表6. 集団群と個別群の肥満度、持久的体力、歩数の変化(秋季参加者のみ)

		集団運動群			個別運動群			時間	交互作用
			介入前	介入後		介入前	介入後		
		n	平均 (*SD*)	平均 (*SD*)	*n*	平均 (*SD*)	平均 (*SD*)	*p*	*p*
肥満度	体重 (kg)	19	63.5 (10.0)	60.9 (10.4)	20	64.6 (13.0)	62.8 (12.1)	0.000 *	0.235
	BMI (kg/m²)	19	25.5 (2.8)	24.4 (3.0)	20	25.0 (3.2)	24.3 (3.1)	0.000 *	0.174
	%FAT (%)	19	33.5 (6.1)	30.3 (6.8)	20	30.0 (7.6)	27.5 (8.2)	0.000 *	0.378
	WHR	19	0.93 (0.05)	0.90 (0.06)	20	0.93 (0.04)	0.91 (0.05)	0.000 *	0.426
体組成	骨格筋量 (kg)	19	23.0 (5.2)	23.2 (5.2)	20	24.9 (6.4)	25.1 (6.5)	0.109	0.625
	体脂肪量 (kg)	19	21.2 (4.7)	18.4 (5.4)	20	19.3 (6.1)	17.2 (6.0)	0.000 *	0.398
	体水分量 (L)	19	31.15 (6.36)	31.18 (6.18)	20	33.33 (7.75)	33.57 (7.85)	0.312	0.437
	蛋白質量 (kg)	19	8.31 (1.74)	8.34 (1.68)	20	8.92 (2.12)	8.98 (2.15)	0.168	0.623
	ミネラル量 (kg)	19	2.89 (0.54)	2.88 (0.53)	20	3.03 (0.68)	3.05 (0.71)	0.775	0.476
持久性体力	最大酸素摂取量 (ml/kg/min)	18	22.9 (5.6)	23.2 (5.8)	17	26.6 (5.9)	29.9 (7.6)	0.055	0.106
身体活動量	歩数 (歩/日)	19	9012 (3403)	10933 (4932)	20	9122 (3946)	8500 (4778)	0.288	0.042 *

* *P*<.05

時間の要因に主効果(P<0.05)が認めれたときは、集団と個別を含めた全体の対象者で介入前より加入後が増加(低下)していることを意味する。
交互作用(P<0.05)が認めれたときは、集団と個別の介入前後の値の変化に差があることを意味する。

表7. 集団群と個別群の肥満度、持久的体力、歩数の変化(冬季参加者のみ)

		集団運動群			個別運動群			時間	交互作用
			介入前	介入後		介入前	介入後		
		n	平均 (*SD*)	平均 (*SD*)	*n*	平均 (*SD*)	平均 (*SD*)	*p*	*p*
肥満度	体重 (kg)	19	63.8 (13.1)	61.3 (13.1)	12	54.0 (10.3)	53.5 (10.6)	0.000 *	0.007 *
	BMI (kg/m^2)	19	25.6 (3.7)	24.5 (3.8)	12	22.6 (2.7)	22.4 (2.7)	0.000 *	0.005 *
	%FAT (%)	19	30.7 (6.0)	27.6 (7.4)	12	27.2 (7.5)	25.9 (6.1)	0.000 *	0.068
	WHR	19	0.92 (0.05)	0.90 (0.05)	12	0.89 (0.06)	0.87 (0.06)	0.000 *	0.235
体組成	骨格筋量 (kg)	19	24.1 (5.6)	24.1 (5.6)	12	21.1 (4.1)	21.4 (4.1)	0.192	0.271
	体脂肪量 (kg)	19	19.8 (6.3)	17.2 (6.8)	12	15.0 (5.8)	14.1 (5.2)	0.000 *	0.021 *
	体水分量 (L)	19	32.47 (6.85)	32.47 (6.89)	12	28.77 (5.01)	29.02 (5.10)	0.318	0.318
	蛋白質量 (kg)	19	8.68 (1.88)	8.66 (1.85)	12	7.67 (1.37)	7.75 (1.39)	0.364	0.186
	ミネラル量 (kg)	19	2.94 (0.57)	2.93 (0.56)	12	2.63 (0.43)	2.63 (0.40)	0.807	0.708
持久性体力	最大酸素摂取量 (ml/kg/min)	16	24.3 (4.3)	26.2 (5.3)	10	22.2 (3.3)	24.8 (5.4)	0.006 *	0.667
身体活動量	歩数 (歩/日)	19	9805 (2802)	11684 (4172)	12	5744 (1130)	8741 (2650)	0.001 *	0.388

* *P*<.05

時間の要因に主効果(P<0.05)が認めれたときは、集団と個別を含めた全体の対象者で介入前より加入後が増加(低下)していることを意味する。

交互作用(P<0.05)が認めれたときは、集団と個別の介入前後の値の変化に差があることを意味する。

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XIth INTERNATIONAL SYMPOSIUM
Biomechanics and Medicine in Swimming
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XIth International Symposium for Biomechanics and Medicine in Swimming

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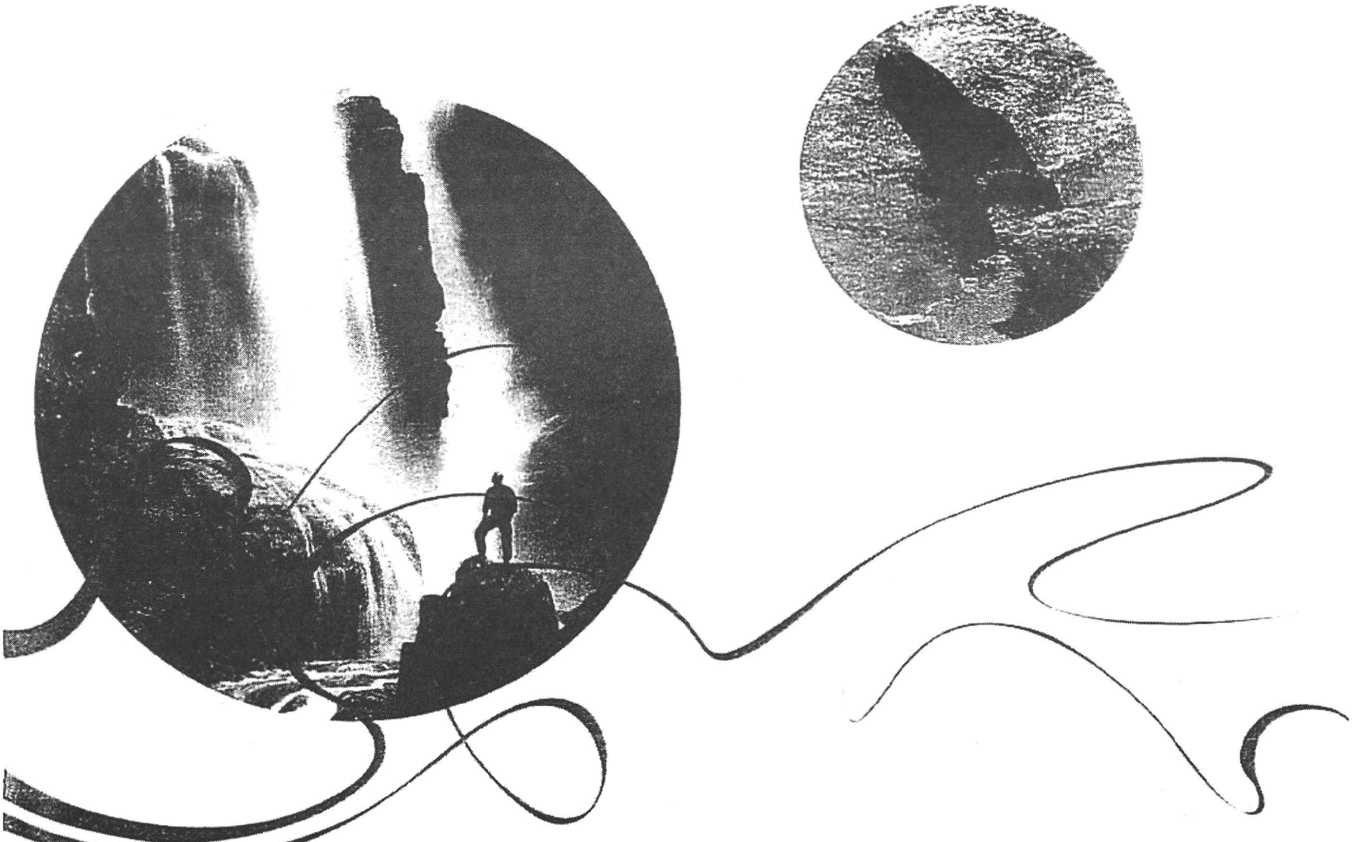
Program & Book of Abstracts

Per-Ludvik Kjendlie, Robert Keig Stallman and Jan Cabri (eds)



rehab; because, he had positive sign of painful arc. Maneuvers of MWMS applied posterioinferior force on the humeral head and mechanically avoided impingement of supraspinus tendon under the coracoacrominal arch. MWMS with light weight and PNF facilitated proprioception to gain good motor control of arm movements. REFERENCES: 1. Mulligan BR. (2004). Manual Therapy. NAGS, SNAGS, MWMS etc. Plane View Services, Wellington, New Zealand.

