Effects of Excessive Ethanol Consumption on the Diagnosis of the Metabolic Syndrome Using Its Clinical Diagnostic Criteria

Hirokazu Yokoyama¹, Hirose Hiroshi¹, Hideki Ohgo², Toshifumi Hibi² and Ikuo Saito¹

Abstract

Objects Various morbid conditions constituting the metabolic syndrome could be also caused by excessive ethanol consumption. Thus, it is conceivable that excessive ethanol consumption may affect the diagnosis of the metabolic syndrome using its current diagnostic criteria. Here, we investigated this.

Materials and Methods A cross-sectional study involving 2,130 Japanese man subjects aged 20 to 65 was performed.

Results The rate of subjects judged to have metabolic syndrome using its diagnostic criteria for Japanese was 15.7%. However, the prevalence was significantly higher in excessive drinkers who consume more than 20 grams of ethanol per day (n=473, 22.0%) than average drinkers (n=1,657, 13.9%, χ²=18.0, p<0.0001). The rate of subjects who satisfied each component of the criteria of the metabolic syndrome, namely that of an excessive waist circumference, hypertension, dislipidemia, or hyperglycemia was significantly higher in the former than in the latter, respectively. When subjects with a waist circumferences of 85 cm or more were selectively studied, the prevalence of the metabolic syndrome was still higher in excessive drinkers (39.2%) than in average drinkers (32.4%, χ²=4.0, p=0.049), whereas the waist circumference was not significantly different between the two groups.

Conclusion Excessive ethanol consumption is associated with an increased prevalence of the metabolic syndrome following the current clinical diagnostic criteria. Excessive ethanol consumption could simply be a factor worsening the metabolic syndrome. However, we must be aware of another possibility that excessive ethanol consumption increases the number of subjects regarded as the metabolic syndrome via mechanisms differing from visceral fat accumulation.

Key words: metabolic syndrome, excessive ethanol consumption

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Introduction

Obesity, especially visceral fat accumulation, causes a series of morbid conditions designated as the metabolic syndrome, which decreases life expectancy (1, 2). From the point of view of public health, it is important to accurately identify individuals with metabolic syndrome and start proper intervention for treatment as soon as possible. To that effect, several lines of its diagnostic criteria based on its clinical features have been proposed. In its early stage, the metabolic syndrome was assumed to be closely related to type 2 diabetes, and thus criteria of the WHO Diabetes Group (3) and those of the European Group for the Study of Insulin Resistance (4) were proposed. However, a new trend in the clinical diagnosis of the metabolic syndrome is to emphasize the relationship with risks of cardiovascular events. On the basis of this idea, the criteria of the US National Cholesterol Education Program: Adult Treatment Panel III (NCEPATPIII) were introduced (5). The criteria simply require the presence of any three of five of the following components: central obesity, hypertension, hyperlipidemia, decreased serum level of high density lipoprotein-cholesterol (HDLC), and fasting hyperglycemia for the diagnosis of the

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Table 1. Effect of Excessive Ethanol Consumption on Various Factors

