SH@W Safety and Health at Work www.e-shaw.org

Saf Health Work 2012;3:287-93 | http://dx.doi.org/10.5491/SHAW.2012.3.4.287

pISSN : 2093-7911
eISSN : 2093-7997

Original Article

Evaluation of Waist Circumference Cut-off Values as a Marker for Fatty Liver among Japanese Workers

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Objectives: Metabolic syndrome has received attention as a risk factor for cardiovascular disease, with particular importance attached to visceral fat accumulation, which is associated with lifestyle-related diseases and is strongly correlated with waist circumference. In this study, our aim is to propose waist circumference cut-off values that can be used as a marker for fatty liver based on a sample of workers receiving health checkups in Japan.

Methods: This study was conducted in a total of 21,866 workers who underwent periodic health checkups between January 2007 and December 2007. The mean age of the subjects was 47.4 years for men (standard deviation [SD]: 8.0) and 44.7 years for women (SD: 6.9). Evaluation included abdominal ultrasound and measurement of waist circumference, body mass index, fasting blood glucose, triglycerides, high-density lipoprotein cholesterol, and blood pressure.

Results: Based on receiver operating characteristic curve analysis, the optimal waist circumference cut-off values were shown as 85.0 cm (sensitivity 0.72, specificity 0.69) for men and 80.0 cm (sensitivity 0.75, specificity 0.78) for women.

Conclusion: Abdominal ultrasound is the most efficient means of diagnosing fatty liver, but this examination seldom occurs because the test is not routinely performed at workers' health checkups. In people found to have a high risk of fatty liver, recommendations can be made for abdominal ultrasound based on the waist circumference cut-off values obtained in this study. That is, waist circumference can be used in high risk individuals as an effective marker for early detection of fatty liver.

Key Words: Waist circumference, Fatty liver, Health-check examination, Ultrasonography, Receiver operating characteristic (ROC) curve analysis

Introduction

According to the cause-of-death statistics provided by the Japanese Ministry of Health, Labor, and Welfare (JMHLW), cerebrovascular disease and cardiovascular disease caused by obesity and arteriosclerosis account for about 30% of all deaths. Risk factors for these diseases include lifestyle factors and metabolic syndrome (visceral fat syndrome) due to the accumulation of visceral fat this involves. Urgent measures are required to reduce the prevalence of these risk factors in Japan. One such measure was the implementation in 2008 of "specific health checkups" and "specific counseling guidance" with a focus on visceral fat-type obesity [1]. This led to the adoption of waist circumference (WC) as a marker for visceral fat-type obesity and the assessment of risk based on lifestyle.

Together with growing knowledge of the concept of metabolic syndrome, the relationship between visceral fat accumula-

Received: June 15, 2012 **Revised:** October 18, 2012
Accepted: October 18, 2012 **Available online:** November 30, 2012
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An abstract of this paper was presented at the 67th annual meeting of the Japanese Society of Public Health (November 2008, Fukuoka).

tion and lifestyle-related diseases such as hypertension, diabetes mellitus, and lipid abnormalities has become increasingly clear [2-6]. Implementing specific health checkups and counseling guidance aims to prevent the onset or progression of lifestyle-related diseases as a cause of cardiovascular events, which is advantageous because the early screening of candidates can promote a reduction in the number of persons with or at risk for such diseases.

One example of visceral fat accumulation is fatty liver, which is a condition characterized by excess accumulation of triglycerides (TG) in hepatocytes. The major causes include obesity, excess alcohol consumption, and endocrine diseases such as diabetes. Fatty liver is promoted by overeating, lack of exercise, and the westernization of dietary habits. The prevalence of fatty liver detected at health checkups has been increasing over the years: 12.6% in 1989, 30.3% in 1998 [7], and 39.6% and 18.2% in 2002 in males and females, respectively [8]. Fatty liver, in terms of visceral fat accumulation, is also strongly associated with metabolic syndrome.

In a 2005 study, a strong correlation was found between histogram indices of aspartate transaminase (AST), alanine aminotransferase (ALT), gamma-glutamyl transpeptidase (γ-GTP) and fatty liver [9]. Kawabe et al. [10] reported that the AST/ALT ratio was better than AST, ALT, and γ-GTP as a marker for fatty liver. Yamada et al. [11] found that body mass index (BMI) and lipid test results, glucose level, and uric acid values were significant risk factors for predicting the probability of fatty liver development. Although studies such as these have been performed using biochemical test values as markers for fatty liver, no known studies have quantitatively specified and demarcated the use of WC as a marker for fatty liver.

Waist circumference is reported to be closely correlated with visceral fat accumulation [12,13]. We believe that visceral fat accumulation, as representative of fatty liver, could be assessed by applying the WC cut-off values obtained in this study and by performing abdominal ultrasound in selected high-risk patients. The aims of this study were thus to 1) compare clinical values between fatty and healthy liver groups, and 2) to provide the optimal WC cut-off values for screening for fatty liver.

Materials and Methods

Subjects

The data used in the present study consisted of the results of employee health checks conducted at a medical examination center between January and December 2007 for employees from 225 companies within the manufacturing, finance and service industries, as well as in local government. Japanese companies are required to implement annual occupational health checkups, which are conducted by medical examination centers that meet national standards and hold related individual contracts with various types of businesses such as those mentioned above. Checkup parameters comprise statutory items established by the government alongside optional tests.

Among 225,602 employees (from 225 companies), a total of 30,650 (13.6%) were from 99 companies that offered ultrasound examination as an optional test. Complete clinical data including WC, BMI, fasting blood sugar (FBS), hemoglobin A1c (HbA1c), TG, high-density lipoprotein-cholesterol (HDL-C), and systolic and diastolic blood pressure were available for 23,740 of the 30,650 employees who underwent optional abdominal ultrasound screening. After excluding 1,874 employees (1,326 men, 548 women) due to hypertension, hyperlipidemia, current diabetes treatment and positivity for hepatitis B and C, data from 21,866 subjects (11,509 men, 10,357 women) were analyzed.

The study protocol was approved by the Ethics Committee of the Association for Preventive Medicine of Japan. No data were collected that could be used for identification.

Fatty liver diagnostic criteria

General purpose ultrasound diagnostic imaging scanners were used for abdominal ultrasound screening at a frequency of 3-5 MHz to produce B mode images, which display levels of brightness based on reflected ultrasound intensity.

Patients satisfying all four items of the diagnostic criteria were diagnosed with fatty liver, while those satisfying less than four items were given the diagnosis of fatty liver change (mild fatty liver). In the present study, individuals of the latter type were included in the fatty liver group as they represented potential cases of fatty liver.

Measurement of WC

Based on the diagnostic criteria for metabolic syndrome, WC was measured in a standing position, during quiet breathing, at the level of the umbilicus. If there was marked fat accumulation with the umbilicus displaced downwards, WC was measured at a point midway between the lower rib margin and the anterior superior iliac spine.

Statistical analysis

The frequency of subjects diagnosed with fatty liver and healthy liver by sex and age was examined using the abdominal ultrasound findings, and the results were divided among age groups representing 5-year intervals. In addition, between the fatty liver group and the healthy liver group, clinical values by