The relationship between waist-to-hip ratio and occupational status and life-style factors among middle-aged male and female Japanese workers

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As a marker of body fat distribution and therefore level of obesity, the waist-to-hip ratio (W:H) is a good indicator of coronary heart disease risk status. The present study investigated the association between occupational status and life-style factors, and W:H of middle-aged Japanese male (n = 2,550) and female (n = 1,283) workers in a metal-products factory. A higher W:H was observed in the management level males as compared with the other male workers and we suggest this was promoted by the sedentary aspect of their work, as well as their higher levels of alcohol consumption and lower levels of leisure-time physical activity. In contrast, a higher W:H was recorded in female labourers, whose work was typically less sedentary as compared with female managers. Life-style factors included in the study were not related to this observation. We conclude that other unmeasured psychosocial factors may be important in promoting higher W:H in female labourers.

Key words: Alcohol consumption; obesity; occupation; physical activity; waist-to-hip ratio.

INTRODUCTION

In Japan, the United States and the United Kingdom estimates suggest that approximately 12% of the working adult population are obese1 and that over 30% are clinically overweight.2 As factors that promote the development of cardiovascular disease,4 being overweight or obese represents a serious threat to the health status of many people. From an employer's point of view, this issue is particularly worrying as employees who are overweight or obese may have high levels of absence.

Body mass index (BMI: kg/m²) is commonly used to estimate obesity levels. However, it has been suggested that fat distribution in the body should also be considered. Obese persons having upper body fat distribution or an accumulation of visceral adipose tissue tend to develop cardiovascular disease more often than those with lower body fat or subcutaneous adipose tissue deposition.5 In addition, some investigators report that waist to hip ratio (W:H) measured as an index of upper body fat distribution is associated with cardiovascular risk factors independently of BMI.8,9 With regard to gender differences in the incidence of cardiovascular disease, it has also been suggested that these differences may be attributable to more upper body fat distribution in men than in women.10

In recent years, research has demonstrated that increases in body weight, W:H and waist circumference are related to aspects of occupation such as employment grade11 and amount of overtime.12 although this relationship is still controversial. As far as we know, there has been no large-scale epidemiological investigation of...
the relationship between markers of obesity and occupational status in a Japanese working population. Therefore, in the present study we analysed the relationship between occupation status and W:H as a simple and practical indicator of upper body fat deposition in a sample of Japanese workers. Various confounding life-style factors, such as alcohol and cigarette consumption and physical activity at leisure time and at work were also included.

MATERIALS AND METHODS

The subjects of this study were approximately 4,000 male and female employees in a metal-products producing factory, aged between 35 and 59 years. All of the subjects were examined by anthropometric measurements when they underwent their routine annual medical check-up, and subjects' waist circumference at the umbilicus level and hip circumference at the widest level were measured by experienced nurses. During the examination all subjects wore the company's standard uniform, a jacket and trousers made of thin cloth.

All of the subjects completed a questionnaire asking them about their alcohol and cigarette consumption, leisure-time physical activity time, physical activity at work, occupational status and medical histories. Alcohol consumption was categorized into nondrinkers, occasional weekly drinkers, light daily drinkers (<50g alcohol) and daily drinkers (≥50g alcohol). Cigarette consumption was categorized into nonsmokers, ex-smokers, light current smokers (≤20 cigarettes/day) and current smokers (>20 cigarettes/day). Leisure-time physical activity was classified into four groups according to amount per week: almost no exercise, light exercise, brisk sweat-inducing exercise once or twice per week and brisk sweat-inducing exercise more than three times per week. Physical activity at work — that is how sedentary each job is — was categorized into three groups according to the percentage of the entire working time spent in physical activity: ≥60%, 20–59%, <20%.

Occupational status was classified into six occupational categories based on the company's own classification: e.g., managers, engineers, clerks, labourers, traffic servicepersons and 'others'. Those employees classified as managers included those workers who acted as general supervisors. The 'others' included guards, gardeners, shop-persons at the branch factory and those engaging in management of dormitory and catering food. Among the female workers there were no management level employees and the 'others' group of women included three traffic servicepersons.

