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Review

Prevention of Weight Gain and Obesity in Occupational Populations: A New Target of Health Promotion Services at Worksites

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Abstract: Prevention of Weight Gain and Obesity in Occupational Populations: A New Target of Health Promotion Services at Worksites: Yuichi YAMADA, *et al.* Department of Hygiene, Kanazawa Medical University—Obesity has been recognized as a global epidemic threatening health and life. Today in Japan, obesity defined as a body mass index (BMI) greater than 30 kg/m^2 is found in 2–3% of adults, but one in five men and women is defined as overweight with a BMI greater than 25, and thus the prevention of obesity should be targeted in health promotion services at worksites. Vigorous research is required in workplaces because a few work-related factors, such as socioeconomic status including job and position, job stress, extended work including overtime, shift or night work and sedentary work, have been suggested in the literature to promote weight gain and abdominal fat accumulation. The obesity prevention programs at worksites should not be focused on reducing weight in a few current obese workers, but on maintaining the current weight in the majority of workers to prevent the development of obesity and its consequences. The measurement of waist circumference is indispensable for assessing the risk of coronary heart disease (CHD) in overweight and obese workers, and those at a high risk of CHD should be referred to medical professionals outside the workplace. The education programs at worksites on dieting and exercise for maintaining body weight should be conducted as a part of the whole lifestyle improvement programs on both a population and an individual basis. Considerable knowledge and skills for the education program are required for health care persons at worksites. Otherwise, professional support should be provided to them by some occupational health service agencies.
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Obesity is now a major health problem in many nations in both developed and developing countries. In the U.S., the Center for Disease Control and Prevention (CDC) estimated that 300,000 premature deaths each year are attributable to obesity, which is close to the 400,000 annual deaths due to cigarette smoking[1]. In some countries, obesity-related health care costs have been estimated to amount to 5% or more of the total health care expenditure[2], imposing a considerable burden on national budgets. In the review of medical problems associated with obesity, Kopelman[3] stated that obesity should no longer be regarded simply as a cosmetic problem affecting certain individuals, but as an epidemic that threatens global well being. Therefore, together with vigorous investigations on the biological bases including genetics involved in the development of obesity, the contributions of the daily life of people living in modern society, such as food intake, physical activity, and other factors as well as psychological status have been extensively explored in relation to weight gain, obesity and their consequences, aiming to devise effective measures for preventing obesity and improving the nations' health.

Meanwhile, various factors involved in performing jobs probably have a close relationship to the lifestyle and behavior of people, thereby contributing to weight gain and obesity. For a simple instance, poor job conditions may promote unhealthy behavior, which in turn expedites weight gain, but the nature of jobs in modern industries has not yet been fully investigated with regard to weight gain and obesity. In this article, we outline briefly the epidemic features of obesity in the modern world and its health implications, and propose here the prevention of weight gain and obesity as a new target of health promotion services at worksites in addition to other

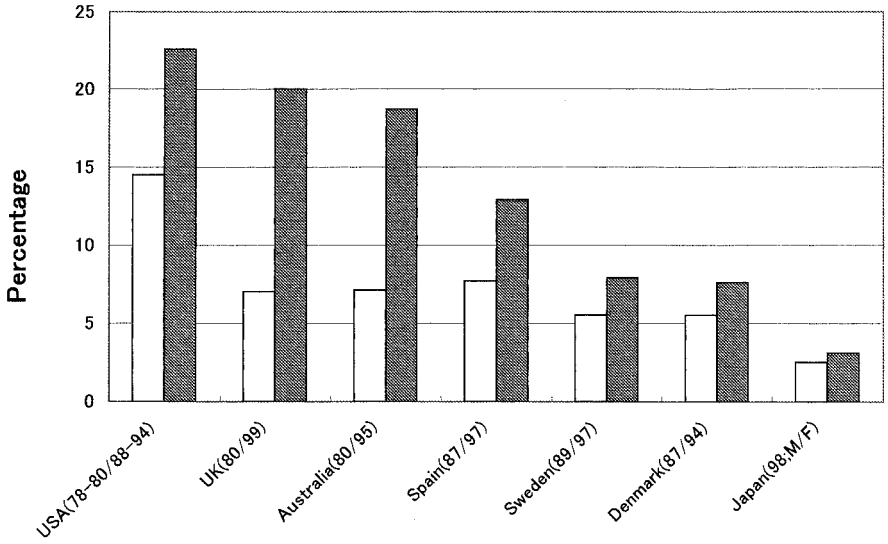

Fig. 1. Obesity among the adult populations of some OECD countries and Japan. Obesity was defined by a BMI greater than 30 kg/m^2. Data sources are OECD health report 2001 and the National Nutritional Survey of 1999 in Japan.