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Comparisons of Water- and Land- based Physical Activity Interventions in Japanese Subjects with Metabolic Syndrome

Hanai, A[1]; *Yamatsu, K*[2]
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INTRODUCTION: We previously reported that group-based physical activity (PA) intervention had beneficial effects on weight loss and metabolic syndrome (MS) risk factors in Japanese subjects with MS1). Although, water- and land-based PA interventions were often conducted, it is unknown which PA interventions were more effective. The aim of this study was to compare the efficacy of these two interventions in Japanese subjects with MS or several MS risk factors. METHODS: Eight subjects with MS or several MS risk factors were selected either water-based PA intervention (WPI, n=4) or land-based PA intervention (LPI, n=4). The main outcome measures were body weight, body mass index (BMI), %Fat and Lean body mass (LBM), Vo2max and daily physical activity (DPA) level (walking steps per day). Both interventions had 10 week duration. RESULTS: After 10-weeks, participants in both groups lost their weight (WPI group: from 67.3±2.6 to 64.4±2.0 kg, LPI group: from 61.5±2.7 to 59.4±3.5 kg, $p<0.05$), BMI (WPI group: from 26.3±2.0 to 25.1±2.1 kg/m2, LPI group: from 25.7±1.6 to 24.6±1.8 kg/m2, $p<0.01$), %Fat significantly (WPI group: from 34.3±10.3 to 31.1±10.6 %, LPI group: from (36.9±2.5 to 34.7±2.5 %, $p<0.01$). DPA levels were maintained pre- to post-intervention at WPI group (from 13,145±3,178 to 13,163±1,593 steps/day), and significantly increased at LPI group (from 9,752±3,858 to 13,610±2,148 steps/day, $p<0.05$). The results showed statistically no significant differences in body weight loss and decrement of %Fat between the WPI and LPI groups. DISCUSSION: From the results, it was suggested that the effects of losing body weight and %Fat were similar regardless of the selection of PA interventions in short term. However, there is a possibility that the efficacy will differ with the long term PA intervention, and further examination might be necessary to investigate the difference of efficacy at water-based and land-based PA interventions. REFERENCES: 1) Yamatsu K, Hanai A: Comparison of Groups- and Home-based physical activity intervention in Japanese subjects with metabolic syndrome. XXX FIMS world congress of sports medicine, Barcelona, Spain, 6: 542, 2008. ACKNOWLEDGMENTS This study was partly supported by the Grant-in-Aid Northern Regions Lifelong Sports Research center (SPOR).

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The Influence of Ai Chi on balance and Fear of Falling in Older Adults: a Randomized Clinical Trial

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INTRODUCTION: Balance and fear of falling (FOF) are major problems in older adults. In water viscosity provides postural support, reducing these hindrances. Ai Chi, a variant of Tai Chi, performed in water, includes slow exercises of the arms, legs and torso, with gradual narrowing of the base of support and may have a positive effect on coordination and balance in older adults (Sova & Konno, 2003). Only one study however with chronic stroke patients was found (Noh et al., 2008). Our study examined the effect of Ai Chi on balance and fear of falling in older adults. METHODS: Thirty older adults were randomly allocated to an experimental or control group. Inclusion criteria were aged 77-88 yrs with either high or medium risk of falling (POMA score from 0 to 24). Minimal adherence was 75%. Balance was assessed with the Performance-Oriented Mobility Assessment (POMA) and FOF with Falls Efficacy Scale (FES). The experimental group received 16 Ai Chi sessions over 6 weeks at a community aquatic centre. The control group received no instruction and was encouraged not to change their ADLs. Prior to intervention, 2 familiarization sessions were held. Many participants had never experienced aquatic therapy and/or had a significant fear of falling. RESULTS AND DISCUSSION: Following intervention the experimental group improved balance (Wilcoxon Z, $p=0.001$) but not fear of falling ($p=0.306$), whereas no change was seen in the controls ($p=0.254$). The control group regressed in FOF ($p=0.011$). Clinically significant effects sizes (ES) to the advantage of the experimental group were found of 1.3pts for the tPOMA (balance), with 1.1pts and 1.4pts for bPOMA and gPOMA respectively. A clinically significant ES for the FES was also reached (1.5pts), but was more a result of the increase in FOF in the controls. Findings suggest that an Ai Chi program leads to a clinical relevant increase of both static and dynamic balance in older persons. There is a tendency to decrease FOF, although statistical significance has not been reached. Nevertheless as FOF increased in the control group, a clinical relevant difference between groups at the end of study was found. REFERENCES: Noh D-K, Lim J-Y, Shin H-I, Paik N-J. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors – a randomized controlled pilot trial. Clin Rehabil 2008; 22: 966-76. Sova R, Konno J. Ai Chi Balance, Harmony & Healing. 2nd ed. Washington (EUA): DSL Ltd.; 2003.

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Predictors of Performance in Pre-Pubertal and Pubertal Male and Female Swimmers

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INTRODUCTION: Swimmers should be in a good body shape and need muscular force in order to achieve a successful performance. For example, arm-span appear to be important determinant of front-crawl swimming performance in young swimmers1 and swimming force is related to sprint swimming velocity2. The purpose of this study was to identify the anthropometric characteristics, body composition and strength as predictors of performance of the 50 m front-crawl swimming in pre-pubertal and pubertal male and female swimmers. METHODS: Seventy-two swimmers (n=72), were divided into two groups, pre-pubertal (n=30) aged 10.5±0.5yrs and pubertal (n=42) aged 13.7±1.5yrs. They underwent a battery of anthropometric, body composition and muscle strength measurements. The Principal Components Analysis (PCA) extracted three components, Component-1: Anthropometric-Tethered Swimming Force (TSF), Component-2: Body Composition and Component-3: Body Dimension. These components were then used in a simultaneous multiple regression procedure to determine which components best explain the variance in swimming performance. RESULTS: Based on the PCA, the Component-1 explained 65.1% of the total variance, Component-2 the 14.6% and Component-3 the 8.2% respectively. In total sample, the anthropometric and TSF were significantly correlated with performance ($r=-0.71$, $p<0.001$). When the multiple regression models were applied to the pre-pubertal swimmers (y=27.242-0.420*TSF+1.01*c-arm), 90.9% of the variation was explained by the average TSF (83.7%) and arm circumference (7.2%) while in pubertal swimmers (y=-38.661-0.111*TSF), the 70.4% of the

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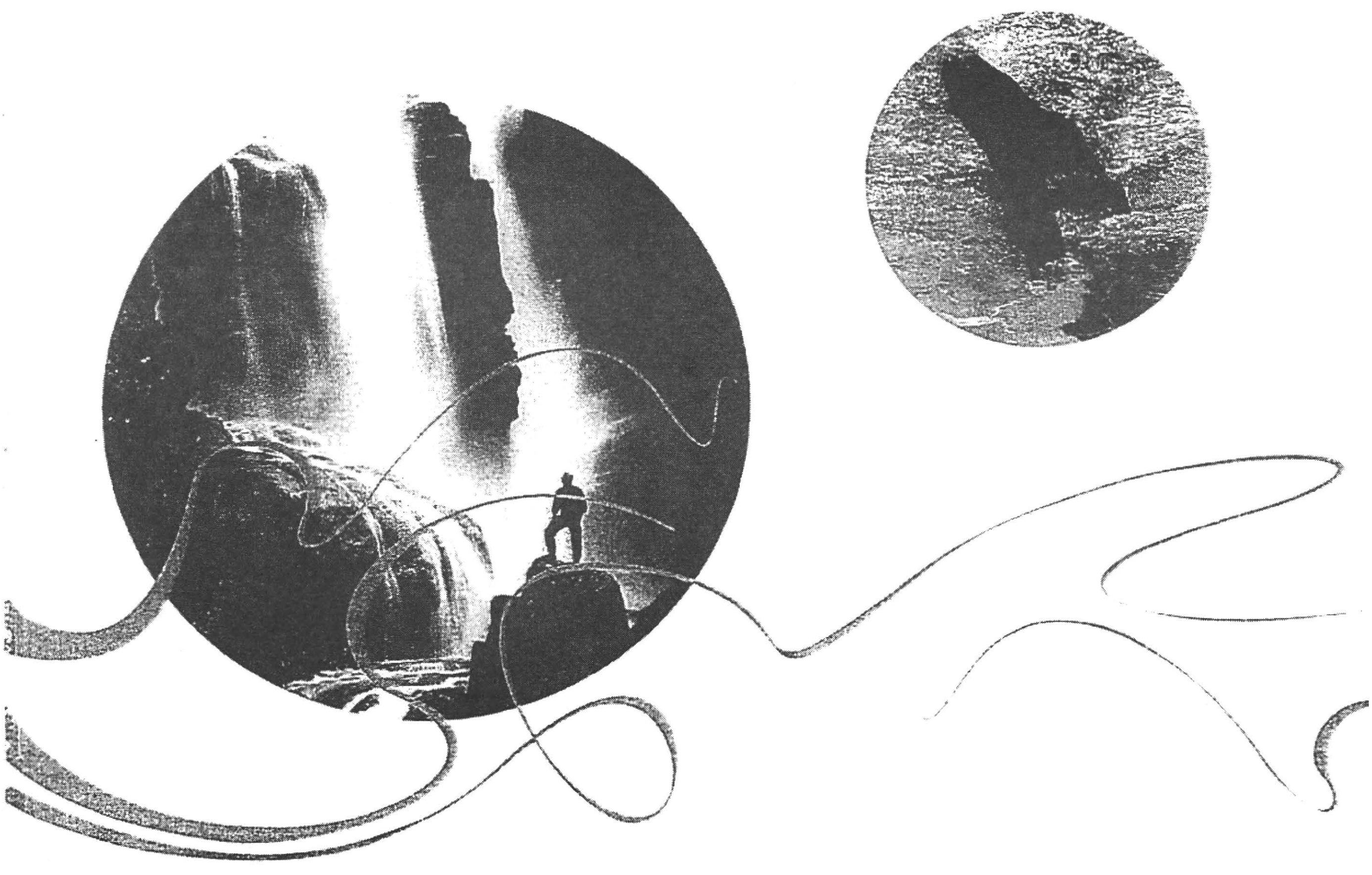
Biomechanics and Medicine in Swimming XI

