 51.6 years old. In these subgroups there is little difference of age. When viewed in relation to age, proportion of continued exercise group was 22.4% in the 40-to-49-year, 17.2% in the 50-to-59-year group, and 23.7% in the over 60 year group.

| Table 1. Number of subjects classified according to sex, age intervals, and continuation of regular exercise. |
|-----------------------------------------------------------|
| **sex** | **age (yrs)** | **total** | **not continued** | **continued** |
|---|---|---|---|---|
| male | 40-49 | 1427 | 1107 | 320 |
| | (100) | (77.6) | (22.4) |
| female | 40-49 | 1376 | 1144 | 232 |
| | (100) | (84.6) | (15.4) |
| total | 50-59 | 1144 | 947 | 197 |
| | (100) | (82.8) | (17.2) |
| | 60-69 | 561 | 428 | 133 |
| | (100) | (76.3) | (23.7) |

percentage in parentheses
Figure 1. The distribution of the results of the 6 physical fitness tests.

Figure 2. The distribution of comprehensive physical fitness intervals in relation to sex and continuation or discontinuation of regular exercise.
Figure 1 shows the distribution of the results of the six physical fitness tests. For standing trunk flexion, there was a deviation toward “low,” while for vertical jumps there was a deviation toward “high.” The distributions for the other items were normal.

Figure 2 shows the distribution of the comprehensive physical fitness level. The subjects were classified according to sex and continuation of regular exercise. The continued regular exercise group deviated toward higher physical fitness level in comparison with the discontinued regular exercise group in both males and females.

Figure 3 shows the distribution of comprehensive physical fitness level in relation by age and continuation or discontinuation of regular exercise. Those who continue regular exercise (in both younger and older age groups) show deviations toward higher physical fitness level in comparison with those who discontinue.

Table 2 shows the proportions of the major factors observed according to the condition of regular exercise. The percentages of smoking (every day), drinking alcoholic beverages (every day), fatigue sensation (swift recovery), and mood recovery (fast) were higher, while those with habits of snacking (every day), obesity (over 120%), and subcutaneous fat accumulation (more than 20 mm on the back) were lower in continued regular exercise group. The number of those with a higher level of physical fitness exceeded by 16.1% in continued regular exercise group, in comparison with those discontinued.

Figure 4 shows the odds ratios and 95% confidence intervals of exercise continuing group to exercise discontinuing group. The odds ratios were adjusted for sex and age. The highest odds ratio [2.09 (95% CI; 1.74 - 2.50)] was noted in relation to the physical fitness level (20 +). Other factors with high odds ratios were fatigue sensation (swift recovery) [1.40 (95% CI; 1.17 - 1.68)] and mood recovery (fast) [1.44 (95% CI; 1.20 - 1.72)]. Thinness (below 89% of a degree of obesity) [0.68 (95% CI; 0.45 - 1.02)], obesity (over 120% a degree of obesity) [0.84 (95% CI; 0.67 - 1.05)], and high blood sugar level (over 120 mg/dl) [0.80 (95% CI; 0.60 - 1.09)] showed particularly low odds ratios.

Odds ratios were low for both thin (less than 89%) and obese (over 120%) individuals. The obesity range of 100 to 109, where many individuals fall (31%), was used as a reference and the body constitution, ranging from thinness to obesity, was divided into 7 level to compute an odds ratio for each level.

Figure 3. The distribution of comprehensive physical fitness intervals in relation to age group and continuation or discontinuation of regular exercise.
Table 2. The proportions of persons with factors according to the continuation or discontinuation of regular exercise.