Excluded from the sample were 70 men and 143 women who did not respond completely to the questionnaire, and 12 men and 14 women who did not consent to anthropometric measurement. The final sample included 2,550 men and 1,283 women who comprised 96.9% and 89.1% of the target populations.

Data analysis

Data were analysed separately for male and female workers using a SAS program package. Correlation coefficients between age, BMI and W:H were performed by Spearman’s rho. The data in different occupational groups were compared using a general linear model method. In order to compare the proportion of life-style factors among groups, chi-square and Fisher Exact Test were used. Stepwise multiple regression analyses were used to test the independent contribution of the variables to W:H level. All p-values less than 0.05 were considered to be significant.

RESULTS

The mean age of the men was 45.4 years (SD ± 6.8 years) and of the women was 44.8 years (SD ± 6.4 years). Mean BMI and W:H was 23.2 ± 2.7 kg/m² and 0.873 ± 0.053 for men, and 22.6 ± 3.0 kg/m² and 0.811 ± 0.078 for women. Correlation coefficients of W:H with age and BMI were all significant: 0.142 (p < 0.001) and 0.620 (p < 0.001) in men, and 0.207 (p < 0.001) and 0.392 (p < 0.001) in women.

Mean values of W:H adjusted for age, BMI and behavioural factors among the six male occupational groups and the four female groups are summarized in Table 1. In men, W:H adjusted for age was higher in managers than in any of the other occupational groups, and the mean value of BMI in managers and traffic servicepersons was higher than in any of the other four groups. The number of current smokers was highest among labourers and the number of daily drinkers was highest in labourers and traffic servicepersons; however, these differences were not significantly different from those among the other occupational groups. The rates of leisure-time physical activity were similar in all six occupational groups, but the rate of physical activity at work was significantly higher in labourers than in any other group. Among female workers, the W:H adjusted for age of labourers and the mean BMI of 'others' were the highest of all the occupational groups. There were no differences in the rates of smoking, alcohol consumption or leisure-time physical activity among the female occupational groups, though the rates were quite low in all four groups. As with men, the rate of physical activity at work was significantly higher in female labourers and 'others' in comparison with the remaining two occupational groups.

The associations of W:H in men and women with alcohol consumption, smoking habit and physical activity during leisure-time and at work are shown in Table 2. W:H was positively and significantly associated with alcohol consumption in men, and a similar though not significant trend was observed in women. There was no significant difference in W:H among the different groups of smokers in either gender. Among men, increased W:H was significantly associated with less leisure-time physical activity and less physical activity at work, while W:H in women was higher in those workers doing a less sedentary job even when adjusting for age and BMI.
Table 2. Mean levels of waist-to-hip ratio according to life-style factors

| Life-style factors | Men | Women |
|-------------------|-----|-------|
| Alcohol consumption | 0.869 | 0.872 |
| Smoking habit | 0.871 | 0.870 |
| Physical activity | 0.874 | 0.874 |
| Physical activity at work | 0.874 | 0.874 |

Table 3 shows the results of stepwise multiple regression analyses which were performed to evaluate the independent contributions of age, BMI, and the life-style factors to W:H. In both genders, older age and higher BMI were significant contributors to increased W:H. In men, higher alcohol consumption was significantly related to higher W:H, while more physically active status in leisure-time and a less sedentary job type were significantly related to a decrease in W:H. In women, however, only a less sedentary job type showed a significant association with an increase in W:H.

Mean values of W:H among the different occupation classifications, adjusted for age, BMI, and life-style factors are shown in Table 4. For men, after adjusting for age, BMI, alcohol and cigarette consumption, managers still showed the highest W:H, while labourers and ‘others’ had the lowest W:H. Although the differences remained significant after adjusting for leisure-time physical activity, none of the differences were significant after adjusting for physical activity at work. For women, labouring workers showed the highest W:H among the four occupational groups even after we adjusted for leisure-time physical activity and physical activity at work.