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Average drinkers*</th>
<th>Excessive drinkers**</th>
<th>z-value***</th>
<th>p-value***</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>(n=2310)</td>
<td>(n=1657)</td>
<td>(n=473)</td>
<td></td>
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</tr>
<tr>
<td>Age (year)</td>
<td></td>
<td>42</td>
<td>42</td>
<td>-0.605</td>
<td>0.5454</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(20-65)</td>
<td>(20-65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170.6</td>
<td>170.9</td>
<td>169.7</td>
<td>-3.061</td>
<td>0.0022</td>
</tr>
<tr>
<td></td>
<td>(130.8-189.5)</td>
<td>(130.8-189.5)</td>
<td>(150.7-189.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.6</td>
<td>67.4</td>
<td>68.4</td>
<td>-1.926</td>
<td>0.0541</td>
</tr>
<tr>
<td></td>
<td>(36.0-128.3)</td>
<td>(36.0-128.3)</td>
<td>(44.8-103.2)</td>
<td></td>
<td></td>
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<tr>
<td>Waist circumference (cm)</td>
<td>84</td>
<td>83</td>
<td>86</td>
<td>-5.117</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(60-122)</td>
<td>(60-122)</td>
<td>(63-115)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>126</td>
<td>124</td>
<td>132</td>
<td>-6.549</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(88-225)</td>
<td>(88-225)</td>
<td>(92-210)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>79</td>
<td>78</td>
<td>84</td>
<td>-9.935</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(45-147)</td>
<td>(45-147)</td>
<td>(57-143)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>93</td>
<td>92</td>
<td>100</td>
<td>-3.273</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(17-1500)</td>
<td>(17-1078)</td>
<td>(31-1500)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL-C (mg/dl)</td>
<td>56</td>
<td>55</td>
<td>60</td>
<td>-7.701</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(29-163)</td>
<td>(29-163)</td>
<td>(30-128)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>93</td>
<td>92</td>
<td>95</td>
<td>-6.022</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(57-246)</td>
<td>(57-246)</td>
<td>(73-217)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>γGTP (IU/l)</td>
<td>33</td>
<td>30</td>
<td>51</td>
<td>-13.764</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>(9-1006)</td>
<td>(9-339)</td>
<td>(14-1006)</td>
<td></td>
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</tr>
</tbody>
</table>

SBP: Systolic blood pressure  
DBP: Diastolic blood pressure  
TG: Triglyceride  
HDL-C: High density lipoprotein-cholesterol  
*: Subjects who consume ethanol up to 20 g per day or teetotalers.  
**: Subjects who consume ethanol at more than 20 g per day.  
***: Comparison between average drinkers and excessive drinkers by Mann-Whitney’s U-test.

metabolic syndrome. However, since several contradictions arose among these criteria, the International Diabetes Federation (IDF) recently revised NCEPATPIII and announced new criteria designated as “the panel: IDF: metabolic syndrome definition”, to coordinate the situation (6). Moreover, cut-off values of ethnic-specific waist circumference (7-9) have been incorporated into the panel as a marker of central obesity, namely visceral fat accumulation. Following this trend, in Japan, a committee that consists of delegates from 8 medical societies revised the IDF panel and established new criteria designated as criteria for the diagnosis of the metabolic syndrome in Japan (the Japanese Criteria, 10). Therefore, the latest clinical diagnostic criteria of the metabolic syndrome comprise clinical features listed in those of NCEPATPIII described above, but they obviously place a lot of significance on the status of visceral fat accumulation reflected by waist circumference as a basic pathogenesis of the metabolic syndrome (11).
It must be noted that excessive ethanol consumption also causes hyperlipidemia (12, 13), diabetes (14), and hypertension (15), constituting alcohol-related syndrome. Since ethanol consumption has been implicated in the development of obesity (16, 17), these morbid conditions seen in excessive drinkers may be caused by the progression of obesity via mechanisms that are common with those of the original metabolic syndrome. However, it is also widely accepted that excessive ethanol consumption also causes these morbid conditions via mechanisms peculiar to ethanol consumption, such as shifts in the redox-state (18), abnormalities of the sympathetic nervous system, changes of hormonal secretions such as the renin-angiotensin-aldosterone system and cortisol production (19), damage to the pancreas (20), and so on, apparently independent of visceral fat accumulation. In either case, excessive ethanol consumption is expected to increase the number of subjects who are regarded as the metabolic syndrome under the current clinical diagnostic criteria. On the other hand, it is well established that excessive ethanol consumption contributes to an increase in the serum HDLC level (13). Since a decrease in the serum HDLC level is one of the factors leading to a positive diagnosis of the metabolic syndrome, excessive ethanol consumption is also expected to be a negative factor for the diagnosis of the metabolic syndrome following the current criteria. Thus, it is fully conceivable that excessive ethanol consumption would multifariously affect the diagnosis of the metabolic syndrome as far as it is judged using the current clinical diagnostic criteria. The aim of this study was to investigate this.