| Factor                                  | Continue (650) | Not Continue (2482) |
|-----------------------------------------|----------------|---------------------|
| Smoking (every day)                     | 30.0           | 23.5                |
| Drinking alcoholic beverages (every day)| 35.7           | 27.4                |
| Habit of snacking (every day)           | 30.9           | 38.8                |
| Soft drink consumption (every day)      | 20.3           | 20.5                |
| Fatigue sensation (swift recovery)      | 38.8           | 30.9                |
| Mood recovery (fast)                    | 46.2           | 38.6                |
| Thinness (less than 89%)                | 4.9            | 6.6                 |
| Obesity (over 120%)                     | 18.9           | 23.1                |
| Subcutaneous fat (over 20mm on the back)| 31.5           | 37.9                |
| Blood sugar (over 120mg/dl)             | 9.5            | 10.2                |
| Total cholesterol (over 250mg/dl)       | 8.0            | 8.6                 |
| Hypertension                            | 5.5            | 6.2                 |
| Physical fitness interval (over 20)     | 61.5           | 45.4                |

The results are shown in Figure 5. The ratio slightly exceeded 1 for the level of obesity from 110 to 119 but the ratios tended to become smaller as level deviate either toward thinness or obesity. The odds ratio was significantly low [0.59 (95% CI: 0.38 to 0.92)] in the group of thin individuals (degree of thinness, 80 to 89).
Figure 5. Odds ratios for 7 intervals of body constitution from thinness to obesity in relation to continuation or discontinuation of regular exercise.

Table 3 shows odds ratios for the major factors observed in relation to continuation of a regular exercise habit according to sex and age adjusted for age and sex. The odds ratio was high for female smokers (smoking every day) [2.50 (95% CI; 1.32 - 4.73)]. The ratio was low with the relation with snacking between meals (every day) in females [0.70 (95% CI; 0.51 - 0.95)]. For the mental health, significantly high odds ratios were noted in fatigue sensation (swift recovery) and mood recovery (fast) in males and those over 50 years of age. For physiological functions, thinness (less than 89%) showed a significantly low odds ratio among males and those over 50, but no significant relationship was noted with obesity (over 120%), subcutaneous fat (over 20 mm on the back), blood sugar (over 120 mg/dl), total cholesterol (over 250 mg/dl), and blood pressure (hypertension). The physical fitness level (20+) showed a high odds ratio regardless of sex or age.

To control confounding factors, factors that were independently related to continued regular exercise were incorporated into multivariate models simultaneously with the sex and age for adjustment and logistic analyses were conducted. The results are shown in Table 4. When fatigue sensation (swift recovery) and mood recovery (fast) were incorporated into the model simultaneously, each odds ratio was lower. Some of the other factors showed a slightly wider spread in the 95% confidence intervals in comparison with the ratio with a single variable but the general tendency remained unchanged.

**DISCUSSION**

With advancing westernization of life style, an increase of the morbidity of ischemic heart disease is expected in Japan. However it is still much lower in Japan than in the United States and European countries. Therefore it is not clear that many risk factors of cardiovascular diseases founded in previous studies suit the Japanese. This study deals with regular exercise as a risk factor, and the purpose is to show the rela-