Per-Ludvik Kjendlie, Robert Keig Stallman, Jan Cabri (eds)



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Comparisons of Water- and Land-based Physical Activity Interventions in Japanese Subjects with Metabolic Syndrome

Hanai, A.[1] and Yamatsu, K.[2]

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We previously reported that group-based physical activity (PA) intervention had beneficial effects on weight loss in Japanese subjects with metabolic syndrome (MS). Although, water- and land-based PA intervention was often conducted, it is unknown which PA interventions were more effective. The aim of this study was to compare the efficacy of these two interventions in Japanese subjects with MS or several MS risk factors (such as overweight, diabetes, hyperlipidemia). As a result, after 10-weeks, participants in both groups reported significant loss of weight, BMI, and percent body fat. Statistical analyses showed no significant differences between the groups with the exception of daily physical activity levels. It was suggested that both water- and land-based physical activity interventions had short-term beneficial effects on weight loss and reduction of percent body fat.

Key words: Physical activity, Water-based intervention, Land-based intervention

INTRODUCTION

We previously reported that group-based physical activity (PA) intervention had beneficial effects on weight loss and metabolic syndrome (MS) risk factors in Japanese subjects with MS. Although, water- and land-based PA interventions were conducted, it is unknown which PA interventions were more effective. The aim of this study was to compare the efficacy of these two interventions in Japanese subjects with MS or several MS risk factors.

METHODS

Eight subjects with MS or several MS risk factors (such as overweight, diabetes, hyperlipidemia) were selected for either water-based PA intervention (WPI, n=4, Figure 1.) or land-based PA intervention (LPI, n=4). The characteristics of the subjects are shown in Table 1. The contents of exercise program prescribed for WPI and LPI are shown in Table 2. The main outcome measures were body weight, body mass index (BMI), percent body fat and lean body mass (LBM) at trunk, upper and lower limbs (measured by body composition analyzer, TANITA co.) and VO_2max. The daily physical activity (DPA) level was measured by the Kenz Lifecorder EX (SUZUKEN co.) attached to subjects for 1 or 2 weeks, registering the number of daily walking steps. Both interventions had a duration of 10 weeks.

SPSS 14.0J was used for statistical analyses. All values are expressed as means ± SD. Two-way analyses of variance with repeated measures (two-way ANOVA test), Mann-Whitney U test were used for analyses. Statistical significance was set at $p<0.05$.

Table 1. Characteristics of the subjects.

	WPI group (n=4) mean (SD)	LPI group (n=4) mean (SD)
Age (yrs)	54.0 (6.5)	57.8 (6.9)
Height (cm)	160.3 (7.5)	155.0 (8.0)
Body weight (kg)	67.3 (2.6)	61.5 (2.7)
BMI (kg/m²)	26.3 (2.0)	25.7 (1.6)

WPI: water-based physical activity intervention
LPI: land-based physical activity intervention

Table 2. Contents of exercise program prescribed for WPI and LPI.

	Contents of exercise program
WPI	Walking and jogging, stretching, muscle strengthening with water gloves
LPI	Stretching and muscle strengthening, including chair-seated exercise and resistance band exercise

WPI: water-based physical activity intervention
LPI: land-based physical activity intervention

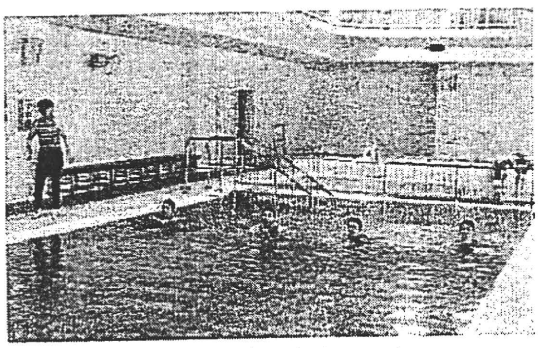

Figure 1. Water-based physical activity intervention.

RESULTS

After 10 weeks, participants in both groups lost weight (p<0.05), BMI (p<0.001), significantly (Table 3). Although, values of LBM were maintained during the PA intervention in both groups, percent body fat significantly decreased, approximately 3.2 kg for the WPI group, and 2.2 kg for the LPI group (p<0.001). No significant changes were found in VO_2max values.

Table 3. Changes of physical characteristics pre- to post-physical activity intervention

	WPI group (n=4)		LPI group (n=4)		time	interaction
	pre	post	pre	post		
	mean (SD)	mean (SD)	mean (SD)	mean (SD)	p	p
Body weight (kg)	67.3 (2.6)	64.4 (2.9)	61.5 (2.7)	59.4 (3.3)	0.01 *	0.56
Body mass index (kg/m²)	26.3 (2.0)	25.1 (2.1)	25.7 (1.8)	24.6 (1.8)	0.00 *	0.77
%Fat (%) Total	34.3 (10.3)	31.1 (10.6)	36.9 (2.5)	34.7 (2.5)	0.00 *	0.25
%Fat (%) upper limbs	31.1 (11.5)	28.2 (11.3)	34.2 (2.8)	32.3 (2.9)	0.00 *	0.35
%Fat (%) lower limbs	34.7 (9.1)	33.1 (9.5)	37.4 (1.4)	35.9 (1.7)	0.00 *	0.03
%Fat (%) trunk	34.7 (10.8)	30.4 (7.7)	37.1 (3.2)	34.4 (3.1)	0.00 *	0.17
LBM (kg) Total	43.4 (8.5)	44.4 (7.3)	38.8 (3.0)	38.5 (2.5)	0.97	0.91
LBM (kg) upper limbs	2.3 (0.6)	2.4 (0.5)	1.6 (0.3)	1.6 (0.1)	0.34	0.12
LBM (kg) lower limbs	7.6 (1.7)	7.6 (1.4)	6.8 (0.3)	6.9 (0.3)	0.83	0.84
LBM (kg) trunk	24.7 (6.0)	24.6 (5.7)	21.5 (2.5)	21.4 (2.3)	0.45	0.86
Walking steps (steps/day)	13145 (3179)	13163 (1591)	9752 (3858)	13610 (2148)	0.03 *	0.03 *
VO_2max (ml/kg/min)	23.8 (3.6)	21.4 (2.6)	16.3 (4.4)	22.1 (5.9)	0.18	0.09

* p<0.05. WPI: water-based physical activity intervention, LPI: land-based physical activity intervention, LBM: Lean body mass

The number of walking steps (DPA level) were maintained in pre- to post-intervention for the WPI group, and increased significantly for the LPI group (from 9752±3858 to 13610±2148 steps, p<0.05).

Changes of percent body fat at trunk, upper and lower limbs are shown in Table 4 (post-value/pre-value*100). No significant changes were found for either group, however, the change of percent body fat at the trunk showed significant reduction compared with the upper limbs (p<0.05) and lower limbs (p<0.05).

Table 4. Percent changes of %Fat at trunk, upper and lower limbs.

percent body fat	WPI group (n=4) % mean (SD)	LPI group (n=4) % mean (SD)	p*
trunk	85.9 (8.4)	92.6 (3.4)	0.20
upper limbs	89.5 (5.7)	94.4 (3.4)	0.20
lower limbs	94.7 (3.8)	96.0 (1.6)	0.89

* *Mann-Whitney U test*
WPI: water-based physical activity intervention
LPI: land-based physical activity intervention

DISCUSSION

Water-based exercise is popular because of the characteristics of water. Buoyancy assistance makes water based activity less physically demanding than exercise on land, and water resistance can be adjusted by changing the speed or direction of the movements. Therefore, it is an effective training strategy for improving physical fitness in those who are overweight or physically unfit[2]. Moreover, because of higher thermal conductivity, caloric consumption is more efficient while exercising in water. Percent changes of body fat at each body part tended to decrease significantly after the water-based PA intervention.

After the 10-week PA interventions, body weight was significantly reduced and percent body fat was also significantly lowered. It has been demonstrated that obesity is related to MS and visceral fat is a factor modulating MS. Therefore, reduction of body fat in the trunk is an important task for subjects with MS. In the present study, % change of body fat in the trunk had decreased greatly compared to upper and lower limbs as a whole (p<0.05). Although, the results showed statistically no significant differences in body weight loss and decrement of percent body fat between the WPI and LPI groups.

As a result, it appears that the loss of body weight and percent body fat were similar regardless of the selection of PA intervention in short term. However, there is a possibility that the efficacy will differ for long term PA intervention, and further examination might be necessary to investigate the difference of efficacy of water-based and land-based PA interventions.

CONCLUSION

From the results, it was suggested that both water- and land-based physical activity intervention had short-term beneficial effects on weight loss and reduction of percent body fat. However, no significant differences of were found between the interventions. Further research is needed to investigate the differences of efficacy of water-based and land-based physical activity interventions in the long term.