existing services such as improvement of physical fitness, cessation and reduction of smoking, and moderation of alcohol consumption. We then present the results of a literature search on the association of jobs and various related factors with weight gain and obesity to facilitate further research in occupational populations. In addition, a brief discussion is made of some basic principles in the strategy of preventing obesity adoptable at worksites including technical problems involved in measuring and assessing adiposity, referring to the guidelines recently published in the U.S.[4, 5], and in Japan[6]. This is because these issues have not yet been fully discussed or well set out in the occupational health field.

Epidemic of obesity

Obesity in the world and Japan

According to a recent OECD report (Fig. 1)[7], obese people defined by body mass index (BMI: weight (kg) divided by the square of height (m)) greater than 30 accounted for 22.6% of the population of the United States in 1988–94, in contrast to 14.5% in 1978–80. In UK, obesity defined in the same way was detected in 20% of the population in 1999, amounting to nearly three-fold the rate in 1980. A similar increase in obese people was found in Australia, 7.1% in 1980 and 18.7% in 1995. In Scandinavian countries, the prevalence of obesity was relatively low a decade ago, 5.5% in Denmark and Sweden in 1987–1989, but increased to 7.6% in Denmark in 1994 and 7.9% in Sweden in 1997. At present in Japan, BMI of 30 or higher is found in 2.5 and 3.1% of males and females aged above 15 yr, respectively[8]. According to the table of height and weight distributions in the report of the national nutritional survey conducted in 1986[9], a BMI of 30 or higher was roughly estimated in 1.5–2.0% of Japanese adults. So, although the prevalence of obesity is still lower in Japan than in many western developed countries, it has increased as rapidly as in other countries during the last two decades.

The WHO Expert Committee[10] in 1995 proposed the term overweight to refer to a BMI greater than 25 and drew special attention to the health effects of overweight and weight gain in adults' life based on their association with increased mortality. Overweight is now found in more than half of the adult population in many western developed countries[11], such as 61% in the U.S., 54% in Russia, 51% in the UK and 50% in Germany. It is also found in many people in some developing countries, such as 36% of the Brazilian and 15% of the Chinese adult population. Recent Japanese statistics[8] showed that 25 and 20% of males and females aged above 15 yr are overweight.

Society modernization and obesity

Increases in obese people in developed countries are undoubtedly related to the socio-economical changes that occurred during the last century. A dramatic decrease in the proportion of workers in primary industries such as agriculture, fishing and mine or forest work, and the introduction of a variety of machines in the production industries, and an increase in the proportion of people engaged in various kinds of service industries must have decreased overall energy expenditure of the working population. Stamler (1967)[12] quoted a work by Pollack and stated that human physical activity contributed 13%

of the energy needed for performing a task in 1850, whereas 100 yr later 98.5% of the energy was obtained mechanically with the contribution of human physical activity limited to 0.9%. The life of people in developed countries may have been changed more drastically after World War II. Together with increased intake of energy, especially of fat origin, a further decrease in energy expenditure in daily life, such as the development of transportation including extensive use of cars, various electronic equipment for household work, and apparatus for audiovisual amusement at home including TV sets, must have also played important roles in the increase in the proportion of obese persons. Factory automation developed during the last three decades has imposed heavy psychological strain on industrial workers in watching the machines or equipment in processing, together with reducing physical activity.

Furthermore, business globalization during the last 10 yr has greatly affected society and the life of people. The urgent requirement to reduce production costs to compete in the worldwide market has prompted 24 h operation in many factories resulting in the need for a large number of shift or night workers, which in turn has changed all of society to a 24 h operating basis[13]. This has imposed far-reaching changes in the lifestyle and behavior of all people. The sedentary life of people living in many developed countries may be attributable, at least in part, to their deep psychological stress associated with adaptation to the rapid technical innovations, intense competition and cultural conflicts related to the increasing globalization that characterizes modern society.