| Table 3. odds ratios for the major factors observed in relation to continuation of a regular exercise habit. |
|-----------------------------------------------|-------------------|----------------|----------------|
| | sex* | age(yrs.)* ** | males | females | 40-49 | over 50 |
|-----------------------------------------------|-------------------|----------------|----------------|
| life style                                     |                   |                 |                 |         |
| smoking (every day)                           | 0.92(0.74-1.15)   | 2.50(1.32-4.73) | 1.10(0.82-1.47) | 0.97(0.72-1.32) |
| drinking alcoholic beverages (every day)      | 1.02(0.82-1.26)   | 1.62(0.86-3.05) | 1.01(0.75-1.35) | 1.18(0.89-1.58) |
| habit of snacking (every day)                 | 1.17(0.90-1.51)   | 0.70(0.51-0.95) | 0.82(0.60-1.12) | 0.98(0.75-1.29) |
| soft drink consumption (every day)            | 0.94(0.73-1.21)   | 0.76(0.49-1.19) | 0.88(0.65-1.20) | 0.88(0.65-1.21) |
| mental health                                 |                   |                 |                 |         |
| fatigue sensation (swift recovery)            | 1.44(1.15-1.79)   | 1.35(0.98-1.86) | 1.17(0.89-1.55) | 1.51(1.18-1.93) |
| mood recovery (fast)                          | 1.49(1.20-1.85)   | 1.36(1.00-1.84) | 1.25(0.96-1.64) | 1.48(1.16-1.90) |
| physiological functions                      |                   |                 |                 |         |
| thinness (less than 89%)                     | 0.62(0.39-0.99)   | 0.95(0.42-2.13) | 0.70(0.40-1.23) | 0.52(0.28-0.96) |
| obesity (over 120%)                          | 0.90(0.67-1.20)   | 0.75(0.52-1.08) | 0.72(0.50-1.05) | 0.98(0.73-1.30) |
| subcutaneous fat (over 20 mm on the back)    | 1.03(0.81-1.31)   | 0.74(0.54-1.01) | 0.85(0.64-1.15) | 1.01(0.78-1.30) |
| blood sugar (over 120 mg/dl)                 | 0.78(0.56-1.08)   | 0.97(0.47-2.01) | 0.69(0.41-1.17) | 0.90(0.62-1.29) |
| total cholesterol (over 250 mg/dl)           | 0.98(0.64-1.49)   | 1.06(0.64-1.74) | 1.04(0.61-1.79) | 1.04(0.69-1.56) |
| hypertension                                 | 1.02(0.67-1.55)   | 0.46(0.18-1.17) | 0.98(0.53-1.81) | 0.83(0.51-1.34) |
| physical fitness intervals (over 20)         | 1.98(1.59-2.45)   | 2.36(1.69-3.29) | 2.26(1.74-2.95) | 1.86(1.45-2.39) |

* adjusted for age
** adjusted for sex
Table 4. Odds ratios in relation to continuation of a regular exercise habit conducted by multivariate logistic model

| Parameter          | Odds Ratio | 95% CI        |
|--------------------|------------|---------------|
| (males)            |            |               |
| Fatigue sensation  | 1.24       | 0.96-1.60     |
| Mood recovery      | 1.34       | 1.04-1.71     |
| Thinness (less than 89%) | 0.64 | 0.40-1.02     |
| (females)          |            |               |
| Smoking (every day)| 2.32       | 1.21-4.43     |
| Habits of snacking | 0.72       | 0.53-0.99     |
| Mood recovery (fast)| 1.36 | 1.00-1.86     |
| (over 50yrs.)      |            |               |
| Fatigue sensation  | 1.34       | 1.02-1.78     |
| Mood recovery      | 1.28       | 0.97-1.69     |
| Thinness (less than 89%) | 0.53 | 0.29-0.98     |

Relationship between regular exercise and physical fitness, lifestyle, mental health, and other cardiovascular risk factors among the Japanese.

The subjects were examinees who visited 7 facilities that are designed to promote health throughout Japan. We can safely assume that these subjects are willing to take positive steps to improve their health. In fact, it is highly likely that they are representative of those who continue to exercise or enjoy a higher level of physical fitness. However, we also believe that it is possible to compare the characteristics of those who continue to exercise and those who do not.

The questions for determining high physical activity group on the survey sheet did not ask to specify the frequency, duration, intensity, or type of sport. In general, it is very difficult to make an objective judgment on physical activities. To determine the daily amount of physical activity, it is necessary to evaluate the extent of exertion on work, commuting, and leisure time activities; and as time is extended from a month, a year, or to a lifetime, making an estimate of the sum of physical activity becomes increasingly difficult. Several methods of evaluation have been introduced but most were designed for men. Women's exertion in household duties tends to be underestimated, thus obscuring the effect of regular exercise on women's health. There is also a bias in responding to a survey about oneself (a "wish bias"), because the tendency is to exaggerate one's exercise habits. Therefore, it appears to be difficult to minimize misclassification even in a detailed survey. The present survey was simple but it focuses on regular exercise habits in the early days that may have significance for one's lifetime physical activity and the extent of regular exercise in which subjects currently engage in their leisure time. The amount of physical activity of those who engage in occupations that require exertion (especially those of females who devote much of their energies to housekeeping) is likely to be underestimated.

