chronological variability.

Theoretically the individually set normal range is a very interesting idea. However, there are several points to be discussed before introducing such a methodology. At first, how to evaluate the items with wide chronological fluctuation, is a problem. Yamaguchi et al. have developed a new method to evaluate the personally set risk based on the probabilistic density of historical data[3]. Trend analysis method such as Box-Jenkins model (ARIMA model) will be applicable if there is a long-period data more than 10 observation points, for example.

Secondary, how to evaluate the data of person with only one year data, or scatter year data is another problem to be solved.

By the introduction of "the specified health checkup and intervention program", it will become possible to analyze a long period data of individual. It is necessary to develop appropriate methodologies for such kinds of chronological data by individual basis, if we intend to establish a life-long health support system.

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Original

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Effect of Obesity on the Development of Life-Style Related Diseases in an Occupational Setting of Japan

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Abstract

In order to investigate the obesity prevalence and its impact on lifestyle related diseases among the working population, we have investigated the chronological data of annual health check up of an occupational setting in Japan. We have compared the prevalence of hypertension, hyperlipidemia, and hyperglycemia in 1999 between the workers in 1995 who become obese in 1999 and who did not, both of whom were categorized as "healthy" in 1995, based on the data of 9,196 "healthy" male workers between 40 to 59 years old. For hypertension statistically positive correlations were observed for the two age groups; 40 to 49, and 50 to 59. For hyperlipidemia statistically positive correlations were observed for the three age groups; 30 to 39, 40 to 49, and 50 to 59. Finally, in the case of hyperglycemia, the two age groups; 40 to 49, and 50 to 59, showed positive correlations. This result has strongly suggested that it is very important to organize an effective anti-obesity program for middle aged men in order to reduce the disease burden of diabetes and other lifestyle related diseases.

Key words: life-style related diseases, obesity, health check-up, occupational setting

❖ Introduction

The Japanese Occupational Safety and Health (OSH) Law requires employers to organize the annual health check up for the employees. One of the particular characteristics of the Japanese OSH system is that the health check-up program includes life-style related disease such as hypertension, hyperlipidemia and hyperglycemia in addition to the screening of occupational diseases.

As shown in Table 1, hyperlipidemia is the most frequently observed abnormality in the occupational setting[1]. Thirty percentages of workers showed abnormal value for this item.

The prevention of death due to overworking, so called "Karoshi" is one of the most important issue for the Japanese occupational health policy. Most of the Karoshi cases are closely related to life-style related disease, such as cardio-vascular disease, and ischemic heart diseases and stroke[2]. Thus it is very important to prevent the life-style diseases in the occupational setting.

For this purpose, in 2001 the Japanese government implemented a new screening program for Karoshi under the Occupational Accident Compensation Law. A worker with all four conditions (hypertension, hyperlipidemia, hyperglycemia and obesity, so called "deadly quartet") must receive the in-depth health examination.

One of the common causes for lifestyle related diseases is obesity. The combination of obesity, hyperlipidemia, hypertension and hyperglycemia is known as "Metabolic syndrome"[3]. As Negishi indi-

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Table 1 Prevalence of above four abnormalities among 1995 "healthy workers" during 1996 to 1999

BMI		1995	1996	1997	1998	1999	Total
–29	N	34	35	34	34	34	56
	%	60.7	62.5	60.7	60.7	60.7	100.0
30–39	N	242	248	248	252	245	549
	%	44.1	45.2	45.2	45.9	44.6	100.0
40–49	N	1009	1013	1012	1073	1071	5850
	%	17.2	17.3	17.3	18.3	18.3	100.0
50–59	N	827	816	810	833	829	4704
	%	17.6	17.3	17.2	17.7	17.6	100.0
60–	N	2	2	2	2	2	7
	%	28.6	28.6	28.6	28.6	28.6	100.0
Total	N	2114	2114	2106	2194	2181	11166
	%	18.9	18.9	18.9	19.6	19.5	100.0

BMI: Body Mass Index.

