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Changes in exercise habits and pulse wave velocity with lifestyle modification in Japanese

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ABSTRACT

We investigated the changes in exercise habits and brachial-ankle pulse wave velocity (baPWV) with lifestyle modification in Japanese. We used data for 105 men (48.2 ± 13.8 years) and 110 women (48.6 ± 12.1 years) without any medications with a 1-year follow up. Subjects were given advice for dietary and lifestyle improvement. At the 1-year follow up, body weight and body mass index (BMI) were significantly decreased in both sexes. Abdominal circumference was significantly decreased in men. In addition, changes in exercise habits were noted in both sexes. In separate analysis in subjects without exercise habits at baseline, the changes in baPWV with exercise habits at follow up was lower than that without exercise habits at follow up in both sexes, but not at a significant level. Lifestyle modification may increase exercise habits, however, it did not evidently change baPWV in this population.

Keywords: Lifestyle Modification; baPWV; Exercise Habits

1. INTRODUCTION

Arterial stiffness represents one of the major hemodynamic factors determining pulse pressure even at an early stage of disease and its changes have been shown to be an independent predictor of hard endpoints in patients with a high cardiovascular risk. Pulse pressure and heart rate constitute other outcomes that may be useful as additional factors in risk assessment [1]. Pulse wave velocity (PWV) is measured from the initial upstroke of pressure wave and constitutes an established index of arterial stiffness. It is directly related to arterial compliance and other factors describing arterial stiffness [2]. PWV is not only a good tool for assessing vascular damage, but also an independent predictor of all-cause and cardiovascular mortality [3].

It is well known that regular physical activity has been shown to increase HDL and reduce resting blood pressure, triglycerides, abdominal fat accumulation, fasting blood sugar, and insulin responses to oral glucose challenge test [4-8]. The prevalence of subjects with exercise habits in Japan was reported to be 29.1% in men and 25.6% in women by the National Nutrition Survey in Japan [9]. Therefore, evaluation of the relationship between exercise habits and PWV may provide quite useful data for preventing future diseases in the Japanese general population.

In this study, we evaluated the changes in exercise habits and brachial-ankle PWV (baPWV) with lifestyle modification in Japanese without medications.

2. SUBJECTS AND METHODS

2.1. Subjects

We used data for 105 Japanese men (48.2 ± 13.8 years) and 110 Japanese women (48.6 ± 12.1 years) among 4200 subjects (1580 men and 2620 women), who met the following criteria: 1) received a health check-up including special health guidance (from April 2006 to August 2010) and a follow-up check-up 1-year later, 2) received anthropometric and exercise habits measurements as part of the annual health check-up, 3) received no medications for diabetes, hypertension, and/or dyslipidemia, and 4) provided written informed consent (**Table 1**).

At the first health check-up, all subjects were given instructions by well-trained medical staff on how to change their lifestyle as special health guidance. Nutritional instruction was provided with a well-trained nutriationist, who planned a diet for each subject based on their data and provided simple instructions (*i.e.* not to eat too much and to consider balance when they eat). Exercise instruction was also provided by a well-trained physical therapist, who encouraged each subject to increase their daily amount of steps walked.

Ethical approval for the study was obtained from the

Table 1. Changes in parameters of enrolled subjects.

	Baseline (Mean ± SD)	**Follow-up** (Mean ± SD)	*p*
Men			
Number of subjects	105		
Age	48.2 ± 13.8		
Height (cm)	170.5 ± 6.0		
Body weight (kg)	71.3 ± 11.6	70.0 ± 11.1	**0.0003**
Body mass index (kg/m^2)	24.5 ± 3.7	24.1 ± 3.4	**0.0002**
Abdominal circumference (cm)	85.6 ± 10.2	84.2 ± 9.6	**0.0033**
Hip circumference (cm)	95.1 ± 6.6	95.0 ± 8.1	0.8221
baPWV (right) (cm/s)	1329.1 ± 210.0	1326.8 ± 198.5	0.8261
baPWV (left) (cm/s)	1333.4 ± 217.9	1326.8 ± 196.4	0.5129
baPWV (mean) (cm/s)	1331.2 ± 212.4	1326.8 ± 195.2	0.6529
Women			
Number of subjects	110		
Age	48.6 ± 12.1		
Height (cm)	157.5 ± 5.0		
Body weight (kg)	54.3 ± 7.6	53.7 ± 7.5	**0.0171**
Body mass index (kg/m^2)	21.9 ± 3.1	21.7 ± 3.0	**0.0175**
Abdominal circumference (cm)	76.4 ± 8.7	76.8 ± 8.8	0.5053
Hip circumference (cm)	91.2 ± 5.2	90.6 ± 5.1	0.0623
baPWV (right) (cm/s)	1241.1 ± 189.1	1231.9 ± 182.8	0.3532
baPWV (left) (cm/s)	1258.6 ± 198.7	1254.3 ± 206.0	0.7391
baPWV (mean) (cm/s)	1249.9 ± 192.0	1243.1 ± 186.3	0.5147