The group composed of individuals who continued to exercise, in comparison with those who did not, were found to maintain a higher level of physical fitness, regardless of age and sex. We believe that this is due to the effects of the continued regular exercise to promote physical strength. There is a significant relationship between the amount of physical activity and physical fitness, which has been supported in many reports. We have stated earlier that there are many kinds of methods to quantify physical activity and it is difficult to evaluate its amount. The index for physical fitness that is recognized most widely is the maximum oxygen uptake, which is also difficult to determine. In the present study, we adopted the method in which the amount was expressed by continued exercise as stated on the survey sheet, while physical fitness was evaluated by the indices that was prepared by combining the physical test results. These are relatively simple methods and can be easily applied to any circumstance. We obtained an odds ratio of 2.09, a significant relation for the high physical fitness level of the group who continued to exercise. This shows validity of the definition for physical activity and physical fitness in this study.

An odds ratio of smoking among females to continuation of exercise was significantly higher than 1. According to former reports, smokers, in comparison with those who gave up smoking earlier in life or those who never smoked, are less likely to continue to exercise and their physical fitness level is low. However, among females the relationship between smoking and continued exercise is reversed in this study. In Japan, smoking is highly prevalent among males but less among women than in other industriized countries. We might even say that smoking is a life style for men. Furthermore, in the present study, those who continued to exercise were predominantly males and regular participation in athletic activities is also a male-specific life style. Therefore we believe that smoking and continuation of exercise are related, both as male sex-related life styles.

The groups composed of individuals who swiftly recover from a sensation of fatigue or from a low mood showed odds ratios that were significantly higher than 1 in relation to continuation of exercise. It has been reported that exercise uplifts one from depression or apprehension and brings a sense of being in a healthy state, which is substantiated by the results of the present study. It has also been reported that exercise reduces mortality, while its lack constitutes a risk comparable to hyperlipidemia, hypertension, and diabetes mellitus. The fact that exercise contributes to a reduction in mortality or the risk of arteriosclerosis and promotes mental health is significant in that the quality of life is improved. We believe that guidance for proper exercise will assume increasing significance in the future.
The odds ratios of the body constitution, ranging from thinness to obesity (with a degree of obesity from 100 to 110 as the basis) were calculated against continued exercise. It was found that the ratios became significantly less than 1 as the degree of obesity deviated from the baseline (either toward heaviness or thinness). It is well-known that exercise is capable of adjusting body weight to approach a standard,\(^6\) which was again substantiated by this result. The present study employed the continued exercise patterns as an index of physical exercise; but the findings, based on the information in the questionnaire, were thoroughly subjective. However, the weight-adjusting effect of the exercise was well-expressed, which we believe is due to the reflection of physical activity by continued exercise patterns.

It is well known that continued exercise or physical activity reduce risk for cardiovascular diseases. In this study, however, significant relationships between continued exercise and cardiovascular risks (total cholesterol, blood sugar and blood pressure) were not founded. We believe this is due to the definition of continued exercise. This definition distinguishes the group of continued exercise for leisure activity. It ignores activities of job time. So persons who have jobs with physical activity, such as females of house keeper, might be misclassified to a group of not continued exercise.

We evaluated confounding factors about items which were significantly related to continued exercise by multivariate analytical models and found that when two factors, sensation of fatigue (swift recovery) and mood recovery (fast), are applied to the models simultaneously, the odds ratios for both were reduced. The other factors showed patterns similar to the instances of a single variable, suggesting that there is no confounding. The odds ratio for mood recovery (fast) to sensation of fatigue (swift recovery) is extremely high (8.98), suggesting that these 2 factors are very closely related. We believe that these two represent a similar mental state.

In conclusion, we observed the relationship between regular exercise and physical fitness, life style, mental health, and other cardiovascular risk factors among the Japanese. It was concluded that high physical fitness level, good mental health, standard body weight are more common in regular exercise group.

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