**DISCUSSION**

Although W:H has generally been accepted as an indicator of upper body fat distribution, it may not correctly...
The present study demonstrated that among men, in addition to increased age and BMI, higher alcohol consumption, less leisure-time physical activity and a more sedentary job type were significantly related to increased W:H, but that smoking status was unrelated to increased W:H. The positive association between alcohol consumption and W:H in men is consistent with the findings of Laws et al.\textsuperscript{18} and Marti et al.\textsuperscript{19} although a lack of association was conversely reported by Haffner et al.\textsuperscript{20} A number of investigations have shown that smoking is associated with an increase in W:H\textsuperscript{18,21-23} however, not all investigations have reported a significant association. For example, smoking status, as indicated by the amount of nicotine inhaled, was not related to W:H in non-obese men,\textsuperscript{24} with similar results reported by Iso et al.\textsuperscript{14} and Keenan et al.\textsuperscript{25} In the present study, the mean W:H in men was 0.873 — lower than in those previous studies; this may account for the weak association between smoking status and W:H.

Duncan et al. demonstrated that less physical activity in leisure-time and at work was related to increased W:H\textsuperscript{26} and the present study confirmed this relationship in men. Among women, however, the least sedentary workers showed the highest W:H. This association remained significant in a multiple regression analysis adjusting for the effects of age and BMI. Furthermore, the associations between W:H and other lifestyle factors were not significant in women, which may be partly explained by the small numbers of women who consume alcohol and cigarettes, and who are physically very active during leisure time.

Although an inverse association between socioeconomic status and W:H has been shown in industrialized countries,\textsuperscript{27} the present study demonstrated that the managers, a proxy for higher socioeconomic status, had the highest W:H of the six groups of male workers even after adjusting for age and BMI. After adjusting for physical activity at work, however, no significant difference remained among the occupational groups. These results suggest that the higher W:H found in the managers may have been promoted by their sedentary job type. On the other hand, W:H in female labourers who had the least sedentary job type, was higher than in female engineers and clerks whose jobs were the most sedentary. This result remained after adjusting for physical activity at leisure and at work. Although the reasons for the discrepancy between male and female workers remain unclear, these findings suggest that the differences in W:H among female occupational groups may be accounted for by factors other than those investigated in the present study.

Several recent investigations have found an association between psychosocial work factors and fat distribution as measured by W:H. For example, the Whitehall II study demonstrated that W:H was higher with decreasing employment grade,\textsuperscript{11} and Rosmond et al. reported that life dissatisfaction\textsuperscript{28} and dissatisfaction with work management\textsuperscript{29} were both associated with increased W:H. In addition, several other studies demonstrated that W:H was higher in people who had a lower level of education than in those with a higher level.\textsuperscript{3,19,30} Seidell et al.,\textsuperscript{31} in

Table 3. Results of multiple regression analyses for variables related to waist-to-hip ratio

| Variable   | Standardized estimate | F     | p   |
|------------|-----------------------|-------|-----|
| Men        |                       |       |     |
| BMI        | 0.619                 | 1,661 | <0.001 |
| Age (yrs)  | 0.139                 | 83.6  | <0.001 |
| PAL\textsuperscript{a} | -0.095               | 38.7  | <0.001 |
| Alcohol\textsuperscript{b} | 0.076                | 25.5  | <0.001 |
| PAW\textsuperscript{c}    | -0.066               | 18.8  | <0.001 |
| R²         |                       | 0.419 |

| Women      |                       |       |     |
|------------|-----------------------|-------|-----|
| BMI        | 0.367                 | 206.5 | <0.001 |
| Age (yrs)  | 0.144                 | 31.2  | <0.001 |
| PAW        | 0.074                 | 8.5   | 0.004 |
| R²         |                       | 0.183 |

\textsuperscript{a} Leisure-time physical activity: none = 1; light = 2; hard (<3 times/w) = 3; hard (≥3 times/w) = 4.
\textsuperscript{b} Alcohol consumption: never = 1; sometimes = 2; light daily (< 50 g/day) = 3; daily (≥50 g/day) = 4.
\textsuperscript{c} Ratio of sedentary job to entire working time: ≥60% = 1; 20-59% = 2; <20% = 3.