Ethical Committee of Okayama Health Foundation.

2.2. Anthropometric Measurements

The anthropometric parameters were evaluated by using the following respective parameters such as height, body weight, body mass index (BMI), abdominal circumference, hip circumference. BMI was calculated by weight/[height]^2 (kg/m^2). The abdominal circumference was measured at the umbilical level and the hip was measured at the widest circumference over the trochanter in standing subjects after normal expiration [10].

2.3. PWV Measurements

The baPWV was measured using a form PWV/ABI (Colin, Co., Ltd., Komaki, Japan) after resting at least 15 minutes as described previously [11]. This instrument records PWV, blood pressure, electrocardiogram and heart sounds simultaneously. The subjects were examined in the spine position after at least 5 minutes rest, with electrocardiogram electrodes placed on both wrists, a microphone for detecting heart sounds placed on the left edge of the sternum, and cuffs wrapped on both the brachia and ankles. The cuffs were connected to a plethymographic sensor that determines volume pulse form and an oscillometric pressure sensor that measures blood pressure. Volume waveforms for the brachium and ankle were stored, and the sampling time was 10 s with automatic gain analysis and quality adjustment.

2.4. Exercise Habits

The data on exercise habits were obtained at interviews conducted by well-trained staff using the structured method of the National Nutrition Survey in Japan. The subjects were asked if they currently exercise (over 30 min per session, 2 times per week for duration of 3 months). When the answer was "yes", they were classified as subjects with exercise habits. When the answer was "no", they were classified as subjects without exercise habits.

2.5. Statistical Analysis

Data are expressed as means ± standard deviation (SD) values. A comparison of parameters between the 2 groups was made using the unpaired *t*-test, χ^2 test and covariance analysis; $p < 0.05$ was considered to indicate statistical significance.

3. RESULTS

The clinical parameters at the baseline and the 1-year follow up are summarized in **Table 1**. Body weight, BMI and abdominal circumference were significantly reduced with lifestyle modification after one year in men. Body weight and BMI were also significantly reduced after one year in women. However, baPWV was reduced after one year in both sexes, but not at a significant level.

We also evaluated the changes in exercise habits in enrolled subjects (**Table 2**). Subjects with exercise habits were significantly increased in both sexes.

The changes in parameters in subjects without exercise habits at baseline were also investigated (**Table 3**). With lifestyle modification, body weight, BMI and abdominal circumference were significantly reduced with lifestyle modification after one year in men. Body weight and BMI were also significantly reduced after one year in women. However, baPWV was also reduced after one year in both sexes, but not at a significant level.

Finally, among subjects without exercise habits at baseline, we further compared the change in baPWV between subjects with and without exercise habits at follow up. The changes in baPWV in subjects with exercise habits at follow up were lower than those in subjects without exercise habits at follow up in both sexes, but not at a significant level even after adjusting for age (men: $p = 0.3204$, women: $p = 0.3462$) (**Table 4**).

4. DISCUSSION

The main objective of this study was to explore the changes in exercise habits and baPWV in apparently healthy Japanese with lifestyle modification with a 1-year follow up.

In some literatures, the link between exercise and PWV has been reported. Gando *et al*. have reported that

Table 2. Changes in exercise habits of enrolled subjects.

		Follow-up		*p*
		Exercise habits (+)	Exercise habits (–)	
Men				
Baseline	Exercise habits (+)	36	6	**0.0052**
	Exercise habits (–)	38	25	
Women				
Baseline	Exercise habits (+)	29	4	**< 0.0001**
	Exercise habits (–)	25	52	

Table 3. Changes in parameters of enrolled subjects without exercise habits at baseline.

