Favorable Life-Style Modification and Attenuation of Cardiovascular Risk Factors

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In order to develop an effective counseling system for prevention of cardiovascular diseases, the association of a favorably changed life-style with improved risk factors was examined. Participants were 7,321 office workers aged 30–69 years from in and around Nagoya city. The age-adjusted odds ratio (OR) and its 95% confidence interval (CI) were calculated to assess the likelihood of risk factor improvement by favorable life-style modifications during a 3-year period. Those who began to eat breakfast and increased their vegetable intake normalized their previously abnormal diastolic blood pressure with more than twice the likelihood (adjusted OR [95% CI] 2.89 [1.29–6.46] and 2.60 [1.18–5.75], respectively). ‘Began to eat breakfast’ was also significantly associated with normalized total cholesterol (TC) (1.84, [1.05–3.21]). ‘Stopped eating till full’ significantly normalized the body mass index (2.03; [1.25–3.28]), uric acid (1.65; [1.07–2.52]) and TC (1.43; [1.04–1.97]). Those who started regular exercise significantly normalized their high-density lipoprotein-cholesterol (HDL-C) abnormality with 1.69-times the likelihood (1.69; [1.24–2.29]) and those who began to walk briskly also improved their TC abnormality (1.85; [1.19–2.89]). HDL-C was normalized with 2.55-times the likelihood in those who quit smoking (2.55; [1.68–3.86]). Because favorable life-style modifications can attenuate abnormal cardiovascular risk factors, then proper advice on specific risk factors should be routinely given at each health check-up in order to prevent the onset of cardiovascular diseases in subsequent years. (*Jpn Circ J* 1999; 63: 184–188)

Key Words: Breakfast; Cardiovascular risk-factors; Exercise; Life-style modification; Walking

Numerous epidemiological studies have shown that poor life-styles are associated with an increased risk of cardiovascular diseases (CVD)¹ and the incidence of these could be decreased by life-style modification, probably through beneficial effects on the risk factors.^{2–5} It is, however, still controversial which life-style specifically affects which risk factors. In order to obtain useful information for establishing an effective counseling system for the prevention of CVD, we examined the association of a favorably changed life-style with improved risk factors, using data obtained from periodic health check-ups for the middle-aged male population.

Methods

Study Population

A total of 7,321 men aged 30–69 years participated in multiphase health testing in 1989 and 1992 at Aichi Prefectural Center of Health Care (Nagoya, Japan). Most participants were office workers from in and around Nagoya city, who had to undergo an annual medical check-up in accordance with the Industrial Health and Safety

Law.⁶ At the Center, each participant routinely underwent a set of laboratory screenings, and was given medical advice according to his test results.

Questionnaire on Life-Style

Together with the medical check-up, life-style profiles were collected by a self-administered questionnaire with answers in a dichotomized form, which included dietary habits (skip breakfast/not, eat much vegetables/not, eat till full/not, prefer oily food/not, and prefer salty food/not), physical activities (exercise regularly/not, walk briskly/not), and smoking and drinking habits (smoke cigarettes/not and drink alcoholic beverages regularly or occasionally/not). Public health nurses interviewed the participants when the questionnaire was not completely filled out. The validity of this questionnaire has been recently confirmed (unpublished data).

Laboratory Procedures

Blood pressure was automatically measured with an automatic mercury sphygmomanometer in a supine position after about a 2-min rest. Systolic and diastolic blood pressures were expressed as the level of Swan’s first and fifth point, respectively. Body mass index (BMI) was defined as weight (kg) divided by height (m) squared. Venous blood sampled from fasting participants was immediately analyzed for total serum cholesterol, glucose, triglyceride, and uric acid by the in-house chemical autoanalyzer. Participants were asked not to take any drugs for at least 14 h before blood sampling, but there was no information about medication on the questionnaire.