**Materials and Methods**

All studies in this report were approved by the research committee of the Health Center, Keio University, based on the ethical guidelines of the 1975 and 1983 Declaration of Helsinki. All subjects were fully informed of the study contents and consented to the use of their data. Two thousand two hundred and thirty man Japanese subjects who took annual health checkups at our office in 2005 were enrolled. Since the Japanese Criteria for women seem to still have contradictions, woman subjects were not enrolled at this time. All were teaching or clerical staff of our university and on its active list, and subjects who were absent from duties for any reason including drinking problems or severe sickness were not included. All subjects fully understood the

<table>
<thead>
<tr>
<th>Table 2. Effect of Ethanol Consumption on Each Metabolic Syndrome Component</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Waist (85 cm or more)</td>
</tr>
<tr>
<td>Hypertension (SBP of 130 mmHg or more and/or DBP of 85 mmHg or more)</td>
</tr>
<tr>
<td>Hyperlipidemia (TG of 150 mg/dl or more and/or HDLC less than 40 mg/dl)</td>
</tr>
<tr>
<td>Hyperglycemia (Glucose of 110 mg/dl or more)</td>
</tr>
</tbody>
</table>

SBP: Systolic blood pressure
DBP: Diastolic blood pressure
TG: Triglyceride
HDLC: High density lipoprotein-cholesterol
*: Subjects who consume ethanol up to 20 g per day or teetotalers.
**: Subjects who consume ethanol at more than 20 g per day.
***: Comparison between average drinkers and excessive drinkers by chi square analysis and Fisher’s exact test.
Table 3. Effect of Ethanol Consumption on Metabolic Factors in Subjects with Waist Circumferences of 85 cm or More

|                      | Average*drinkers (n=713) | Excessive**drinkers (n=265) | P-value*** | P-value**
|----------------------|--------------------------|-----------------------------|------------|---------
| Waist (cm)           | 90 (85-122)              | 89 (85-118)                 | .385       | 0.7002  
| SBP (mmHg)           | 131 (91-225)             | 135 (92-210)                | .2579      | 0.0099  
| DBP (mmHg)           | 81 (54-147)              | 87 (61-143)                 | .5462      | <0.0001 
| TG (mg/dl)           | 96 (17-1078)             | 120 (36-1150)               | .8940      | 0.3711  
| HDL-C (mg/dl)        | 51 (29-93)               | 56 (30-94)                  | 7.105      | <0.0001 
| Glucose (mg/dl)      | 94 (58-246)              | 97 (78-217)                 | .0022      | 0.4180  
| Age (year)           | 45 (20-65)               | 45 (23-65)                  | .8105      | <0.0001 
| γGTP (IU/l)          | 39 (13-335)              | 60 (14-1006)                | .8946      | <0.0001 

median (range)

SBP: Systolic blood pressure
DBP: Diastolic blood pressure
TG: Triglyceride
HDL-C: High density lipoprotein-cholesterol
*: Subjects who consume ethanol up to 20 g per day or teetotalers.
**: Subjects who consume ethanol at more than 20 g per day.
***: Comparison between average drinkers and excessive drinkers by Mann-Whitney’s U-test.

The aim of this study and were expected to answer accurately and faithfully to a self-administered questionnaire. Subjects who did not complete the examination and questionnaire mentioned below for any reason were excluded; finally, 2,130 subjects aged 20 to 65 (median: 42) were studied. Their drinking habits were assessed by a simple questionnaire to ascertain whether their average daily ethanol consumption was more than 20 g or not. Subjects who consumed ethanol up to 20 g per day including teetotalers were tentatively designated as average drinkers, and the others as excessive drinkers according to the suggestion of the Japanese Ministry of Welfare and Labor (21). Their waist circumferences were measured at the navel level according to the recommendation in the Japanese Criteria (10). Their systolic and diastolic blood pressures (SBP and DBP, respectively) were routinely examined. A blood sample was collected from each subject after fasting for at least 10 hours, and routine blood chemistry tests including serum levels of triglyceride (TG), HDLC, and gamma GTP (γGTP) and the level of glucose in whole blood (FBS) were performed. Then, each subject was examined regarding whether they satisfied the Japanese Criteria (10). Subjects who received medication(s) for hypertension, dislipidemia, and/or hyperglycemia were judged to satisfy each component of the Japanese Criteria regardless of the actual value of each test. Based on the information, the diagnosis of the metabolic syndrome was also made using the criteria of NECEPATPIII, but in which the cut-off value of an excessive waist circumference was set at 85 cm according to the Japanese standard (10, the modified NECEPATPIII). Since some values such as SBP, DBP, FBS, TG, and HDLC showed skewed distributions, all values were expressed by their medians and ranges. Differences between the two groups were non-parametrically examined by Mann-Whitney’s U-test, and differences in prevalence were examined by Chi-square analysis followed by Fisher’s exact test. All statistical analyses were performed by StatView® (ver 5.0, SAS Institute Inc., NC, USA) using a Macintosh PowerBook G3 (Apple Japan, Inc., Tokyo, Japan). P-values less than 0.05 were considered to indicate significance.