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Body Mass Index and Risk of Stroke and Myocardial Infarction in a Relatively Lean Population

Meta-Analysis of 16 Japanese Cohorts Using Individual Data

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Background–The association of overweight/obesity with the incidence of cardiovascular diseases, especially stroke, has not been comprehensively examined in relatively lean populations in which stroke is more prevalent than coronary heart disease.

Methods and Results–Pooled individual data from 16 Japanese cohorts comprising 45 235 participants ages 40 to 89 years without previous history of cardiovascular disease were studied. During follow-up, 1113 incident strokes and 190 myocardial infarctions were identified. At baseline, mean ages of men and women were 55.4 and 56.5 years and mean body mass indices (BMI) were 23.0 and 23.4 kg/m^2, respectively. Compared with those with BMI <21.0, incidence rates of cerebral infarction in subjects with BMI ≥27.5 were significantly elevated in both men (hazard ratio, 1.81; 95% confidence interval [CI], 1.28 to 2.56) and women (hazard ratio, 1.65; 95% CI, 1.23 to 2.21), adjusted for age, smoking, and drinking habit. Incidence of cerebral hemorrhage was also associated positively with BMI in both men (hazard ratio, 2.51; 95% CI, 1.21 to 5.20) and women (hazard ratio, 1.98; 95% CI, 1.12 to 3.52). Adjustment for systolic blood pressure, a mediating factor, significantly attenuated most BMI association with stroke in both sexes. For myocardial infarction, the hazard ratio was 3.16 (95% CI, 1.66 to 6.01) for BMI 27.5 or greater versus less than 21.0 only in men, which appeared partly mediated by total cholesterol and SBP.

Conclusions–Overweight/obesity was associated with an increased risk of cerebral infarction and hemorrhage in men and women and myocardial infarction in men. Weight control may have the potential to prevent both stroke and myocardial infarction in Japan. ***(Circ Cardiovasc Qual Outcomes*. 2010;3:00-00.)**

Key Words: obesity ■ acute cerebral infarction ■ stroke ■ myocardial infarction ■ epidemiology

Although obesity in adults defined by a body mass index (BMI) of ≥30 kg/m^2 has roughly tripled over the past few decades in Japan, obesity prevalence is only 3.8% in Japan versus 34.3% in the United States in 2005.[1,2] Nevertheless, the impact of overweight or obesity on the incidence of cardiovascular diseases (CVD), especially stroke, has not been comprehensively examined in relatively lean Asian populations in which stroke is more prevalent than coronary heart disease (CHD).[3] In addition, the association of stroke with BMI is less clear, especially in the case of hemorrhagic stroke, partly because hemorrhagic stroke was rare in previous Western studies.[4–6]

The societal burden of CVD morbidity is high even in a lean population such as Japan. Japan's national health expenditures on stroke and CHD is large, and more so for cancer.[7] In addition, CHD has increased in parts of urban Japan,[8] and ischemic stroke subtypes may be shifting from lacunar to atherothrombotic stroke predominance,[9] as observed in Western populations.[10] Thus, additional prospective studies of obesity and CVD incidence

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are needed in an era of growing obesity to offer clues for their prevention.

The Japan Arteriosclerosis Longitudinal Study-Existing Cohorts Combine (JALS-ECC) is a pooling project based on individual participant data from existing high-quality prospective cohort studies in Japan. This meta-analysis of 16 cohort studies allowed detailed investigations with more than 1000 stroke events and about 200 myocardial infarction (MI) events from more than 400 000 person-years of follow-up in middle-aged and older Japanese men and women.

WHAT IS KNOWN

- Obesity (body mass index ≥30 kg/m^2) is an established risk factor for cardiovascular disease; however, elevation of body mass index within normal to overweight range has not been evaluated sufficiently across different cardiovascular diseases.

WHAT THE STUDY ADDS

- Elevation of body mass index even within normal to overweight range was positively associated with an increased risk of cardiovascular disease in both men and women.
- Effects of increased body mass index on stroke incidence were mediated largely by elevated blood pressure. Obesity control including prevention of weight gain will play an important role as a way to prevent and control hypertension and thus stroke.
- Obesity independently increased the risk of myocardial infarction, implying additional importance of obesity control.
- A rise in weight in the population should be prevented vigorously, and weight control should be emphasized in those with elevated weight regardless of age and sex even in relatively lean populations.

Methods

Study Population

The rationale, study design, and methods of the JALS-ECC have been described elsewhere.[11] In brief, cohort studies were potentially eligible for inclusion in this project if they satisfied the following criteria: (1) Japanese population; (2) prospective cohort study; (3) at least 3000 persons-years of follow-up; (4) date of birth (or age), sex, height, weight, blood pressure, and total cholesterol recorded at baseline; and (5) date of death or the age at death (for death from stroke or coronary heart disease, at least) recorded during follow-up. Quality control of collected cohort data was performed at the JALS Coordinating Center. Consequently, individual records for each of 66 691 participants ages 18 to 99 years in 21 cohort studies were included in this project, with 82.7% of the participants from community-based cohorts and 17.3% from work site–based cohorts. Baseline years of the cohorts ranged from 1985 to 1999. Mean ages at baseline and at the end of follow-up in the community-based cohorts were 57.2 and 66.7 years and 48.8 and 55.0 years in work site–based cohorts, respectively. Permission to submit cohort data to the JALS central office was obtained from each institute's review board for ethical issues.

Baseline Data

The JALS study group requested for each participant: date of baseline survey, date of birth or age at baseline, sex, height, weight, systolic and diastolic blood pressure (SBP and DBP), serum total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, glucose, smoking status (current, past, and never) and alcohol drinking habits, and history of CVD, hypertension, hypercholesterolemia, and diabetes mellitus (DM). In each cohort, weight and height were measured with the subjects in typical indoor clothing but without shoes; weight to the nearest 0.5 kg, and height to the nearest 1 cm. BMI (kg/m^2) was calculated as weight (in kg) divided by the square of height (in meters). In the present analyses, we considered age, sex, BMI, SBP, TC, and smoking status and alcohol drinking habits as essential variables because all the cohorts did not necessarily obtain all data. As additional analyses, history of DM or HDL cholesterol was further adjusted in a subsample in which these variables were available.

End Points

In each cohort, vital status and the incidence of stroke and/or MI were ascertained during the follow-up period using population-based stroke and/or MI registration systems, death certificates, hospital medical records, and/or questionnaires. The diagnosis of stroke was based on 24 hours or more of typical clinical features and characteristic changes on computed tomographic and/or MRI brain scans and was typically based on criteria from the MONICA study[12] or from the WHO.[13] The diagnosis of MI was based on chest pain, cardiac enzyme levels, and ECGs and was typically based on criteria from the MONICA study.[12] Disease classifications were made using the 9th revision of the International Classification of Diseases (ICD) as follows: stroke (ICD9: 430, 431, 433, 434, 436), cerebral infarction (ICD9: 433 to 434), cerebral hemorrhage (ICD9: 431), subarachnoid hemorrhage (ICD9: 430), and MI (ICD9: 410).

Exclusions

From 21 cohorts of the JALS-ECC, 3 cohorts were excluded because they lacked stroke and MI incidence end points, and 2 cohorts were excluded because did not assess baseline BMI. From the remaining 60 616 participants in 16 cohorts, participants age <40 years or ≥90 years (n=7484), those lacking baseline data on blood pressure, serum TC, smoking, and/or alcohol drinking habits (n=6828), and those with a history of CVD (n=570) were excluded. Among the remaining 45 734 participants, 499 participants (1.1%) dropped out during the follow-up period. Thus, this report was based on a total of 45 235 participants (19 760 men and 25 475 women). Among the 16 cohorts, analyses for stroke were performed in 15 cohorts (38 515 participants) in which stroke events were surveyed; analyses for MI were performed in 13 cohorts (33 128 participants) in which MI events were surveyed; and analyses for CVD or ischemic CVD (cerebral infarction and MI) were performed in 12 cohorts (26 408 participants) in which both stroke and MI events were surveyed.

Statistical Analyses

We grouped subjects according to the World Health Organization classification[14]; however, because of the small number of samples in underweight (<18.5, 4.7%) and obese (≥30.0, 2.3%) categories, we collapsed them with the adjacent categories. We then divided the category with BMI 23 or lower by additional cutoff point (21) to describe incidence within normal range. Consequently, the following 5 categories were used: BMI <21.0, 21.0 to 22.9, 23.0 to 24.9, 25.0 to 27.4, and ≥27.5. A fixed-effect Poisson regression model with a fixed effect representing a combination of cohort enrollment year (1980s or 1990s) and cohort characteristics (community-based or work site–based) provided multivariate-adjusted hazard ratios (HRs) for each BMI category taking <21 as the reference. The multivariate model initially adjusted for age, current smoking, and current drinking habits. Probability values and HRs described in the text were derived from this model if not specified otherwise. SBP and TC were then separately and simultaneously adjusted for as mediation analyses. If the final model still showed a significant association of

Table 1. Proportions or Mean Values (Standard Deviations) of Baseline Risk Factors According to BMI Categories