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Table 1 Frequency of Unfavorable Life Style and Abnormal Biological Markers in 1989 and Their Improvement Through 1992 Among 7,321 Male Participants of the Comprehensive Health Check at Aichi Prefectural Center of Health Care

		No. of prevalence in 1989 (%)	No. of improvement through 1992 (%)
<i>Life style</i>			
<i>Skip breakfast</i>		1,087 (14.8)	427 (39.3)
<i>Diet low in vegetables</i>		1,261 (17.2)	608 (48.2)
<i>Eat till full</i>		3,535 (48.3)	832 (23.5)
<i>Prefer oily foods</i>		2,299 (31.4)	806 (35.1)
<i>Prefer salty foods</i>		3,187 (43.5)	942 (29.6)
<i>Do not exercise regularly</i>		4,302 (58.8)	966 (22.5)
<i>Do not walk briskly</i>		1,462 (20.0)	524 (35.8)
<i>Smoke cigarettes</i>		3,371 (46.0)	373 (11.1)
<i>Drink alcoholic beverages regularly</i>		5,603 (76.5)	241 (4.3)
<i>Biological markers</i>			
<i>Systolic blood pressure</i>	≥ 140 mmHg	1,012 (13.8)	267 (26.4)
<i>Diastolic blood pressure</i>	≥ 90 mmHg	839 (11.5)	276 (32.9)
<i>Total cholesterol</i>	≥ 220 mg/dl	1,991 (27.2)	537 (27.0)
<i>High density lipoprotein-cholesterol</i>	≤ 40 mg/dl	1,491 (20.4)	522 (35.0)
<i>Triglyceride</i>	≥ 200 mg/dl	1,074 (14.7)	480 (44.7)
<i>Fasting plasma glucose</i>	≥ 110 mg/dl	1,184 (16.2)	432 (36.5)
<i>Uric acid</i>	≥ 7.0 mg/dl	921 (12.6)	360 (39.1)
<i>Body mass index</i>	≥ 26 kg/m ²	838 (11.5)	155 (18.5)

Data Analysis

The following were defined as abnormal biological markers in this study: systolic blood pressure (SBP) ≥140 mmHg, diastolic blood pressure (DBP) ≥90 mmHg, total cholesterol (TC) ≥220 mg/dl, high-density lipoprotein-cholesterol (HDL-C) <40 mg/dl, triglyceride (TG) ≥200 mg/dl, fasting plasma glucose (FPG) ≥110 mg/dl, uric acid (UA) ≥7.0 mg/dl, and body mass index (BMI) ≥26. Associations between favorably modified life-styles and improved biological markers after 3 years were assessed.

Differences in frequency were examined by the Mantel-Haenszel extension test adjusting for age, and odds ratio (OR) was routinely calculated with its 95% confidence interval (CI). When OR is greater (less) than 1, it implies that a favorably modified life-style is positively (negatively) associated with an improved biological marker. The strength of association is expressed as the size of the OR. Statistical significance of association is judged by the 95% CI; that is, when the 95% CI does not include 1, the association is statistically significant. Multiple logistic regression using dummy variables was also applied for the test of independent contribution of each favorably modified life-style. Statistical analyses were performed using an SAS package (version 6.0.8, SAS Institute, Cary, NC, USA). A p-value less than 0.05 (2-tailed) was considered statistically significant.

Results

Frequency of Unfavorable Life-Style and Abnormal Biological Markers

Table 1 shows the frequency of men who, among the 7,321 men, had had unfavorable life-styles and abnormal biological markers in 1989 and who had improved such life-styles in 1992. Unfavorable life-styles frequently observed were 'drink alcoholic beverages regularly' (76.5%), 'do not exercise regularly' (58.8%), 'eat till full' (48.3%) and 'smoke cigarettes' (43.5%). Those less frequently observed were 'skip breakfast' (14.8%) and 'do not walk briskly' (20.0%).

By 1992, 48.2% of the study objects with a shortage of vegetables in the diet (608/1261), 39.3% of those skipping

breakfast (427/1087), 35.8% of those not walking briskly (524/1462), and 35.1% of those preferring oily foods (806/2299) had improved their problematic life-styles. In contrast, only 4.3% of drinkers and 11.1% of smokers had abandoned their habits.