Results

The subjects’ profiles are shown in a column of “all” in Table 1. In this population, the numbers of subjects who satisfied 6 components constituting the foundation of the Japanese Criteria, i.e., waist circumference, SBP, DBP, and levels of TG, HDLC, and FBS were 978 (45.9%), 911 (42.7%), 691 (32.4%), 511 (24.0%), 115 (5.4%), and 206 (9.7%), respectively. The numbers of subjects who satisfied the criterion of dislipidemia including components of TG and HDLC, and that of hypertension including components
Table 4. Effect of Excessive Ethanol Consumption on Metabolic Syndrome Component in Subjects with Waist Circumferences of 85 cm or More

<table>
<thead>
<tr>
<th></th>
<th>Average* drinkers (n=713)</th>
<th>Excessive** drinkers (n=265)</th>
<th>Chi square value***</th>
<th>p value***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist (85 cm or more )</td>
<td>713 (100.0)</td>
<td>265 (100.0)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Hypertension (SBP of 130 mmHg or more and/or DBP of 85 mmHg or more)</td>
<td>412 (57.8)</td>
<td>174 (65.7)</td>
<td>4.990</td>
<td>0.0276</td>
</tr>
<tr>
<td>Hyperlipidemia (TG of 150 mg/dl and/or HDLC of less than 40 mg/dl)</td>
<td>275 (38.6)</td>
<td>104 (39.2)</td>
<td>0.037</td>
<td>0.8826</td>
</tr>
<tr>
<td>Hyperglycemia (Glucose of 110 mg/dl or more)</td>
<td>87 (12.2)</td>
<td>50 (18.9)</td>
<td>7.127</td>
<td>0.0094</td>
</tr>
</tbody>
</table>

SBP: Systolic blood pressure
DBP: Diastolic blood pressure
TG: Triglyceride
HDLC: High density lipoprotein-cholesterol
NS: not studied
*: Subjects who consume ethanol up to 20 g per day or teetotallers.
**: Subjects who consume ethanol at more than 20 g per day.
***: Comparison between average drinkers and excessive drinkers by chi square analysis and Fisher’s exact test.

of SBP and DBP were 549 (25.8 %) and 990 (46.5%), respectively. Finally, 335 subjects (15.7%) were judged to have the metabolic syndrome under the Japanese Criteria. On the other hand, 368 subjects (17.3%) were judged so using the modified NCEPATPIII. The rate of coincidence in the diagnosis of the metabolic syndrome using the two different criteria was 98.0% in the present population.

Based on the present self-administered questionnaire as to drinking habits, the population was divided into two groups, namely 1,657 average drinkers and 473 excessive drinkers. As also shown in Table 1, there was no difference in age between the two groups. However, all levels of waist circumference, SBP, DBP, serum TG, serum HDLC, and FBS were significantly higher in the excessive drinkers than in the average drinkers. Moreover, serum γGTP activity was significantly higher in the former than in the latter (p<0.0001).

Regarding the 4 components of waist circumference, hypertension, dislipidemia, and hyperglycemia, which are the direct determinants of the Japanese Criteria, the rate of subjects who satisfied each criterion was significantly higher in the excessive drinkers than in the average drinkers, respectively (Table 2). The numbers of subjects who were judged to be the metabolic syndrome was 104 in the former (22.0%) and 231 in the latter (13.9%), and the prevalence was significantly different ($\chi^2=18.0$, p<0.0001). Even when the diagnosis of the metabolic syndrome was made by the modified NCEPATPIII, its prevalence was significantly higher in the excessive drinkers (23.5%) than average drinkers (15.5%, $\chi^2=16.3$, p<0.0001).