		BMI Categories, kg/m²					
	All	<21.0	21.0–22.9	23.0–24.9	25.0–27.4	27.5+	P*
Men							
n	19 760	4997	5426	4855	3263	1219	
Age, y	55.4 (10.3)	57.8 (11.1)	55.3 (10.2)	54.3 (9.8)	54.1 (9.5)	53 (9.1)	<0.0001
Height, cm	163.0 (7.0)	162.4 (7.1)	162.8 (7.0)	163.1 (6.8)	163.7 (6.9)	163.9 (7.0)	<0.0001
Weight, kg	61.1 (9.5)	51.6 (5.5)	58.4 (5.2)	63.8 (5.6)	69.9 (6.2)	78.3 (8.3)	<0.0001
TC, mg/dL	193.9 (36.1)	182.4 (33.1)	191.4 (35.4)	199.1 (35.8)	203.3 (36.4)	206 (37.0)	<0.0001
SBP, mm Hg	131.3 (18.9)	128.1 (19.6)	129.3 (18.4)	132.3 (18.3)	135.3 (18.2)	138.3 (18.2)	<0.0001
DBP, mm Hg	79.6 (11.7)	76.3 (11.3)	78.1 (11.3)	80.6 (11.3)	83.2 (11.5)	86.3 (11.7)	<0.0001
Antihypertensive medication, %†	11.7	8.7	9.6	12.6	15.7	19.6	<0.0001
Current smoker, %	54.5	63.1	55.0	51.6	46.3	50.5	<0.0001
Current drinker, %	71.1	69.0	71.5	72.6	71.7	70.8	0.0019
Women							
n	25 475	6051	6481	5907	4598	2438	
Age, y	56.5 (10.2)	56.4 (11.4)	55.6 (10.3)	56.5 (9.8)	57.2 (9.5)	57.4 (9.3)	<0.0001
Height, cm	149.8 (6.3)	150.2 (6.6)	150.1 (6.3)	149.8 (6.0)	149.2 (6.0)	148.9 (5.9)	<0.0001
Weight, kg	52.4 (8.1)	44 (4.8)	49.7 (4.4)	53.8 (4.5)	58.1 (4.9)	65.8 (7.1)	<0.0001
TC, mg/dL	203.1 (36.0)	196.3 (34.5)	201.5 (35.6)	204.6 (36.1)	207.7 (35.9)	211.8 (37.0)	<0.0001
SBP, mm Hg	129.2 (19.2)	123.6 (18.9)	127 (18.6)	130.2 (18.2)	133.7 (18.6)	138.4 (18.9)	<0.0001
DBP, mm Hg	76.2 (11.1)	72.3 (10.5)	74.8 (10.7)	76.8 (10.5)	79.3 (10.8)	82.5 (11.2)	<0.0001
Antihypertensive medication, %†	14.8	8.1	11.5	15.5	20.7	29.0	<0.0001
Current smoker, %	4.3	5.1	4.0	3.8	4.1	4.8	0.0058
Current drinker, %	12.7	13.0	13.8	12.8	12.1	10.2	0.0001

*Continuous variables were tested by ANOVA and categorical variables were tested by χ^2 tests for the differences across BMI categories.
†Proportions among 11 741 men and 13 174 women for whom the data were available.

BMI with incidence, further adjustment was attempted for history of DM and HDL cholesterol to evaluate their mediation effects in the available sample (n=26 694, 58.8% of total sample). These variables were entered into the model as fixed effects. For each end point—total stroke, cerebral infarction, cerebral hemorrhage, MI, ischemic CVD, and total CVD—analyses were done for men and women, separately.

Supplementarily, stratified analyses were performed by age (≤60 or >60), current smoking, hypercholesterolemia, and hypertension to evaluate possible effect modification. Hypercholesterolemia was defined total cholesterol ≥5.69 mmol/L (220 mg/dL) or use of cholesterol-lowering medication. Hypertension was defined SBP/DBP ≥140/90 mm Hg or use of hypertensive medication. These stratified analyses were carried out in the sex-combined sample after confirming that there was no significant sex-BMI category interaction by likelihood ratio test caused by the small number of events among women. Finally, we conducted analyses excluding events within 1 year of baseline in an attempt to eliminate the potential effect of occult disease on baseline BMI. Age-adjusted incidence rate was obtained by standardizing it to the age distribution of the total sample (n=45 235) and expressed as the number per 10 000 person-years. HR estimates and 95% confidence intervals (CIs) were determined by PROC GLIMMIX in the SAS program for Windows, Release 9.13 (SAS Institute Inc, Cary, NC). The linear trend of HRs across the BMI categories was tested, when appropriate, by a continuous variable assigning the median value of each quintile to corresponding individuals. Forest plots were used to qualitatively assess heterogeneity of associations between BMI and outcomes among included cohorts. These figures are also shown in sex-combined fashion due to small number of events in some cohorts. A probability value less than 0.05 was considered statistically significant.

Results

Mean baseline age and BMI were 55.4 years and 23.0 kg/m² in men and 56.5 years and 23.4 kg/m² in women (Table 1). Higher BMI was associated with higher TC, SBP, and DBP in both men and women. In men, age was inversely associated with BMI. Women in the lowest BMI category were oldest on average, but mean age tended to increase in the subsequent BMI categories. Current smoking was most prevalent in the lowest BMI category in both sexes.

There were 1113 total strokes and 190 MI events during 337 287 person-years for the stroke analyses, 261 702 person-years for the MI analyses, and 206 011 person-years for the total CVD analyses. Among stroke events with reported stroke subtype information, 725 were classified as cerebral infarction and 229 as cerebral hemorrhage. There was no heterogeneity among the cohorts in the association of BMI with any cardiovascular diseases events (P for heterogeneity >0.4, MI shown in Figure 1, cerebral infarction shown in Figure 2, and cerebral hemorrhage shown in Figure 3).

In men, the incidence of cerebral infarction was increased 86% in subjects with BMI ≥27.5 compared with those with BMI <21.0 after adjusting for age, current smoking, and current drinking habits (Table 2). Risks of cerebral infarction tended to increase for each successive BMI category (trend P=0.007). Further adjustment for possible mediating factors (SBP and TC) attenuated the association (HR, 1.51; 95% CI, 0.99 to 2.30). Similarly, in men, BMI was positively associ-

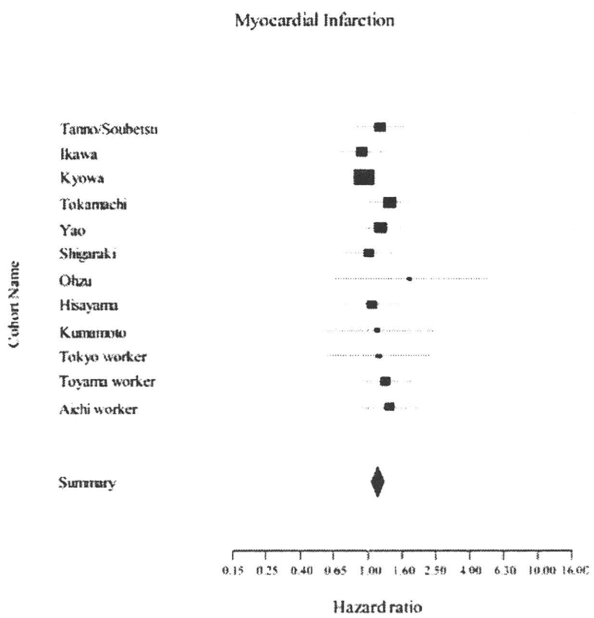

Figure 1. Fixed-effect Poisson regression model was used to determine age, current smoking, and current drinking habits by adjusted HRs of MI per each 2 kg/m² increment in BMI. The HR from each cohort was plotted in the Forest plot for a qualitative assessment of heterogeneity in the associations among included cohorts. *P* for heterogeneity=0.61.

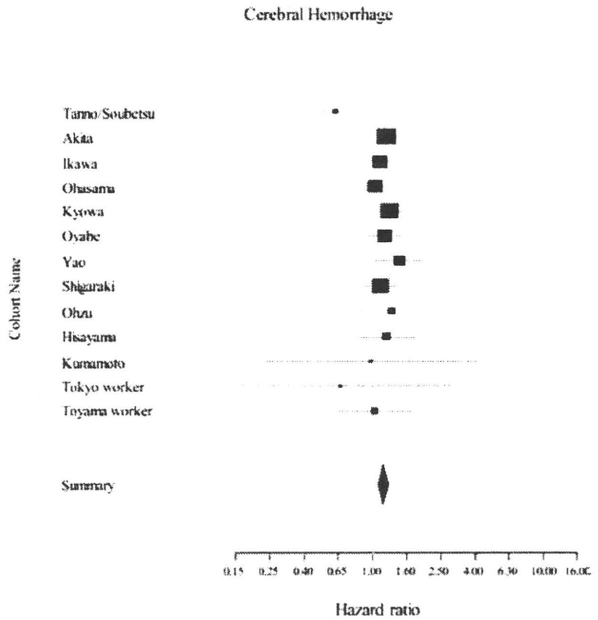

Figure 3. Fixed-effect Poisson regression model was used to determine age, current smoking, and current drinking habits by adjusted HRs of cerebral hemorrhage per each 2 kg/m² increment in BMI. The HR from each cohort was plotted in the Forest plot for a qualitative assessment of heterogeneity in the associations among included cohorts. *P* for heterogeneity=0.60.

ated with risk of cerebral hemorrhage (HR, 2.51; 95% CI, 1.21 to 5.20); this, however, appeared to be highly mediated by SBP (HR, 1.85; 95% CI, 0.89 to 3.86 after adjustment for SBP). For MI, the HR was 3.16 (95% CI, 1.66 to 6.01) for BMI ≥27.5 versus BMI <21.0 only in men, which appeared only partly mediated by TC and SBP (trend $P=0.012$ after adjustment for TC and SBP). Further adjustment for history of DM and HDL cholesterol in a subsample in which these variables were available did not eliminate the MI-BMI association (trend $P=0.004$ data not shown in the table).