There was a wide range in the frequency of abnormal biological markers: from 11.5% of DBP and BMI to 27.2% of TC in 1989. Of them, improvements (ie, shift from abnormal to normal zone) were observed in BMI (from 18.5%) and TG (44.7%) in 1992.

Relationship Between Improved Life-Style and Normalized Biological Markers

To examine the effects of a favorable life-style modification, we calculated the age-adjusted OR of improved life-styles for normalized biological markers in the 3 years from 1989 to 1992. The results are summarized in Table 2.

Twenty-four (5.6%) out of 427 men who began to eat breakfast normalized their previously abnormal DBP, while only 17 (2.6%) of the 660 who continued skipping breakfast normalized their DBP (adjusted OR 2.89; 95% CI 1.29–6.46). This OR indicated that 'began to eat breakfast' was positively and significantly associated with normalized DBP with 2.89-fold likelihood. 'Began to eat breakfast' was also positively and significantly associated with a normalized TC (adjusted OR 1.84; 95% CI 1.05–3.21). 'Increased vegetables intake' was significantly associated with a normalized DBP (adjusted OR 2.60; 95% CI 1.18–5.75). Normalized BMI was found in 31 (3.7%) among 832 men who stopped 'eating until full' and in 61 (2.3%) among 2,703 men who continued to eat until full (adjusted OR 2.03; 95% CI 1.25–3.28), indicating that BMI was significantly normalized when food intake was moderated, with approximately 2-fold likelihood. 'Stop eating till full' were also significantly associated with a normalized UA (adjusted OR 1.65; 95% CI 1.07–2.52) and TC (adjusted OR 1.43; 95% CI 1.04–1.97). When the intake of salty foods was reduced, HDL-C was normalized with 1.46-fold likelihood (adjusted OR 1.46; 95% CI 1.05–2.04). However, only 24 (2.5%) out of 942 men who reduced their salty food intake normalized their SBP, whereas 82 (3.7%) of 2,245 men who continued to eat salty foods achieved

Table 2 Adjusted Odds Ratios Between Improvement of Unfavorable Life-Style and Normalization of abnormal Biological Markers From 1989 to 1992 Among 7,321 Male Participants

	SBP	DBP	TC	HDL-C	TG	FPG	UA	BMI
<i>Began to eat breakfast</i>	1.91	2.89*	1.84*	0.79	1.23	0.96	1.41	1.17
<i>Increased vegetable intake</i>	1.26	2.60*	0.85	1.22	1.17	1.34	1.04	2.46
<i>Stopped eating till full</i>	1.00	1.34	1.43*	1.11	1.35	0.77	1.65*	2.03**
<i>Reduced oily foods</i>	1.03	1.01	1.11	1.15	0.97	1.22	1.42	1.60
<i>Reduced salty foods</i>	0.53+	0.81	0.98	1.46*	0.93	0.89	1.29	1.20
<i>Started exercise regularly</i>	0.79	0.96	1.07	1.69**	1.09	0.93	1.39	1.38
<i>Started walking briskly</i>	0.76	1.17	1.85**	1.10	0.96	1.37	1.32	1.59
<i>Quit smoking</i>	1.32	0.47	0.98	2.55***	1.03	1.18	0.41**	1.15
<i>Quit drinking</i>	1.29	2.05	1.07	0.98	1.57	1.28	1.29	1.44

Postive association ($OR > 1$); * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Negative association ($OR < 1$); + $p < 0.05$, ** $p < 0.01$.

Odds ratio is the ratio of 'normalized/non-normalized ratio of each laboratory test in the respective unimproved life style group' over 'normalized/non-normalized ratio in the correspondent improved life style group' after adjustment of age. SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; HDL-C, high-density lipoprotein-cholesterol; TG, triglyceride; FPG, fasting plasma glucose; UA, uric acid; BMI, body mass index.