	Baseline (Mean ± SD)	**Follow-up** (Mean ± SD)	*p*
Men			
Number of subjects	63		
Age	45.4 ± 12.4		
Height (cm)	171.9 ± 5.1		
Body weight (kg)	73.5 ± 12.2	71.9 ± 11.8	**0.0013**
Body mass index (kg/m^2)	24.9 ± 4.0	24.3 ± 3.9	**0.0011**
Abdominal circumference (cm)	87.4 ± 10.6	85.7 ± 10.5	**0.0092**
Hip circumference (cm)	96.5 ± 6.9	96.6 ± 9.5	0.8989
baPWV (right) (cm/s)	1313.4 ± 200.9	1302.7 ± 172.9	0.4220
baPWV (left) (cm/s)	1317.4 ± 207.6	1305.2 ± 22.9	0.3716
baPWV (mean) (cm/s)	1315.4 ± 202.3	1304.0 ± 175.3	0.3851
Women			
Number of subjects	77		
Age	49.0 ± 11.8		
Height (cm)	157.7 ± 4.7		
Body weight (kg)	54.6 ± 7.7	54.0 ± 7.3	**0.0357**
Body mass index (kg/m^2)	22.0 ± 3.2	21.8 ± 3.0	**0.0481**
Abdominal circumference (cm)	76.3 ± 8.8	77.1 ± 8.9	0.1943
Hip circumference (cm)	91.0 ± 5.4	90.7 ± 5.1	0.3186
baPWV (right) (cm/s)	1256.1 ± 197.8	1241.6 ± 184.9	0.2160
baPWV (left) (cm/s)	1270.1 ± 203.6	1270.0 ± 217.4	0.9916
baPWV (mean) (cm/s)	1263.1 ± 198.6	1255.8 ± 190.4	0.5532

Table 4. Comparison of changes in baPWV between subjects with and without exercise habits at follow up (subjects without exercise habits at baseline).

	Number of subjects	Mean ± SD	*p*	*p* (after adjusting for age)
Men				
Exercise habits (–) → (+)	38	–21.0 ± 99.0	0.3749	0.3204
Exercise habits (–) → (–)	25	3.0 ± 111.5		
Women				
Exercise habits (–) → (+)	25	–29.1 ± 101.1	0.2206	0.3462
Exercise habits (–) → (–)	52	3.2 ± 110.0		

longer time spent in light physical activity is associated with attenuation of arterial stiffening, especially in older people by cross-sectional analysis of 538 healthy Japanese [12]. Yamamoto K *et al*. also reported that baPWV was higher in poor-flexibility than in high-flexibility group [13]. In longitudinal analysis, Kawasaki *et al*. showed that a 6-month, twice-a-week exercise program emphasizing swimming significantly decreased baPWV in 11 men and 24 women [14]. Figueroa *et al*. also reported that a 12-week moderate-intensity combined circuit resistance and endurance exercise training improves arterial stiffness in 12 subjects [15]. In addition, home-based resistance training decreased baPWV in12 healthy premenopausal women [16]. In this study, with lifestyle modification at an annual health check-up, subjects with exercise habits were significantly increased. Among subjects without exercise habits, the changes in baPWV in subjects with exercise habits at follow up was more decreased than that in subjects without exercise habits at follow up, but not at a significant level. Therefore, it seems reasonable to suggest that simply promoting exercise habits might result in decrease baPWV in some Japanese.

Potential limitations remain in our study. First, the small sample size in our study makes it difficult to infer causality between exercise habits and baPWV. baPWV did not significantly change with a 1-year follow up. Possibly, these results may come from low statistical power and/or misclassification of life-style modification. Second, we also could not reveal the mechanism of the linkage between exercise habits and baPWV. Insulin resistance is associated with arterial stiffness independent of obesity [17]. Exercise habits may improve insulin resistance and baPWV. The third, the 105 men and 110 women among 4200 subjects, all of whom wanted to change their lifestyle, underwent measurements for this study: they were therefore more health-conscious than the average person. Further prospective and large sample size studies are required in Japanese subjects.

5. ACKNOWLEDGEMENTS

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