In women, both cerebral infarction and hemorrhage were significantly and positively associated with BMI (Table 3). Although the association with cerebral hemorrhage was largely mediated by SBP (trend $P=0.17$ after adjustment for SBP), BMI showed a somewhat independent association with cerebral infarction (trend $P=0.044$ after adjustment for SBP). No association was observed between BMI and MI in women.

Analyses excluding events within 1 year after baseline produced similar results in both men and women. Associations were similar in the stratified analyses by age or current smoking habit for all end points (all trend $P<0.05$). Cerebral infarction and MI were similarly associated with BMI within cholesterol strata (all trend $P<0.05$). Although incidence rates of these end points in subjects with hypertension were much higher than the rates in those without it, associations with BMI were more prominent for nonhypertensive subjects (Table 4).

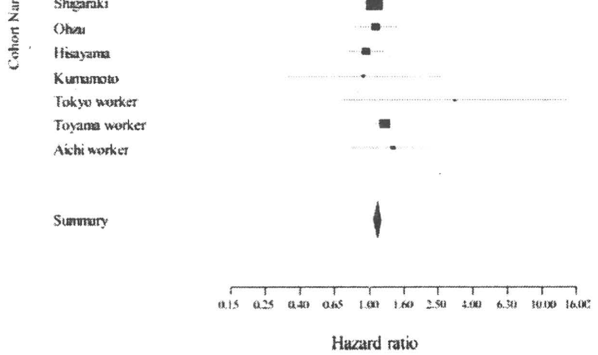

Figure 2. Fixed-effect Poisson regression model was used to determine age, current smoking, and current drinking habits by adjusted HRs of cerebral infarction per each 2 kg/m² increment in BMI. The HR from each cohort was plotted in the Forest plot for a qualitative assessment of heterogeneity in the associations among included cohorts. *P* for heterogeneity=0.58.

Discussion

In the present meta-analysis of prospective studies of a relatively lean population, incidence of cerebral infarction and hemorrhage in both sexes and that of myocardial infarction in men were associated positively and linearly with the degree of obesity as measured by BMI. The associations

Table 2. Hazard Ratios and 95% Confidence Intervals for CVD According to BMI Categories in Men

End Points Model	<21.0 HR (95% CI)	21.0–22.9 HR (95% CI)	23.0–24.9 HR (95% CI)	25.0–27.4 HR (95% CI)	27.5+ HR (95% CI)	Trend *P*
Total stroke						
n of cases/N	147/4383	167/4869	138/4364	82/2992	42/1132	
Age-adjusted incidence rate	36.1	44.8	44.4	43.7	57.6	
Model 1	1	1.29 (1.03–1.61)	1.30 (1.03–1.64)	1.24 (0.94–1.63)	1.81 (1.28–2.56)	0.003
+SBP	1	1.24 (0.99–1.55)	1.15 (0.91–1.46)	1.04 (0.79–1.38)	1.48 (1.04–2.10)	0.17
+SBP+TC	1	1.25 (1.00–1.56)	1.17 (0.92–1.48)	1.06 (0.80–1.40)	1.50 (1.06–2.14)	0.13
Cerebral infarction						
n of cases/N	111/4383	117/4869	108/4364	58/2992	29/1132	
Age-adjusted incidence rate	26.2	31.5	35.2	32.5	41.1	
Model 1	1	1.23 (0.95–1.60)	1.41 (1.08–1.84)	1.23 (0.89–1.69)	1.77 (1.17–2.68)	0.007
+SBP	1	1.19 (0.92–1.55)	1.28 (0.97–1.67)	1.06 (0.77–1.47)	1.50 (0.99–2.28)	0.12
+SBP+TC	1	1.19 (0.92–1.55)	1.28 (0.98–1.68)	1.06 (0.76–1.47)	1.51 (0.99–2.30)	0.12
Cerebral hemorrhage						
n of cases/N	23/4383	33/4869	21/4364	19/2992	11/1132	
Age-adjusted incidence rate	6.0	8.6	6.4	8.7	14.0	
Model 1	1	1.47 (0.86–2.51)	1.10 (0.61–2.01)	1.54 (0.83–2.86)	2.51 (1.21–5.20)	0.045
+SBP	1	1.40 (0.82–2.39)	0.95 (0.52–1.73)	1.22 (0.66–2.28)	1.85 (0.89–3.86)	0.32
+SBP+TC	1	1.41 (0.83–2.42)	0.97 (0.53–1.77)	1.26 (0.67–2.36)	1.92 (0.91–4.03)	0.26
MI						
n of cases/N	26/3918	5/4231	33/3864	27/2632	15/1011	
Age-adjusted incidence rate	8.5	8.4	12.5	18.9	25.2	
Model 1	1	1.07 (0.61–1.85)	1.68 (1.00–2.83)	2.21 (1.28–3.83)	3.16 (1.66–6.01)	<0.001
+SBP	1	1.03 (0.60–1.80)	1.54 (0.91–2.59)	1.90 (1.09–3.30)	2.65 (1.38–5.08)	<0.001
+SBP+TC	1	0.93 (0.54–1.63)	1.30 (0.77–2.21)	1.53 (0.87–2.69)	2.12 (1.10–4.10)	0.012
Ischemic CVD						
n of cases/N	77/3304	82/3674	96/3373	51/2361	30/924	
Age-adjusted incidence rate	32.4	37.1	49.6	44.3	64.8	
Model 1	1	1.25 (0.91–1.71)	1.74 (1.28–2.35)	1.39 (0.97–1.99)	2.16 (1.41–3.30)	<0.001
+SBP	1	1.20 (0.88–1.64)	1.58 (1.16–2.14)	1.19 (0.83–1.72)	1.84 (1.20–2.83)	0.008
+SBP+TC	1	1.17 (0.85–1.60)	1.51 (1.11–2.05)	1.13 (0.78–1.63)	1.75 (1.13–2.70)	0.022
Total CVD						
n of cases/N	97/3304	111/3674	113/3373	64/2361	37/924	
Age-adjusted incidence rate	40.9	48.4	57.4	53.5	76.4	
Model 1	1	1.30 (0.99–1.72)	1.57 (1.19–2.07)	1.34 (0.98–1.85)	2.03 (1.39–2.98)	<0.001
+SBP	1	1.24 (0.94–1.64)	1.39 (1.06–1.83)	1.11 (0.80–1.54)	1.65 (1.12–2.43)	0.036
+SBP+TC	1	1.22 (0.93–1.61)	1.35 (1.02–1.78)	1.07 (0.77–1.49)	1.59 (1.08–2.35)	0.070

n indicates number; N, number of subjects.

Incidence rate was adjusted to the age distribution of total sample (n=45 235) and expressed as the number per 10 000 person-years.

Model 1: Adjusted for age and current smoking and current drinking habits.

Stroke analyses were carried out using data from 15 cohorts (17 740 men); MI analysis, 13 cohorts (15 656 men); and ischemic (cerebral infarction and MI) and total CVD analyses, 12 cohorts (13 636 men).

between stroke, especially cerebral hemorrhage, and BMI in both sexes were largely mediated by blood pressure, but BMI tended to explain incidence of cerebral infarction independent of TC and SBP. Although further mediation analyses using DM history information in the available sample were possible, the results would not be readily interpretable because SBP adjustment alone significantly attenuated the association. Thus, the association of cerebral infarction with BMI largely appears to be mediated by SBP. In contrast, the association of MI incidence with BMI in men was strong and was independent of TC and SBP. Even further adjustment for history of DM and HDL cholesterol did not eliminate the association. Although residual confounding caused by measurement error of these covariates is possible, other factors that accompany obesity may increase MI risk, such as prothrombotic factors[15] or low-grade systematic inflammation.[16] In any case, the present results imply that avoidance of obesity offers the potential of reducing CVD in Japan.

Table 3. Hazard Ratios and 95% Confidence Intervals for CVD According to BMI Categories in Women