Table 4. Waist-to-hip ratio levels in worker-groups of different kinds of occupations

|          | I        | II       | III      | IV       |
|----------|----------|----------|----------|----------|
| Men      |          |          |          |          |
| Manager  | 0.880    | 0.881    | 0.875    | 0.873    |
| Engineer | 0.873    | 0.874    | 0.868    | 0.868    |
| Clerk    | 0.876    | 0.877    | 0.872    | 0.869    |
| Labourer | 0.871    | 0.872    | 0.865    | 0.869    |
| Traffic serviceperson | 0.874 | 0.875 | 0.869 | 0.869 |
| Others   | 0.869    | 0.870    | 0.864    | 0.865    |
| Heterogeneity (p) | 0.035 | 0.051 | 0.016 | 0.473 |

| Women    |          |          |          |          |
| Engineer | 0.786    | 0.789    | 0.787    | 0.786    |
| Clerk    | 0.787    | 0.801    | 0.799    | 0.797    |
| Labourer | 0.817    | 0.821    | 0.819    | 0.817    |
| Others   | 0.802    | 0.805    | 0.803    | 0.802    |
| Heterogeneity (p) | <0.001 | <0.001 | <0.001 | <0.001 |

I: Adjusted for age and BMI.  
II: Adjusted for age, BMI, alcohol consumption and smoking habit.  
III: Adjusted for age, BMI, alcohol consumption, smoking habit and leisure-time physical activity.  
IV: Adjusted for age, BMI, alcohol consumption, smoking habit, leisure-time physical activity and physical activity at work.

reflect fat deposition in the visceral cavity. In a study of 67 obese Japanese women, Kanai et al. demonstrated that visceral fat accumulation assessed by computed tomography was greater in a hypertensive group than in a normotensive group, while the W:H showed no significant difference between the two groups.\textsuperscript{13} However, in several other studies, W:H was found to be positively associated with the development of cardiovascular risk factors in Japanese men, positively associated with blood pressure and total-cholesterol, and inversely associated with HDL-cholesterol.\textsuperscript{14,15} Furthermore, in the Hisayama study in Japan, W:H was associated with impaired glucose tolerance and diabetes mellitus in both men and women.\textsuperscript{16} Therefore, it would seem safe to conclude that increased W:H has an association with the development of coronary heart disease risk factors in Japanese, as well as Caucasians.\textsuperscript{8,9,17}
their study of 38-year-old men, demonstrated that W:H tended to be positively related to physical activity at work regardless of a negative relationship between physical activity at sports and W:H, and that this relation was weakened after adjusting for education levels. Thus lower income, dissatisfaction with life and work and lower level of education seem to be strongly related to an increase of W:H.32

We did not inquire as to the educational backgrounds of the subjects in the present study, but it can be generally said that in this factory, male labourers and traffic servicepersons had less than 12 years' education, and that managers, engineers and clerks had more than 12 years. Furthermore, we can also say with some certainty that female workers had less education than male workers at the same occupational levels. In addition, the results of our previous study conducted in Japan demonstrated that women in lower occupational positions experienced more stress than men in similar positions, and other women in higher occupational positions.33 Therefore, indicators of psychosocial disadvantage such as experiencing relatively more job stress, relatively less education, etc., may have had a larger effect on the W:H in our female workers.

In conclusion, we found that male workers who had higher levels of alcohol consumption and less physical activity showed increased W:H. However, among the levels of occupation, this relationship was mainly accounted for by differences in the levels of physical activity at work. In contrast, W:H was higher among female workers who did more physical activity at work than any of the other female occupational groups. The W:H in this female group may be affected by psychosocial factors which were not investigated in the present study. Hitherto the relationship between psychosocial work factors and increasing W:H has not been investigated in a Japanese workforce. Based on our findings we suggest that more attention needs to be paid to unravelling this relationship. Improving our understanding of this relationship will have major implications for reducing the development of cardiovascular disease.

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