Table 3 Interrelationship in Improvement of Life-Style From 1989 to 1992 Among 7,321 Male Participants (Values are Odds Ratios)

	<i>Began to eat breakfast</i>	<i>Increased vegetable intake</i>	<i>Stopped eating till full</i>	<i>Reduced oily foods</i>	<i>Reduced salty foods</i>	<i>Started exercise regularly</i>	<i>Started walking briskly</i>	<i>Quit smoking</i>	<i>Quit drinking</i>
<i>Began to eat breakfast</i>		2.76***	1.63*	1.41	1.87**	1.38	1.08	1.49	0.91
<i>Increased vegetable intake</i>			1.16	1.64*	2.69***	1.66**	1.16	1.15	1.46
<i>Stopped eating till full</i>				2.39***	1.72***	1.39**	1.09	0.69	1.72**
<i>Reduced oily foods</i>					2.21***	1.40*	1.22	0.96	1.08
<i>Reduced salty foods</i>						1.28*	1.11	1.00	1.10
<i>Started exercise regularly</i>							2.85***	1.77***	1.16
<i>Started walking briskly</i>								1.30	1.15
<i>Quit smoking</i>									1.48

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Odds ratio is the ratio of 'improved/non-improved ratio of each life style in the respective improved life style group' over 'improved/non-improved ratio in the correspondent unimproved life style group' after adjustment of age.

SBP normalization (adjusted OR 0.53; 95% CI 0.32–0.89); indicating that sodium restriction was inversely and significantly associated with blood pressure normalization.

Ninety-two (9.5%) out of 966 men who started exercising regularly normalized their HDL-C, while 229 (6.7%) of 3,336 who remained sedentary achieved a normalized HDL-C (adjusted OR 1.69; 95% CI 1.24–2.29). 'Began to walk briskly' was significantly associated in a positive fashion with a normalized TC (adjusted OR 1.85; 95% CI 1.19–2.89). Forty-nine (13.1%) out of 373 men who quit smoking normalized their HDL-C, while 238 (7.9%) of 2,998 who continued to smoke had a normalized HDL-C (adjusted OR 2.55; 95% CI 1.68–3.86). However, 'quit smoking' was inversely and significantly associated with UA normalization (adjusted OR 0.41; 95% CI 0.22–0.78). 'Quit regular drinking' was not linked to any normalized biological markers with statistical significance.

A multivariate analysis by a logistic regression model did not essentially alter these associations between life-style modifications and improvements in the biological markers. But the OR of 'stopped eating till full' for UA normalization and of 'reduced salty food intake' for HDL-C normalization turned to be insignificant, and the inverse association of 'quit smoking' with DBP normalization reached statistical significance (adjusted OR 0.40; 95% CI 0.16–0.98).

We also examined the relationships between continued unfavorable life-style and no change/worsening of abnor-

mal biological markers in the same population, as this was the contraposition of the aforementioned theme. From that we obtained results which almost reversed the earlier findings (data not shown).

Interrelationship Among Life-Style Modifications

Table 3 summarizes the adjusted OR for interrelationships among favorably modified life-styles.

Improved dietary habits were associated with each other. For example, 55 (56.7%) out of 97 men who began to eat breakfast also increased their vegetable intake, whereas only 58 (32.2%) of the 180 who continued to skip breakfast increased vegetable intake (adjusted OR 2.76; 95% CI 1.67–4.56), indicating that when one began to eat breakfast, one also ate more vegetables, with a 2.76-fold likelihood of statistical significance. 'Started exercising regularly' was also significantly linked to 'increased vegetable intake' (adjusted OR 1.66; 95% CI 1.17–2.33) and such other dietary improvements as 'stopped eating till full,' 'reduced oily foods' and 'reduced salty foods'. Smoking ceased in 64 (14.3%) out of 448 men who started exercising regularly, whereas it ceased in only 146 (8.6%) of 1696 who remained sedentary (adjusted OR 1.77; 95% CI 1.30–2.42).

Discussion

This is the first study, to our best knowledge, which

systematically examined associations between life-style and cardiovascular risk factors over a 3-year period in a large, male, working population. Because no special interventions other than routine verbal advice from the Center occurred, the life-style changes were presumed to be voluntary.

In this study, the focus was on the shift of the risk factors from the abnormal to the normal zone, not on changes in the within-normal range. All biological markers, originally continuous variables, were dichotomized and compared with qualitative changes in life-style.