BP		1995	1996	1997	1998	1999	Total
–29	N	31	34	41	33	39	56
	%	55.4	60.7	73.2	58.9	69.6	100.0
30–39	N	238	272	279	275	299	549
	%	43.4	49.5	50.8	50.1	54.5	100.0
40–49	N	2036	2332	2378	2557	2891	5850
	%	34.8	39.9	40.6	43.7	49.4	100.0
50–59	N	1941	2177	2193	2379	2594	4704
	%	41.3	46.3	46.6	50.6	55.1	100.0
60–	N	2	3	4	3	4	7
	%	28.6	42.9	57.1	42.9	57.1	100.0
Total	N	4248	4818	4895	5247	5827	11166
	%	38.0	43.1	43.8	47.0	52.2	100.0

BP: Blood pressure.

HL		1995	1996	1997	1998	1999	Total
–29	N	22	32	26	26	22	56
	%	39.3	57.1	46.4	46.4	39.3	100.0
30–39	N	283	320	289	276	278	549
	%	51.5	58.3	52.6	50.3	50.6	100.0
40–49	N	1896	2142	1861	1835	1808	5850
	%	32.4	36.6	31.8	31.4	30.9	100.0
50–59	N	1477	1551	1316	1275	1203	4704
	%	31.4	33.0	28.0	27.1	25.6	100.0
60–	N	2	1	2	2	3	7
	%	28.6	14.3	28.6	28.6	42.9	100.0
Total	N	3680	4046	3494	3414	3314	11166
	%	33.0	36.2	31.3	30.6	29.7	100.0

HL: Hyperlipidemia.

HG		1995	1996	1997	1998	1999	Total
–29	N	7	6	7	6	7	56
	%	12.5	10.7	12.5	10.7	12.5	100.0
30–39	N	42	27	47	70	61	549
	%	7.7	4.9	8.6	12.8	11.1	100.0
40–49	N	580	495	716	873	707	5850
	%	9.9	8.5	12.2	14.9	12.1	100.0
50–59	N	613	610	835	972	843	4704
	%	13.0	13.0	17.8	20.7	17.9	100.0
60–	N	1	1	1	1	1	7
	%	14.3	14.3	14.3	14.3	14.3	100.0
Total	N	1243	1139	1606	1922	1619	11166
	%	11.1	10.2	14.4	17.2	14.5	100.0

HG: Hyperglycemia.

cated, metabolic syndrome lying ahead of lifestyle related diseases is largely associated with obesity, particularly visceral fat obesity, and promoted by overeating, food satiation, high-fat foods, lack of exercise, unbalanced nutrition, and irregular lifestyle, further leading to the development of genuine lifestyle-related diseases by the involvement of genetic background or aging[4].

The National Nutrition and Health Survey has clarified that obesity prevalence increases after 40 years old, especially among men. In order to establish effective programs to prevent Karoshi, it is quite important to investigate the obesity prevalence and its impact on lifestyle related diseases among the working population.

For this purpose, we have investigated the chronological data of annual health check up of an occupational setting in Japan.

❖ Study Subject and Methods

We followed the 1995–1999 health check-up data of workers of a large scale company in the western part of Japan. The used data was obtained after the getting written approval from its health insurance fund. Data were combined by individual basis in an anonymous way in order to protect the privacy.

The items of examination, which had been observed, are blood pressure, serum lipid, blood sugar (HbA1C), and BMI.

The definitions of abnormalities are as bellows;

1. Hyperlipidemia: Triglyceride >= 150 or HDL cholesterol <40
2. Hypertension: Systolic Blood Pressure >=130 or Diastolic Blood Pressure >=85
3. Hyperglycemia: HbA1C >= 5.5
4. Obesity: BMI >= 25

The definition of healthy workers in this study is worker who had no abnormality for the above 4 items in 1995. We analyzed the data of 11,166 workers. The data were divided by age-category (–29, 30–39, 40–49, 50–59, 60–) and sex, and then we calculated the basic descriptive statistics.