Health implications of overweight and obesity

In the original sense, overweight refers to an excess of body weight compared with height, while obesity refers to an excess of body fat[10]. But, the two terms are practically interchangeable, and overweight is often used to mean a mild increase in an index of relative body weight to height such as BMI, and obesity to mean a marked increase in the index. Since the exact measurement of body fat composition requires complicated equipment and is a time-consuming process, various indices to simply calculate and approximate body fat mass have been proposed and used. At present, BMI is accepted as the most reliable such index reflecting body fat in both male and female adults in western countries; the correlation coefficient is 0.75 or higher with the percentage of body weight as fat and around 0.90 with the fat mass directly measured by standard methods[14, 15]. Similar findings have been obtained in Japanese adults[16].

The Metropolitan Life Insurance Company in the U.S.[17] in 1959 proposed a desirable relative body weight to height based on the data showing high mortality in their clients either being short of or exceeding a certain point on the relative body weight index. Early studies conducted since then in the U.S.[18, 19], and in European countries[20–22] on the association of mortality with relative body weight also showed J- or U-shaped curves, i.e., higher mortality in people being either lower or higher than the ideal zone of relative body weight, reflected in a BMI of 21–25. But, recent studies[23–25] have suggested that the higher mortality in thin people could be a reflection of smoking effects or undiscovered underlying diseases, or of the large disparity between relative body weight and body fat mass among older people. The harmful effects of leanness with regard to mortality thus remain questionable. Only a few epidemiological studies have been conducted in Japan on the association between obesity and mortality, and most of them showed a U-shaped pattern[26–28], but the effects of smoking, underlying disease and aging on the association have not been fully evaluated in those studies.

Although some studies[20, 29] suggested an increase in cancer of the uterus, gallbladder and breast in women and prostate and colon in men with increases in body weight, the high mortality in obese people is largely attributable to the excessive occurrence of cardiovascular disease, particularly coronary heart disease (CHD)[25, 30, 31], which in obese people with a BMI of 30 or higher amounts to 2 to 3-fold that in people with a BMI of 20–24.9. The development of major CHD risk factors, such as hypertension, impaired glucose tolerance and dyslipidemia, with increases in body weight must greatly contribute to the high occurrence of CHD. As mentioned above, there are relatively few obese people in Japan at present, but one in five adults is overweight. Middle-aged overweight Japanese, both men and women, have 1.5 to 2-fold the prevalence of hypertension, high serum cholesterol and diabetes mellitus in those with a normal BMI[32, 33]. These associations between BMI and various CHD risks are basically in accordance with those observed in western nations[34–39]. The current lower mortality of CHD in Japanese as compared with western nations, therefore, must be in large part attributable to the small number of obese people among the former. The prevention of obesity is therefore very important for suppressing future CHD mortality in Japan.

More recently, great attention has been paid to the distribution of fat in the body regarding the risk of CHD[40]. Kaplan[41] in 1989 proposed the term “deadly quartet” as a profile of persons at very high CHD risk, namely the combination of upper body obesity, hypertension, high serum triglycerides and impaired glucose tolerance. This multiple CHD risk complex has been named alternatively “metabolic syndrome X”[42] or “insulin-resistance syndrome”[43]. The term upper body obesity is basically interchangeable with the term android-type obesity[44], or visceral-type obesity detectable by computer tomography (CT)[45] and characterized by massive fat deposition in the abdominal cavity. The accumulation of fat in the

abdominal cavity can be approximated with certain accuracy by the waist circumference or the ratio of waist to hip circumferences (W/H)[46, 47], which have been shown to be associated with the occurrence of CHD or risk factors more closely than BMI in some epidemiological studies[48–51].

Apart from cancer and CHD, obesity or overweight may exert other significant effects on the development of various health problems in occupational populations. Osteoarthritis[52] and neck pain[53, 54], sleep apnea and consequent daytime sleepiness[55, 56], adult-onset bronchial asthma[57], and accidents[58–60] and absence[61] from the workplace have been reported to relate to obesity. Among these, knee or ankle joint pains in overweight or obese women at middle age sometimes cause unendurable health problems limiting their daily activities[62, 63]. Therefore, the control of body weight and the prevention of obesity should be raised as a major target for health promotion services in the workplace, not only to prevent disease but also to improve the activity and quality of life of workers.