End Points Model	<21.0 HR (95% CI)	21.0–22.9 HR (95% CI)	23.0–24.9 HR (95% CI)	25.0–27.4 HR (95% CI)	27.5+ HR (95% CI)	Trend *P*
Total stroke						
n of cases/N	108/4911	110/5255	121/4753	120/3766	78/2090	
Age-adjusted incidence rate	21.9	23.3	26.8	313	34.8	
Model 1	1	1.05 (0.81–1.38)	1.22 (0.94–1.58)	1.45 (1.12–1.89)	1.65 (1.23–2.21)	<0.001
+SBP	1	0.99 (0.76–1.29)	1.09 (0.84–1.42)	1.23 (0.94–1.60)	1.31 (0.97–1.76)	0.028
+SBP+TC	1	1.00 (0.77–1.31)	1.10 (0.85–1.44)	1.25 (0.96–1.62)	1.33 (0.98–1.79)	0.021
Cerebral infarction						
n of cases/N	61/4911	58/5255	67/4753	75/3766	41/2090	
Age-adjusted incidence rate	12.3	12.3	14.8	19.3	18.4	
Model 1	1	1.01 (0.71–1.45)	1.22 (0.86–1.73)	1.64 (1.17–2.30)	1.56 (1.05–2.32)	0.001
+SBP	1	0.96 (0.67–1.37)	1.10 (0.78–1.56)	1.40 (0.99–1.97)	1.25 (0.84–1.87)	0.050
+SBP+TC	1	0.96 (0.67–1.39)	1.11 (0.78–1.57)	1.41 (1.00–1.99)	1.27 (0.85–1.90)	0.044
Cerebral hemorrhage						
n of cases/N	26/4911	22/5255	24/4753	28/3766	22/2090	
Age-adjusted incidence rate	4.8	4.6	5.3	7.3	9.4	
Model 1	1	0.88 (0.50–1.55)	1.02 (0.58–1.78)	1.43 (0.83–2.45)	1.98 (1.12–3.52)	0.010
+SBP	1	0.80 (0.45–1.41)	0.87 (0.49–1.52)	1.12 (0.65–1.93)	1.41 (0.79–2.52)	0.17
+SBP+TC	1	0.81 (0.46–1.43)	0.89 (0.50–1.55)	1.15 (0.67–1.99)	1.44 (0.80–2.59)	0.15
MI						
n of cases/N	13/4389	17/4494	11/4047	17/2975	6/1567	
Age-adjusted incidence rate	3.3	4.5	3.0	6.0	3.6	
Model 1	1	1.37 (0.66–2.83)	0.92 (0.41–2.06)	1.73 (0.83–3.57)	1.15 (0.44–3.04)	0.42
+SBP	1	1.26 (0.61–2.60)	0.79 (0.35–1.78)	1.43 (0.69–2.97)	0.89 (0.33–2.36)	0.89
+SBP+TC	1	1.14 (0.55–2.36)	0.73 (0.32–1.64)	1.26 (0.60–2.62)	0.78 (0.29–2.09)	0.86
Ischemic CVD						
n of cases/N	51/3249	44/3268	45/2893	51/2143	24/1219	
Age-adjusted incidence rate	19.1	18.3	18.6	26.5	20.4	
Model 1	1	0.98 (0.65–1.46)	1.02 (0.68–1.52)	1.41 (0.96–2.09)	1.12 (0.69–1.82)	0.19
+SBP	1	0.92 (0.62–1.38)	0.94 (0.63–1.40)	1.25 (0.84–1.86)	0.95 (0.58–1.55)	0.60
+SBP+TC	1	0.91 (0.61–1.37)	0.92 (0.62–1.38)	1.23 (0.83–1.83)	0.93 (0.57–1.53)	0.65
Total CVD						
n of cases/N	76/3249	64/3268	73/2893	78/2143	47/1219	
Age-adjusted incidence rate	27.7	26.8	30.5	40.9	40.8	
Model 1	1	0.94 (0.67–1.31)	1.10 (0.80–1.52)	1.46 (1.07–2.01)	1.49 (1.04–2.15)	0.003
+SBP	1	0.88 (0.63–1.23)	1.00 (0.72–1.38)	1.26 (0.92–1.74)	1.22 (0.84–1.77)	0.077
+SBP+TC	1	0.87 (0.62–1.22)	0.99 (0.72–1.37)	1.25 (0.91–1.73)	1.21 (0.84–1.76)	0.087

n indicates number; N, number of subjects.

Incidence rate was adjusted to the age distribution of total sample (n=45 235) and expressed as the number per 10 000 person-years.

Model 1: Adjusted for age and current smoking and current drinking habits.

Stroke analyses were carried out using data from 15 cohorts (20 775 women); MI analysis, 13 cohorts (17 472 women); and ischemic (cerebral infarction and MI) and total CVD analyses, 12 cohorts (12 772 women).

This pattern of BMI independently associated with MI is consistent with most previous reports.[4,17–20] Most studies conclude that the effect of obesity on stroke was explained by etiologically mediating factors that accompany obesity. For example, a significant association of BMI with stroke was explained by hypertension, hypercholesterolemia, and DM in the Framingham study.[17] The relative risk for ischemic stroke was successively significantly attenuated by adjustments for hypertension, hypercholesterolemia, and DM in the Women's Health Study.[5] The association of BMI with intracerebral hemorrhage was no longer significant after adjustment for blood glucose, cholesterol, and SBP in Korean women.[19] Other studies suggest some residual association of BMI with stroke[4,18,20] after controlling for the established risk factors associated with adiposity.

Although we found that the incidence of cerebral hemorrhage was associated positively with BMI, previous studies are less consistent. No[21,22] inverse or J-shaped[6] associations

Table 4. Hazard Ratios and 95% Confidence Intervals of Stroke and MI According to BMI Categories in Subjects With or Without Hypertension

		BMI Categories, kg/m²					
End Points	n of Cases/N	<21.0 HR (95% CI)	21.0–22.9 HR (95% CI)	23.0–24.9 HR (95% CI)	25.0–27.4 HR (95% CI)	27.5+ HR (95% CI)	Trend *P*
Cerebral infarction							
Without hypertension	257/24 404	1	1.23 (0.88–1.72)	1.31 (0.91–1.87)	1.72 (1.17–2.53)	1.82 (1.07–3.08)	0.002
With hypertension	468/14 311	1	1.03 (0.78–1.35)	1.17 (0.89–1.53)	1.07 (0.80–1.43)	1.19 (0.85–1.68)	0.29
Cerebral hemorrhage							
Without hypertension	63/24 404	1	1.16 (0.59–2.32)	0.94 (0.44–2.05)	1.46 (0.67–3.18)	2.79 (1.18–6.59)	0.067
With hypertension	166/14 311	1	1.05 (0.65–1.67)	0.91 (0.56–1.47)	1.13 (0.70–1.83)	1.36 (0.79–2.32)	0.32
MI							
Without hypertension	64/20 291	1	1.06 (0.52–2.17)	1.57 (0.79–3.14)	2.36 (1.13–4.93)	2.08 (0.69–6.25)	0.016
With hypertension	126/12 837	1	1.22 (0.70–2.14)	1.19 (0.67–2.08)	1.58 (0.91–2.76)	1.69 (0.88–3.23)	0.061

n indicates number; N, number of subjects.

All HRs were adjusted for age, sex, and current smoking and current drinking habits.

Hypertension was defined as those who reported the use of antihypertensive medications or SBP and/or DBP was ≥140/90 mm Hg.

Interactions for BMI category by hypertension tested in Model 1 using likelihood ratio test with 5 degrees of freedom were significant ($P<0.05$) for all end points.

have been reported. Small numbers of cases, heterogeneity of hemorrhagic strokes,[4] or differences in other factors such as average cholesterol level might contribute to such discrepancies.[23] However, large-scale studies of Korean men and women also reported BMI positively associated with cerebral hemorrhage as well as corroborative evidence that overweight/obesity increases risk of cerebral hemorrhage through the elevation of blood pressure.[19,20]

There are several strengths of the present study, apart from its large-scale and prospective design. We used measured weight and height rather than self-reported measures. We could also examine the potential effect of mild or moderate increases in relative weight in our lean population. The present study included participants from urban and rural areas, or community-based and work site–based cohorts, strengthening the generalizability of the study findings.

There are also several limitations that should be considered. First, other obesity measures incorporating abdominal regional adiposity may better predict individual risk of CVD beyond BMI. It is, however, reported that differences of such measures applied to a population are unlikely to be clinically important.[24,25] Second, it is possible that physical activity may explain or modify some of our findings, although previous studies have shown independent associations of BMI with CVD.[26,27] Another limitation may be the lack of information on ischemic stroke subtypes (lacunar, atherothrombotic. or embolic), which should specifically be addressed in future studies. Furthermore, the number of events was still small, so sex-specific stratified analyses were not feasible.

In conclusion, in the present large, population-based, prospective study of Japanese men and women, greater BMI was associated with an increased risk of total stroke, cerebral infarction, and cerebral hemorrhage in men and women and MI in men. The fact that stroke risks associated with obesity appeared largely explained by concomitant rise in blood pressure emphasizes the role of weight control including prevention of weight gain as a way to prevent and control hypertension and thus stroke. Our finding that obesity independently increased MI risk implies additional importance of obesity control in MI prevention in men. To avoid a possible upturn of stroke and CHD incidence in Japan, we believe that a rise in weight in the population should be prevented vigorously and that weight control should be emphasized in those with elevated weight regardless of age and sex.

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研究ノート

減量プログラムによる女性の食行動改善と減量効果との関連

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Association between Change in Eating Behaviors and Weight Reduction Through a Health Guidance Program for Improvement of Obesity among Japanese Women

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Several observational studies have suggested that some eating behaviors are related to obesity, but few studies have indicated the association between change in eating behavior and improvement of obesity. Therefore, the objective of this study was to determine whether changes in eating behaviors are associated with changes in body weight and dietary intakes. The subjects were 144 Japanese women (age, 19–78 years; body mass index [BMI], 18.6–43.8 kg/m^2) who participated in a health guidance program for improvement of obesity "Slim-de-kenko-Juku" at Osaka Medical Center for Health Science and Promotion from September 2003 to August 2008. During this 2.5-month program, participants were provided health guidance 8 times, and 2 health check-ups were performed. Anthropometric measures, blood pressure, serum chemistry, dietary intakes, and eating behaviors were evaluated at the 2 health check-ups. We analyzed associations between changes in BMI and eating behaviors by stepwise multiple linear regression analysis. After the program, body weight, BMI, body fat, and waist circumference were significantly reduced (mean values, −1.8 kg, −0.8 kg/m^2, −1.5%, and −3.6 cm, respectively; $p<0.001$). Dietary energy and intake of carbohydrates, fat, sugar, oils, and snacks were decreased, vegetable intake and physical activity were increased. Further, eating behaviors were improved, especially among obese individuals. Results of stepwise multiple liner regression analysis revealed that improvement of "substitute eating and drinking" was significantly associated with decrease in BMI ($\beta=-0.284$; $p<0.001$). In conclusion, our findings suggested that improvement of eating behaviors, particularly "substitute eating and drinking" is important for improvement of obesity in Japanese women.