The rate of subjects who satisfied the HDLC criterion was significantly lower in excessive drinkers (2.75%) than in average drinkers (6.16%, $\chi^2=7.7$, p=0.0055) when the whole subjects were studied. Even when 549 subjects who satisfied the dislipidemia criterion comprising 139 excessive drinkers and 410 average drinkers, the rate was significantly lower in the former (9.3%) than in the latter (24.5%, $\chi^2=15.1$, p=0.0001), whereas there was no significant difference in waist circumference level between the two groups. Medians (and ranges) of waist circumference were 89.0 cm (70 cm-112 cm) and 88.2 cm (60 cm-120 cm), respectively in this selected population (z=-1.176, p=0.2393).
Moreover, 978 subjects with a waist circumferences of 85 cm or more, comprising 713 average drinkers and 265 excessive drinkers, were selectively examined. There were no differences in age and waist circumference between the two groups. However, the levels of SBP, DBP, and FBS as well as that of serum \( \gamma \)GTP were significantly higher in the former than in the latter (Table 3). In this population, the rates of subjects who satisfied the criterion of hypertension and that of hyperglycemia in the Japanese Criteria were significantly higher in the excessive drinkers than in the average drinkers. There was no difference in the rate of subjects who satisfied the dislipidemia criterion between the two groups (Table 4). The rate of subjects who were judged to be the metabolic syndrome was also significantly higher in the excessive drinkers (39.2\%) than in average drinkers in this selected population (32.4\%, \( \chi^2 \)=4.0, \( p \)=0.049).

**Discussion**

This study demonstrated that the prevalence of the metabolic syndrome is significantly higher in excessive drinkers than in average drinkers when the diagnosis of the metabolic syndrome is made following the current Japanese Criteria. Recently, several criteria for the clinical diagnosis of the metabolic syndrome have been proposed, in which its clinical features including central obesity, hypertension, hyperglycemia, and dislipidemia are determinants. Since excessive ethanol consumption could also cause hypertension, hyperglycemia, and dislipidemia, it was fully expected that it would affect the diagnosis of the metabolic syndrome using the current clinical diagnostic criteria.

In the present study, subjects were divided into two groups, namely average drinkers and excessive drinkers, using a self-administered questionnaire regarding their drinking habits. Since we have performed similar questionnaires in the present population repeatedly over the last five years (22, 23), it was fully assumed that the outcomes of the questionnaire would be reliable. The cut-off point of the two groups was set at an ethanol consumption of 20 grams per day according to the current definition of acceptable drinking for Japanese announced by the Japanese Ministry of Welfare and Labor (21). Although this cut-off point is apparently different from that for the selection of alcoholic subjects, it seems to be valid when investigating some effects caused by ethanol consumption, since the serum \( \gamma \)GTP level was significantly higher in subjects designated as excessive drinkers than in those designated as average drinkers.

Two plausible explanations for the higher prevalence of the metabolic syndrome in excessive drinkers are as follows: The first one is that excessive ethanol consumption increases the visceral fat accumulation, resulting in the development of the metabolic syndrome. This view may be supported by the present observation that the waist circumference was significantly larger in excessive drinkers than in average drinkers when the whole population was examined. Ethanol consumption may stimulate appetite via the inhibition of an increase in the blood glucose level after a meal by the inhibition of gluconeogenesis (24) or glycogenolysis (25). Moreover, a recent study demonstrated that it also inhibits ghrelin secretion, resulting in appetite stimulation (26). Indeed, associations between excessive ethanol consumption and obesity have been recently documented (16, 17). The appetite-enhancing effect of ethanol consumption has been introduced as one of its beneficial effects. However, it seems to be rather disadvantageous and deleterious for the development of the metabolic syndrome today, namely in an era so-called a “satiation period”, when voracious appetite is widespread. In this case, excessive ethanol consumption is assumed to simply contribute to deterioration of the status of the metabolic syndrome in the context of its original meaning i.e., morbid conditions caused by visceral fat accumulation and subsequent abnormalities of adipocytokines. Since alcoholics, who usually have negative nitrogen balances and/or increased protein turnovers, are generally lean (27), excessive ethanol consumption is easily implicated in leanness. However, such alcoholics who drop out from normal social lives are not included in the present population.