Work-related factors expediting weight gain

Job and social class

In most countries, obesity was most likely once a characteristic of persons of a high social or economic status. For example, in classical cartoons, kings and lords were often portrayed as fatty whereas their attendants and general workers, mainly farmers, were shown as thin. In "Yamai Soushi" (a booklet of disease) published in Japan a thousand yeas ago, a morbidly obese woman was illustrated as the wife of a moneylender who could not walk without the assistance of attendants. The situation might have been true even in western developed countries until the beginning of the last century, when some epidemiological studies revealed a higher prevalence of obesity in persons of a lower social class as determined by their job, job position, education and/or income. Moore *et al*.[64] and Goldblatt *et al*.[65] reported in the 1960s an inverse association between social class and relative body weight in inhabitants of New York City. Silverstone *et al*.[66] and Baird *et al*.[67] then observed a similar inverse association in Londoners around the year 1970. Studies conducted later in other European nations also showed more obese persons in the lower socio-economic classes[68, 69]. Although these earlier studies often detected a marked inverse association only in women, and they sometimes showed an opposite finding in men, i.e., obesity was more frequent in men of a higher social class[70–72], more recent studies conducted in the U.S. and European countries have shown an inverse association in both sexes[73–75].

There have been few studies in Japan on the association between job, social class and overweight or obesity. Okumura *et al*.[76] observed a higher mean relative body weight in male managing and clerkship workers of a metal-products factory located in a rural area in Toyama in comparison with the manual laborers. Konishi *et al*.[77] also reported a higher relative body weight in clerical workers than in manual laborers in men living in Osaka, an urban area of Japan. They observed decreases in the difference between the two groups during the 22 yr between 1963 and 1985. Kikuoka *et al*.[78] showed a higher BMI in male clerical workers than in manual laborers working for industries located in the suburbs or rural areas of Wakayama. In general, clerical workers are more educated and in higher job positions than manual laborers in Japan. On the other hand, in female workers, a higher BMI was observed in manual laborers than in clerical workers in Wakayama[78] and in the metal-products factory in Toyama[79].

A similar inverse association between social class and upper body fat distribution evaluated by W/H has been observed in western countries[80, 81]. In Japan, Ishizaki *et al*.[79] reported a higher W/H, independently of BMI, in male managers and clerical workers in comparison with manual laborers in a metal-products factory, whereas female manual laborers inversely had a higher W/H than clerical workers. Meanwhile, the determinants of waist circumference, W/H and BMI must be mostly common, but some of them may exert different effects on the indices. For example, in contrast to BMI that has been often reported to be lower in current smokers[82, 83] and vaguely associated with increases in alcohol consumption[84], W/H was generally high in current smokers[85–87] and in large volume alcohol consumers[79, 84, 88, 89]. The consumptions of cigarettes and alcohol, which would be major confounders because of their close relationship to job or social class, may have some special effects on fat distribution in the body.

The reasons for the inverse association of social class with BMI and W/H observed in people in western countries and in women in Japan, and those for the controversial findings in different countries, time and gender are obscure. The higher BMI and W/H observed in the male managers and clerical workers in the rural factory in Toyama must be largely attributable to their sedentariness at work and at leisure[79], resulting in low energy expenditure in their life. In female Japanese workers, as well as people in western countries, however, some factors other than energy expenditure at work may greatly affect their body weight and fat distribution. In western countries, it has been pointed out that people of a lower social class prefer more fat-rich foods, smoke more, and are more physically inactive at leisure[90, 91], which means that people in lower social classes often exhibit unhealthy behaviors facilitating weight gain and abdominal fat accumulation. This has not yet been fully elucidated in Japan.

Psychological stress at work

In addition to the lifestyle factors, the higher body weight in people of a lower social class has been suspected to relate to the strong psychological strain due to such factors as dissatisfaction with the job[80] or life[92] that they are exposed to. The facilitating effects of psychological stress at work on body weight or abdominal fat accumulation are so far controversial[93–100], but would be very plausible since job stress has often shown a close relationship to unhealthy behavior, such as heavy smoking[94, 97, 100], large alcohol consumption[101] and sedentariness at leisure[93, 97, 99, 100]. Another possible mechanism would be mediated by changes in some endocrine activities due to psychological strain. Stress may cause an increase in adrenal corticoid and insulin excretion but a decrease in sex and growth hormones[102, 103]. An increase in body weight[104] and abdominal fat[105] after decreases in sex hormone has been typically illustrated in women at the menopause. The effects of excessive cortisol excretion on fat distribution in the body are typically seen in the central-type obesity in patients with Cushing's syndrome[106]. The roles of the endocrine changes in weight gain and changes in body fat distribution in workers exposed to heavy job stress remain to be elucidated.