Finally we have compared the prevalence of hypertension, hyperlipidemia, and hyperglycemia in 1999 between the workers in 1995 who become obese in 1999 and who did not, both of whom were categorized as "healthy" in 1995. For this analysis, we limited analysis for the data of 9,196 "healthy" male workers between 40 to 59 years old.

All the statistical analyses were conducted by SPSS J ver.15 (SPSS inc.).

❖ Results

Table 1 shows that the prevalence of above four abnormalities among 1995 "healthy workers" during 1996 to 1999. For obesity prevalence, persons between 30 and 49 showed an increasing trend but other age groups were relatively stable. For blood pressure, all age categories showed an increasing trend. For hyperlipidemia prevalence, all age category groups showed a decreasing trend. In the case of blood sugar level, all age categories showed an increasing trend, even though there is a drop observed in 1999.

Table 2 showed effects of obesity on the occurrence of hypertension, hyperlipidemia and hyperglycemia. For hypertension statistically positive correlations were observed for the two age groups; 40 to 49, and 50 to 59. For hyperlipidemia statistically positive correlations were observed for the three age groups; 30 to 39, 40 to 49, and 50 to 59. Finally, in the case of hyperglycemia, the two age groups; 40 to 49, and 50 to 59, showed positive correlations.

❖ Discussion

It is well known that obesity is associated with an increased risk of premature death and chronic illness such as diabetes mellitus, hyperlipidemia, stroke, heart diseases, some cancers, etc[5, 6]. The present results have re-assured this relationship. As we could not obtain the information about medical treatment status of each worker, we cannot deny the possibility of bias caused by treatment. However, as the medical intervention shall weaken the correlation between obesity and the target abnormalities, it is more plausible that the present results underestimate the relationships.

Most of the investigations including our study have indicated the importance of obesity control program in order to reduce the prevalence of lifestyle related disease and its medical cost. The CDC estimated that obesty-attributable medical cost expenditures reached $75 billion in 2003 and that taxpayers finance about half of these cost through Medicare and Medicaid[7].

Table 2-1 Effects of obesity on the occurrence of hypertension

Age category	BMI 1999		BP 1999		Total	RR P-value
			Normal	HT		
–29	Not obese	N	10	10	20	
		%	50.0	50.0	100.0	NA
	Obese	N	2	0	2	
		%	100.0	0.0	100.0	
	Total	N	12	10	22	0.481
		%	54.5	45.5	100.0	
30–39	Not obese	N	160	124	284	
		%	56.3	43.7	100.0	
	Obese	N	13	10	23	1.00
		%	56.5	43.5	100.0	
	Total	N	173	134	307	0.986
		%	56.4	43.6	100.0	
40–49	Not obese	N	2539	2034	4573	
		%	55.5	44.5	100.0	1.43
	Obese	N	97	171	268	
		%	36.2	63.8	100.0	
	Total	N	2636	2205	4841	<0.001
		%	54.5	45.5	100.0	
50–59	Not obese	N	1823	1876	3699	
		%	49.3	50.7	100.0	1.51
	Obese	N	42	136	178	
		%	23.6	76.4	100.0	
	Total	N	1865	2012	3877	<0.001
		%	48.1	51.9	100.0	

BMI: Body Mass Index, BP: Blood pressure, RR: Relative risk.

Especially, diabetes is a growing, serious and costly disease[8]. Worldwide there are nearly 200 million with diabetes, 90–95% of whom have Type 2 Diabetes. It is projected that there were nearly 400 million cases of diabetes worldwide by 2030. Diabetes reduces life expectancy, on average, 10–15 years and causes considerable morbidity and loss of quality of life. While several effective treatments exist for reducing diabetes complication, no absolute treatment does exist for elimination of such complications. Thus, prevention of diabetes is very important. Narayan et al indicated that the progression to Type 2 diabetes can be prevented or delayed by 30–58% in people at high risk of the disease[8]. He has suggested that the modification of lifestyle, such as increasing physical activity, reducing calorie intake and reducing body weight is more effective than medication.