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Key words: eating behaviors, BMI, dietary intake, health guidance program, japanese women

緒　　言

わが国では，2008年度からメタボリックシンドロームの概念を取り入れた，特定健康診査・特定保健指導が導入された。この制度は，生活習慣病につながる内臓脂肪型肥満に着目して，保健指導対象者を階層化し，介入を行うことが特徴である[1)]。介入の目的は内臓脂肪量を減ら

キーワード：食行動，BMI，食事摂取状況，減量プログラム，日本人女性

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すことにあり，食事療法と運動療法を積極的に併用することが求められる。

内臓脂肪型肥満を含む肥満症の者は，「水を飲んでも太る」等の誤った認識や，「他人が食べているとつられて食べてしまう」等の食行動異常が多くみられ，このことが減量を阻害する要因の一つとなっている場合がある[2]。食行動異常と肥満の関連を検討したわが国の先行研究では，女子大生及び中高年勤務者男女において，「早食い」の者ほど Body Mass Index（BMI）の平均値が高いことが報告されている[3,4]。秋田県及び大阪府の地域住民を対象にした横断研究[5]では，「早食い」に「満腹まで食べる」行動が加わると，肥満との関連がさらに強くなることが示されている。また工場勤務者においては，坂田らの食行動質問表[2]の食行動異常のスコアが高いほど，肥満の傾向がみられた[6,7]という報告がある。しかしながら，食行動異常に着目した指導の効果についての検討は少ない[8,9]。本研究では，より効果的な減量食事指導法の確立に資するため，一般健常者を対象として実施した減量プログラムにおける介入前後の所見をもとに，種々の食行動の変化と減量効果との関連について検討した。

方　　法

1．対　　象

2003年9月－2008年8月に，大阪府立健康科学センターにおいて，一般人を対象に参加を募った減量プログラム「スリムで健康塾（以下スリム塾）」を完了した女性144名（年齢19－78歳，平均53.6歳，実行率92％）を対象とした。

2．調査方法

スリム塾では，約2ヶ月半，計10回の教室を実施した（図1）。1回目に身体計測・血液検査・全身体脂肪測定 dual x-ray absorptiometry（DXA），腹部 computed tomography（CT），体力測定，問診，食行動調査，食事診断を行った。DXA で体脂肪率，体脂肪重量，除脂肪重量を測定し，腹部 CT で，内臓脂肪量面積，皮下脂肪量面積を測定した。食行動調査は，坂田らが示している食行動領域別の設問の30項目[2]を用いた（図2）。本質問表の食行動異常のスコアは，BMI と逆相関し，対照群は肥満群に比し有意に低値を示したことから，妥当性が確認されている[2,10]。食行動は内容別に，体質に関する認識（質問数3，以下同様），空腹感・食動機（3），代理摂食（6），満腹感覚（5），食べ方（3），食事内容（5），リズム異常（5）の7領域に分類し，質問項目の答を，「全くその通り：1点，そういう傾向がある：2点，時々そういう傾向がある：3点，そんなことはない：4点」とスコア化した。各領域ごとに，それぞれの各質問項目のスコアを加算したものを各領域のスコアとした。食事診断は，1週間の秤量法による食事調査を実施し，半定量食物摂取頻度調査法（ゲンキープ FFQ[11,12]）を用いた。本ゲンキープ FFQ の妥当性を検討するため，23歳－77歳の女性30名を対象として，本法と7日間食事記録法による結果を比較した結果，主な栄養素摂取量のスピアマン相関係数は，エネルギー（$r=0.63$），炭水化物（$r=0.64$），たんぱく質（$r=0.38$），脂質（$r=0.52$），脂質エネルギー

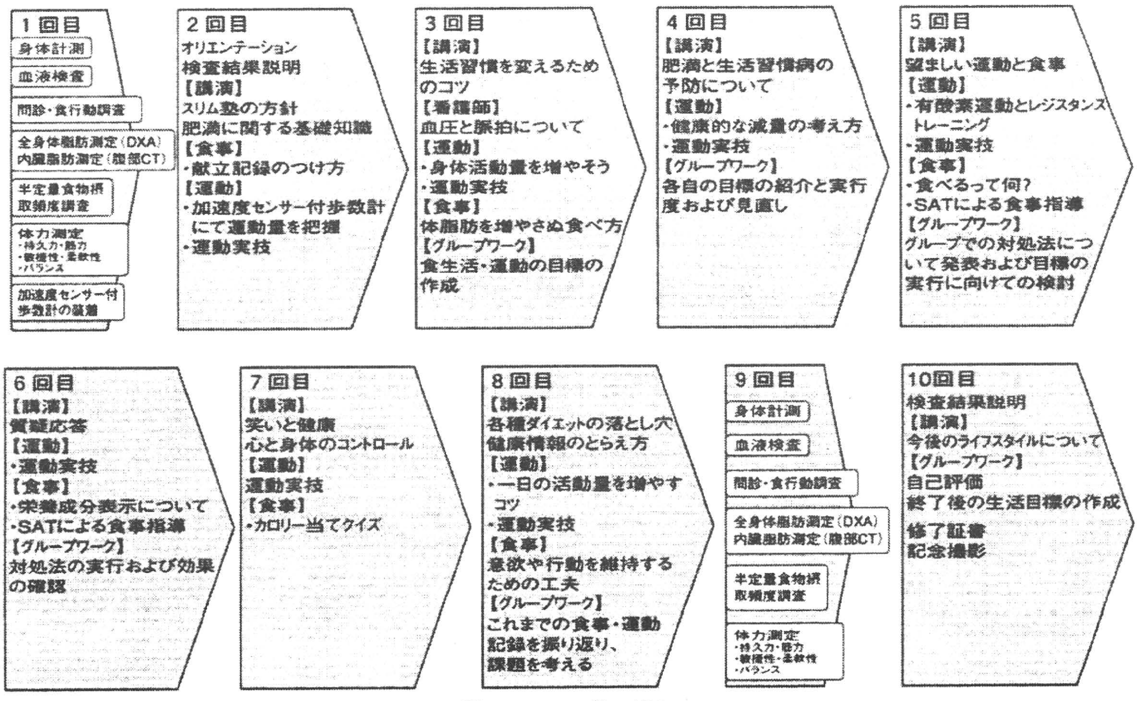

図1　スリム塾の流れ

食行動について　以下の問いに，次に示す番号で答えて下さい

1：全くその通り　　2：そういう傾向がある
3：時々そういう傾向がある　　4：そんなことはない

		（質　問　項　目）	あなたの答え
1	体質に関する認識	自分は他人よりも太りやすい体質だと思う	
2		水を飲んでも太るほうだ	
3		小さい頃から良く食べるほうだった	
4	空腹感・食動機	食料品を買うときには，必要量より多めに買っておかないと気がすまない	
5		料理を作るときには，多めに作らないと気がすまない	
6		外食や出前をとるときに多めに注文してしまう	
7	代理摂食	他人が食べていると，つられて食べてしまう	
8		鉢に果物やお菓子をいれて身近に置いてある	
9		果物やお菓子が置いてあるとついつい手がでてしまう	
10		食べ物をもらうと，もったいないので食べてしまう	
11		連休や盆，正月にはいつも太ってしまう	
12		イライラすると食べることで発散する	
13	満腹感覚	お腹いっぱい食べないと満腹感を感じない	
14		食後でも好きなものなら入る	
15		食べ過ぎを他人によく注意される	
16		たくさん食べてしまった後で後悔する	
17		料理が余るともったいないので食べてしまう	
18	食べ方	早食いである	
19		ほとんど噛まない	
20		よく噛めない	
21	食事内容	めん類が好きである	
22		濃い味好みである	
23		油っこいものが好きである	
24		ファーストフードをよく利用する	
25		スナック菓子をよく食べる	
26	リズム異常	食事の時間がでたらめである	
27		ゆっくり食事をとる暇がない	
28		昼間，間食をする	
29		夜食をとる	
30		缶ジュース・缶コーヒー，ポカリスエット，栄養ドリンクをよく飲む	

図2　食行動質問紙の質問項目

比率（$r=0.33$）であった。また食品群摂取量のスピアマン相関係数は，いも類（$r=0.22$），砂糖類（$r=0.14$）では小さかったが，他の食品群では0.35－0.68と中等度の相関を認めた（データ略）。このゲンキーブ FFQ を用いて，過去1週間の食品の摂取頻度をもとに，フードモデルを使用して一回量等を確認した後，一日平均の摂取エネルギー及び各栄養素，食品群の量を算出した。この際，サプリメント類は栄養素の摂取量に含めなかった。

スリム塾の2回目は検査結果の説明，3回目から8回目は，肥満に関する講義と運動・食事に関する指導を行った。まず，医師，看護師，運動トレーナー，管理栄養士の指導のもと，減量のための行動目標を作成し，その後は毎回グループワークを実施して，目標に対する効果や続けるための工夫等の意見交換の場を設けた。グループワークでも，医師，看護師，運動トレーナー，管理栄養士が参加し，専門的なアドバイスを行い，目標の見直しや意欲の継続を促すよう努めた。9回目に1回目と同様の検査を行い，10回目は1回目と9回目の検査結果比較による自己評価をし，今後につながる行動目標を作成した。1回目から10回目まで，参加者は食事や体重