Long work, overtime and shift work

Emdad *et al.*[107] found a significant association between the length of work hours behind the wheel and increases in BMI among professional motor vehicle drivers. They speculated that exhaustion after driving for a long time encourages consumption of heavy meals and then remaining sedentary after arriving home. Long working hours has been suggested to be the strongest stressor for many workers in Japan[108], and overtime has been determined to be an expediting factor of both BMI and W/H increases[109]. Deterioration of behavior associated with exhaustion after long time or overtime work must be the most common and significant problem with regard to preventing weight gain and abdominal fat accumulation in occupational populations.

One of the typical adverse health effects associated with shift or night work was once weight loss[110]. Shift workers tend to complain of gastrointestinal dysfunction and loss of appetite, thereby losing weight. This may be true even now in some workplaces in developed countries and in many in developing ones, where workloads are generally heavy. During the last 10 yr, however, increased body weight has been reported among some shift workers in developed countries[111–113]. Although increases in body weight after undertaking shift work have been often suspected, there have been few studies successfully demonstrating such evidence because of difficulty in eliminating various biases in the study designs. Healthy workers' effect is the most common bias[114]. In addition to this, in many workplaces, shift workers and control daytime workers have been engaged in substantially different jobs, differing not only in the length or intensity but also content. Another difficulty arises from the fact that in many workplaces where shift work is undertaken, all laborers are requested to be involved in the shift work, and only exceptional workers would be assigned to daytime work in cases of ill health, or special family or social conditions. These circumstances would cause great difficulty in designing proper comparisons between shift and non-shift workers.

Meanwhile, we observed a weight gain, 1 kg on average, in clean room workers who had moved from an 8-h shift to a 12-h shift in an electronic-parts factory[115]. The 12-h shift workers complained of more fatigue after the shift change. In a separate study in the same factory, poor recuperation, life dissatisfaction and sedentary behavior at home were found more frequently in the 12-h shift workers than in the 8-h shift workers[116]. Considering the fact that not a few previous studies have denied deterioration in the health of workers doing 12-h shifts as compared with those on 8-h shifts[117], the weight gain observed in the 12-h shift clean room workers may have been caused by their sedentariness during leisure and off days after exhaustion due to the long work hours, stress associated with clean room work, or inappropriate rotation schedules. In any case, shift and night work could distort the behavior of workers in such a way as to facilitate weight gain, if the work time, loads and rotation schedules were not well controlled. A significant contribution of shift work to increases in W/H, independent of BMI, has been detected in studies conducted in Sweden[80] and the Netherlands[112]. Special attention, therefore, should also be paid to unhealthy changes in body fat distribution in people engaged in shift work.

Some principles in the strategy adoptable in workplaces

We should remember that it is difficult for obese persons to maintain long-term weight loss even if once achieved by vigorous intervention programs, and that repeated regaining of weight (weight cycling) would cause considerable harmful effects on their health[118, 119]. Also, in considering the limited human, financial and temporal resources available at worksites, treatment of highly obese persons who need vigorous weight reduction should be referred to some appropriate medical professionals outside the workplace. The efforts at worksites should be focused on the primary prevention of obesity, i.e., maintaining current weight in the majority of workers to prevent the development of obesity in future, rather than reducing weight in a few current highly obese workers. Some principle matters, however, remain to be discussed before starting such obesity prevention programs at worksites.

Technical problems in measuring adiposity

Since obesity originally refers to an excess of fat mass in the body, any indices of relative body weight to height, such as BMI, are unsatisfactory because they do not discriminate increases in fat mass from those in other tissues such as muscle. More direct measurements of adiposity are therefore preferable, one of which is the measurement of subcutaneous adipose tissue thickness with a special pair of calipers[120–123] or alternatively using an ultrasound technique[124, 125]. But, the need for special skills for reliable measurements[3] would limit their use at worksites. A more sophisticated measurement is the impedance method utilizing the different electrical impedance between fat tissue, which is relatively nonconductive owing to its anhydrous nature, and the other parts of body containing fluid, which are conductive. Experimental studies on the accuracy of the impedance method have shown a quite high correlation of 0.95 or higher with the fat mass determined by X-ray densitometry[126, 127]. Some commercial products even for home use also showed fairly good reliability if the measurements are performed in the proper manner[128, 129]. However, there is no advantage with the impedance method in detecting the risk factors for CHD as compared with BMI.[3] The use of the impedance method must be limited to some special persons such as athletes or the elderly in whom a great discrepancy between body fat and weight would be expected.