Normalization of DBP was significantly associated with not-skipping breakfast and increased vegetable intake. Regular intake of breakfast is one of the seven so-called health practices,⁷ and Kenkel⁸ reported that this practice was weakly associated with BP in a positive fashion. Several investigators⁹⁻¹³ have shown that hypertension is less frequent in vegetarians. An increased vegetable intake may lead to increased serum potassium concentration¹² and either reduced sympathoadrenal activities or increased atrial natriuretic peptide,¹³ which would consequently result in lowering BP.

In contrast, dietary sodium restriction was significantly associated with an elevation of SBP in our study. According to the cross-center analysis of Intersalt,^{14,15} a direct association between sodium excretion and BP was not shown, and some genetic factors might determine age-dependent BP increases beyond life-style modification. Gene analyses or randomized trials will therefore be required to disclose this particular aspect.

As expected, stopping eating till full decreased the serum TC abnormality. However, a reduction in oily food intake did not significantly improve a TC abnormality. This particular finding might possibly be explained as follows: to reduce the total energy intake means, in Japan, restricting saturated fatty acid-rich foods, and so reducing deep-fried dishes (representative oily foods in Japan and usually cooked with unsaturated fatty acid-rich vegetable oils) would not reduce the serum TC level.¹⁶⁻¹⁸ Eating breakfast everyday was also associated with TC reduction. Although an association between the frequency of meals and lipid metabolism has only rarely been investigated,¹⁹ not taking meals regularly may lead to compensatory over-intake at other meals, which would result in excess cholesterol synthesis.

Hypo-HDL-cholesterolemia was improved by starting regular exercise, a well known association,²⁰⁻²⁶ and the American College of Sports Science, American Heart Association and The Center for Disease Control and Prevention have recommended daily sports activities.²⁷⁻²⁹ In our study, however, brisk walking did not significantly improve the serum HDL-C abnormality, which might be explained in part by the low exercise intensity of walking even when one walks briskly.³⁰ It would imply that rather more strenuous exercise might be needed to increase the HDL-C level. Smoking cessation was associated with a favorable shift of HDL-C to normal values. The mechanism of this effect has not been thoroughly elucidated. Because quitting smokeless tobacco did not increase HDL-C,³¹ this change in lipid metabolism might be affected by something other than nicotine.

TG was not significantly affected by life-style modifications in this study, possibly because of the large intraindividual variation of this marker. We also found no significant associations between FPG and favorable life-style modifications. FPG is not a sensitive marker of impaired

glucose tolerance, as compared to the serum insulin level, so changing dietary habits and physical activities would not accompany an FPG shift across 110 mg/dl.

Uricemic status was rather worsened after quitting smoking. Increased eating after quitting smoking might have some effect on the status, because quitting smoking and stopping eating till full were somewhat negatively interrelated. However, multiple logistic regression analysis did not diminish the inverse association between smoking cessation and UA normalization, so the true mechanism remains uncertain. In this study BMI was not affected by quitting smoking. Physical activity, which might accompany alcohol abstinence, would cancel out the unfavorable effects on BMI of quitting smoking.³²

This study has some limitations. First, many examinees had undergone previous health check-ups. Some of them might have already tried to modify their life-style, which would possibly attenuate the associations between a favorably modified life-style and improved biological markers, resulting in underestimated effects. Second, we failed to exclude participants who took medication because of incomplete information in the questionnaire regarding drugs. However, in this center drug therapy is recommended only for participants with marked abnormalities, so changes in the variables of drug-users across the cut-off levels set for the study seem less likely than those of non-drug-users. Third, the questionnaire did not cover all aspects of the life-style, so it is unknown how variables such as resting, sleeping, and mental or social activities could change risk factor profiles.

Despite those limitations, we demonstrated that certain favorable life-style modifications could significantly attenuate abnormal biological risk factors for cardiovascular diseases. Thus, appropriate advice on life-style habits should be given to each examinee in a positive, systematic way following the periodic health check-ups in order to reduce the person's risk.

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