According to the present results, the correlation between obesity and hyperglycemia was not clear under 40 years old. The relatively higher Basal Metabolic Rate (BMR) might explain this phenomenon. On the contrary, the relationship becomes very clear after 40 years old. This result has strongly suggested that it is very important to organize an effective anti-obesity program for middle aged men in order to reduce the diabetes prevalence.

Considering the fact that more than 40% of this age-category men receives the annual health check-up and following health promotion program in the occupational setting, it is very reasonable to implement such programs in the worksite. In fact, as Tanaka et al. reported, there have been many anti-diabetes program

Table 2-2 Effects of obesity on the occurrence of hyperlipidemia

Age category	BMI 1999		HL 1999 Normal	HL 1999 HL	Total	P-value
–29	Not obese	N	16	4	20	
		%	80.0	20.0	100.0	2.50
	Obese	N	1	1	2	
		%	50.0	50.0	100.0	
	Total	N	17	5	22	0.411
		%	77.3	22.7	100.0	
30–39	Not obese	N	167	117	284	
		%	58.8	41.2	100.0	1.69
	Obese	N	7	16	23	
		%	30.4	69.6	100.0	
	Total	N	174	133	307	0.008
		%	56.7	43.3	100.0	
40–49	Not obese	N	3358	1215	4573	
		%	73.4	26.6	100.0	1.80
	Obese	N	140	128	268	
		%	52.2	47.8	100.0	
	Total	N	3498	1343	4841	< 0.001
		%	72.3	27.7	100.0	
50–59	Not obese	N	2869	830	3699	
		%	77.6	22.4	100.0	1.88
	Obese	N	103	75	178	
		%	57.9	42.1	100.0	
	Total	N	2972	905	3877	< 0.001
		%	76.7	23.3	100.0	

BMI: Body Mass Index, HL: Hyperlipidemia, RR: Relative risk.

organized under the OSH law[9].

According to the 2006 Health Reform, the specified health checkup and follow-up health guidance and intervention program will be introduced from 2008[10]. All public health insurers have to organize health check-up and the following health promotion programs for the insured between 40 and 74 years old. The main target of screening is "Metabolic syndrome".

In order to avoid the duplication of health check ups among the different schemes, and then to make the whole system harmonized, the program under the OSH law is required to be adjusted to the new scheme from 2008.

As the new program might increase the labor cost, some insurers and employers hesitate its full implementation. However, it is very important for the employers to protect the workers health and thus to contribute to the stability of society from the viewpoint of CSR. It is very expected for the company to positively promote the new program.

There is a critic that it is too late to start the anti-obesity program from 40 years old, because the germination of the obesity related diseases can be observed in childhood. As Negishi has indicated, the obesity among children is becoming an important health problem in Japan[4]. According to the statistics of Ministry of Education, Science and culture, 10.8% of 12 years children are evaluated as obese in 2005. It is very important to provide children/students with education and guidance for better understanding of the obesity.

Table 2-3 Effects of obesity on the occurrence of hyperglycemia

Age category	BMI 1999		HG 1999		Total	P-value
			Normal	DM		
–29	Not obese	N	17	3	20	
		%	85.0	15.0	100.0	0.00
	Obese	N	2	0	2	
		%	100.0	0.0	100.0	
	Total	N	19	3	22	0.74
		%	86.4	13.6	100.0	
30–39	Not obese	N	261	23	284	
		%	91.9	8.1	100.0	0.54
	Obese	N	22	1	23	
		%	95.7	4.3	100.0	
	Total	N	283	24	307	0.445
		%	92.2	7.8	100.0	
40–49	Not obese	N	4120	453	4573	
		%	90.1	9.9	100.0	1.54
	Obese	N	227	41	268	
		%	84.7	15.3	100.0	
	Total	N	4347	494	4841	0.005
		%	89.8	10.2	100.0	
50–59	Not obese	N	3107	592	3699	
		%	84.0	16.0	100.0	1.44
	Obese	N	137	41	178	
		%	77.0	23.0	100.0	
	Total	N	3244	633	3877	0.013
		%	83.7	16.3	100.0	

BMI: Body Mass Index, HG: Hyperglycemia, RR: Relative risk.

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