Another aspect of assessing obesity is the distribution of adipose tissue in the body. Fat mass accumulated in the abdominal cavity would be critical for developing CHD and associated risk factors, and could be measured exactly by such equipment as CT, X-ray or ultrasound that are limited to special facilities such as hospitals. The W/H has been used as a practical approximation of the abdominal fat mass in epidemiological studies[48–51], but more recently, the waist circumference alone has been proposed as a better approximation of abdominal fat mass[130, 131] and an indicator of CHD risks[132]. The clinical and practical guidelines published in the U.S.[4, 5] proposed the screening of high-risk obesity by the waist circumference being greater than 40 inches (102 cm) for men and 35 inches (89 cm) for women among those with a BMI greater than 25, following the studies in the Netherlands[133, 134] which demonstrated these values as the threshold for action level 2 (need for medical advice). Meanwhile, the Japan Society for the Study of Obesity (JASSO)[6] proposed the waist circumference being greater than 85 cm for men and 90 cm for women as the screening criteria, which were much lower in men but showed a higher setting in women than in men in contrast to those in the U.S. guidelines. This higher setting in women in the Japanese guidelines was based on the association between waist circumference and abdominal fat mass evaluated by a CT technique, i.e., waist circumference corresponding to visceral fat area (VFA) of 100 cm^2 was found at 85 cm in men and 90 cm in women.

The Japanese guidelines, therefore, emphasized the implications of absolute abdominal fat mass for developing CHD risks in both sexes, rather than the relative waist size in each gender. Meanwhile, we have observed that blood pressure levels[135] and the prevalence of hypertension[136] are quite similar in men and women who do not drink alcohol at a given level of serum gamma-glutamyl transferase (GGT). Since high serum GGT in non-drinkers would reflect hepatic steatosis and abdominal fat accumulation[137, 138], our findings suggested that hypertension, a major complication of obesity, would be determined by fat deposition in the liver and in the abdominal cavity in both men and women. Therefore, the criteria of waist circumference in the JASSO guidelines based on a given abdominal fat mass in both sexes seemed unique but reasonable in a sense.

The great difference in the criteria of waist circumference between the American and Japanese guidelines may have reflected some ethnic differences in the meaning of waist circumference in relation to CHD risks as was suggested in the recent WHO report[40]. Nevertheless, it is important that reliable data on waist circumference and the relation to CHD risk in Japanese men and women, particularly those on population bases, be fully accumulated. The validity of the criteria in the Japanese guidelines remains to be further studied. In addition, waist circumference has been measured at different locations in the body in different studies[139], such as the minimal circumference between the thoracic cage and pelvis, or at the navel level such adopted in the Japanese guidelines[6], or at the top of the iliac bone adopted in the US guidelines[4, 5], which may cause considerable confusion in interpretation of the data.

Assessment of obesity at worksites

The first step in the strategy of preventing obesity in workplaces is the assessments of obesity both in the population and individuals. The prevalence of obese workers (BMI≥30) and that of overweight or pre-obese (BMI of 25.0–29.9) calculated in the working population should be compared to reliable references such as found in the national nutritional survey. If the size of the occupational population is sufficiently large, analyses of the relevance of occupational factors to obesity and overweight, as well as gender and age, will produce valuable information for identifying the target population in the workplace on whom resources should be focused. Individual base assessments are then required particularly in overweight workers.