On the other hand, excessive ethanol consumption might also cause hypertension, hyperlipidemia, and hyperglycemia via mechanisms that are apparently independent from obesity (18-20). So long as subjects satisfy the waist circumference criterion, which is the essential determinant for the diagnosis of the metabolic syndrome using the current criteria, these effects peculiar to excessive ethanol consumption might contribute to the increase in the number of subjects who are regarded to have the metabolic syndrome. This view may be supported by the present observations of subjects with waist circumferences of 85 cm or more. Although there was no significant difference in waist circumference between excessive and average drinkers, the prevalence of the metabolic syndrome was still significantly higher in the former than in the latter. This suggests that some pathogenesis other than visceral fat accumulation, most likely excessive ethanol consumption per se, contributed to the increase in the prevalence of the metabolic syndrome in excessive drinkers. If so, among subjects who are judged to have the metabolic syndrome, subjects combined both the visceral fat syndrome and the alcohol-related syndrome are expected to be intermingled. Further studies including longitudinal monitoring of the occurrence of events related to metabolic syndrome are necessary to ascertain whether such combined cases are substantially different from non-combined “original” cases of the metabolic syndrome. However, since such effects peculiar to excessive ethanol consumption are not apparently related to abnormalities of adipocytokines due to visceral fat accumulation, we believe that these two cases should be separately considered.

Consistent with the general understanding (13), the serum HDLC level was significantly higher in excessive drinkers than in average drinkers, and the ratio of subjects who satisfied the HDLC criterion in the Japanese Criteria was signifi-
cantly lower in the former than in the latter whereas wait circumference level was significantly higher in the former than in the latter when all subjects were studied. Even when subjects who were positive for the dislipidemia criterion were selectively studied, a similar feature was observed. This may contribute toward lowering the number of subjects who satisfied the diagnostic criteria of the metabolic syndrome, contrary to the other effects of ethanol consumption described above, since the HDLC criterion, namely a lower serum HDLC level, is one of the factors for a positive diagnosis in the criteria. However, since the HDLC criterion is tied together with the TG criterion and constitutes a dislipidemia criterion at least in the Japanese Criteria, such an effect of excessive ethanol consumption on the HDLC criterion in the diagnostic criteria of the metabolic syndrome may be offset in this scheme. Indeed, the rate of subjects who satisfied the dislipidemia criterion was still significantly higher in excessive drinkers than in averaged drinkers.

The higher prevalence of the metabolic syndrome in excessive drinkers was also observed even when its diagnosis was performed using criteria other than the Japanese Criteria, namely the modified NCEPATPIII. We believe that such a discrepancy may occur as far as diagnoses of the metabolic syndrome are made by criteria comprising only components of the clinical features of the metabolic syndrome. Thus, the incorporation of some factors reflecting its fundamental pathogenesis to its diagnostic criteria may be helpful to settle this issue. For instance, the status of adipocytokines such as adiponectin could be a candidate as already proposed (28). Such an improvement should contribute to the prediction of which factors, namely visceral fat accumulation, excessive drinking, or both, are involved in the pathogenesis of morbid conditions seen in subjects who are expected to have both factors of visceral fat accumulation and of excessive ethanol consumption.

In conclusion, an excessive but socially acceptable level of ethanol consumption is associated with an increased prevalence of the metabolic syndrome when its diagnosis is made following the current clinical diagnostic criteria. A possible association between excessive ethanol consumption and obesity may account for this observation. However, we must also be aware of the possibility that excessive ethanol consumption causes such a discrepancy independently from the progression of visceral fat accumulation via mechanisms peculiar to ethanol consumption. Although further studies such as longitudinal monitoring of the occurrence of events related to metabolic syndrome are necessary to clarify the situation, the present findings suggest that the current clinical criteria of the metabolic syndrome still have some room for improvement.

References


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