A more direct measurement of body fat such as using an impedance method would be useful in individual assessment, but, to assess the CHD risk profile in overweight or obese workers, the measurement of waist

Table 1. Prevalance of high-risk obesity[a)] according to the settings of waist circumference in an occupational population aged 35–59 yr

	Waist circumference							
	80–84 cm		85–89 cm		90–94 cm		≥95 cm	
Men								
n=2967			272	9.2%	224	7.5%	88	3.0%
Women								
n=1626	79	4.9%	56	3.4%	41	2.5%	30	1.8%

a: Those who had a BMI greater than 25 kg/m^2 and a large waist circumference.

circumference is indispensable, together with searching for the presence and severity of the major complications: hypertension, dyslipidemia and diabetes mellitus. The American guidelines[4, 5)] recommended that overweight persons with either a waist circumference exceeding the criteria or two or more of the complications should be referred to medical professionals for treatment. Similar recommendations were also made in the Japanese guidelines[6)]. The criterion of waist circumference was, however, far from that in the U.S., and might cause considerable problems in its adoption at worksites. In our unpublished preliminary observation in middle-aged Japanese, according to the JASSO criteria, nearly 20% of the male workers would be defined as high-risk obese, to be referred to medical professionals, in contrast to fewer than 5% of female workers (Table 1). From the viewpoint of the associated costs and benefits, referring so many workers to medical professionals is hardly adoptable at worksites. Alternatively, the waist circumferences above 95 cm in men and 90 cm in women with a BMI greater than 25, which are close to the means of waist circumference in the male and female workers with a BMI of 30 (96 cm and 88 cm, respectively) and correspond to 5% of the population, would be better as the criteria for practical use, although this has not been based on any evidence, so that further studies are urgently required.

Activities for maintaining body weight

The energy intake per capita in Japan has remained in the ideal range during the last 30 yr, but the numbers of overweight and obese persons have increased rapidly during the same period. Since energy expenditures at work and at home in modern life are continuing to decrease, the most practical way for many people to maintain their weight is to expend energy by increasing physical activities at leisure. But, people taking any kind of physical exercise for 30 min or longer twice a week or more were found to be only 25% of male and female adults[8)]. The prevalence was even lower in younger adults below 50 yr of age, 20% in men and 15% in women. One common factor preventing Japanese workers from taking physical exercise is the shortage of free time at the end of the long working day[140)]. Health promotion activities are composed of three dimensions: preventing disease, health education and legal health protection. The controlling of working time length at an appropriate level should be achieved by both legal and non-legal approaches in the workplace.

Health education is the most important activity in health promotion, and should be performed on both population and individual bases. In the education programs, people will be encouraged to become capable of estimating foods for contained energy and nutritional variety accurately, while avoiding harmful dieting, such as consuming too much fat-rich foods, few but heavy meals and eating just before going to bed or night eating. Light and safe regular physical exercises, such as brisk walking, slow jogging, or swimming, will be recommended according to age, sex and fitness level[141)]. Such programs should be conducted as a part of multi-oriented whole lifestyle improvement programs covering fitness, smoking, drinking, stress-coping and even safety at home and worksites. Health care persons at worksites are required to have considerable knowledge and skills for educating people in both the nutritional and exercise fields. Otherwise, some occupational health service agencies should assist them by training or sending their skilled specialists to conduct educational programs.

Prevention of disease, mainly CHD, is the main objective for workers defined as having high-risk obesity, who should be referred to appropriate medical professionals. Although there are some limitations, the costs of closer examinations of overweight workers with several risk factors for CHD have been covered by the Insurance for Occupational Disease and Accident in Japan since April 1, 2001[142)].

Further investigations

Since there have been few extremely obese persons in Japan, public and professional concerns regarding obesity and its consequences have been raised only during the last two decades or so. Research articles on obesity, particularly population-based studies, have been quite

limited in number and quality, and thus more are urgently required. Disparities in the occurrence of obesity among people of various socioeconomic types have not been fully elucidated in Japan, resulting in considerable gaps in knowledge of all the epidemic features of obesity in Japan. Even on the worldwide scale, work-related factors possibly facilitating weight gain or abdominal fat accumulation had been poorly elucidated except for a few mentioned in this article. The ever increasing spread of repetitious monotonous work, heavy psychological strain associated with rapidly advancing information technology or intense market competition, irregular working hours including flex time, unstable employment in part time or dispatched workers, and the change or loss of jobs associated with company restructuring are issues occurring in many workplaces in Japan, and should be evaluated for the effects on body weight and its consequences. Furthermore, the causal associations of overweight and obesity with absence, accidents and work-related diseases should also be evaluated to clarify all the implications of overweight and obesity in occupational health.

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