TRADITIONAL JAPANESE DIET SCORE - ASSOCIATION WITH OBESITY, INCIDENCE OF ISCHEMIC HEART DISEASE, AND HEALTHY LIFE EXPECTANCY IN A GLOBAL COMPARATIVE STUDY

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Abstract: *Objectives:* We created a Traditional Japanese Diet Score (TJDS), and to clarify the relationship between TJDS and obesity, ischemic heart disease (IHD), and healthy life expectancy (HALE). *Design:* Ecological study. *Setting:* Food (g/day/capita) and energy (kcal/day/capita) supply was determined using the Food and Agriculture Organization of the United Nations Statistics Division database. The sum of characteristic traditional Japanese foods (beneficial food components in the Japanese diet: rice, fish, soybeans, vegetables, eggs, and seaweeds; food components rarely used in the Japanese diet: wheat, milk, and red meat) was divided as tertiles (beneficial food components: -1, 0, 1; rarely used food components: 1, 0, -1). Obesity rate was determined using the World Health Organization database. Incidence of IHD, HALE and smoking rate were determined using the Global Burden of Diseases, Injuries, and Risk Factors Study 2015 database. Gross domestic product per capita, percentage of population > 65 years old, and health expenditure were determined using the World Bank database. Education years were obtained from the United Nations Educational, Scientific and Cultural Organization Institute for Statistics. Associations between TJDS and obesity, IHD and HALE were examined in 132 countries with a population of 1 million or greater using a general linear model controlled for co-variables. Results: TJDS was distributed from -6 to 7. TJDS was inversely correlated to obesity ($\beta\pm SE$; -0.70 ± 0.19, $p<0.001$), IHD (-19.4 ± 4.3, $p<0.001$), and positively correlated to HALE (0.40 ± 0.14, $p<0.01$). *Conclusions:* TJDS is a good indicator of a healthy diet, and applies to preventing obesity, IHD and extending HALE.

Key words: Traditional Japanese diet, obesity, ischemic heart disease, healthy life expectancy.

Japanese traditional dietary culture, known as "WASHOKU", was registered as a United Nations Educational, Scientific and Cultural Organization (UNESCO) intangible cultural heritage in 2012. A major reason why Japanese dietary culture was recognized by UNESCO is that it is nutritionally well balanced and healthy (1).

According to the Global Burden of Disease (GBD) database, the average life expectancy of the Japanese was 83.2 years in 2015 (2), the third longest in the world. Further, the healthy life expectancy (HALE) of the Japanese was 73.9 years, the second longest in the world. On the other hand, obesity is defined as a Body Mass Index (BMI) of 30 or greater. According to the World Health Statistics 2014 (3), the Japanese age-standardized obesity rate ranks 161 for men and 198 for women among 200 countries or regions. Further, the age-standardized incidence of ischemic heart disease (IHD) is also the lowest among 288 countries according to the GBD database (2). Since obesity and IHD are lifestyle-related diseases, they are greatly affected by diet. From these data, the traditional Japanese diet is considered to be healthy and is applicable to prevent lifestyle-related diseases such as obesity and IHD.

The basic style of "WASHOKU" is "one soup and three dishes". This comprises a combination of typical Japanese dishes, such as a soup, a main dish (typically fish or meat), and two side dishes (typically vegetables, mushrooms, seaweeds, or soy products), in addition to cooked rice as a staple food (4). A joint FAO/WHO consultation (WHO Technical Report Series 880) recommended that food-based dietary guidelines for health promotion be prepared and implemented for individual countries or regions (5). The guidelines contain information on foods, food groups and dietary patterns in order to provide the required nutrients to the general public with the aim of promoting overall health and preventing chronic diseases. The "Japanese Food Guide Spinning Top" (6) is a dietary guideline based on typical Japanese dish combinations. The food guide is presented as a combination of staple food (grain dishes), main dishes (fish and meat dishes), and side dishes (vegetable dishes, etc.), and unlike other countries, is not based on food groups.

Some studies have scored the Japanese dietary guidelines and have examined the relationship between scores and health outcomes. Oba et al. studied the relationship between adherence to the score and future mortality in a prospective cohort study in Japan. The adherence score was significantly associated with a lower risk of mortality from all-cause, non-cardiovascular, non-cancer, and cardiovascular diseases (CVD) in a multivariate analysis of women only (7). Kurotani et al. reported on the mortality rate of the Japan Public Health Center-based Prospective Study (JPHC) cohort in relation to

the adherence score to Japanese dietary guidelines in a 15-year follow-up study. The all-cause mortality rate of the highest adherence score quantile was lower than the lowest adherence score quantile after adjusting for confounders. The high adherence score group showed significantly lower mortality from CVD, especially cerebrovascular disease (8). However, the Japanese dietary guidelines are based on typical Japanese dishes, making it difficult to compare these scores to different food cultures outside of Japan. Some studies have examined the benefits of a traditional Japanese diet; however, these grouped and scored the foods using statistical methods such as factor analysis or principal component analysis (PCA). Shimazu et al. (9) examined the association between dietary patterns and CVD mortality among more than 40 thousand Japanese after 7-year follow-up using factor analysis. "The Japanese dietary pattern" (which depended greatly on soybean products, fish, seaweeds, vegetables, fruits and green tea) was associated with a decreased risk of CVD mortality, despite its relation to high sodium intake and a high prevalence of hypertension. Tomata et al. investigated the association between dietary patterns and incident functional disability among Japanese 65 years and older in the Ohsaki Cohort study using PCA (10). The Japanese dietary pattern (which relied heavily on fish, vegetables, mushrooms, potato, seaweeds, pickles, soybean and fruits) was associated with a decreased risk of incident functional disability after multivariate adjustment. On the other hand, Nanri et al. generated JPHC data as dietary patterns using PCA (11). The prudent dietary pattern (characterized by a high intake of vegetables, fruits, soy products, potato, seaweeds, mushrooms, and fish) was significantly associated with decreased risk of all-cause and CVD mortality. Incontrast, Westernized dietary pattern (characterized by a high intake of meat, processed meat, bread, and dairy products) was associated with a increased risk of all-cause and CVD mortality in Japanese adults. But a traditional Japanese dietary pattern (characterized by high intakes of fish and shellfish, pickled vegetables, vitamin D, vitamin B12, and cholesterol, and inversely associated with fat intake) was not associated with these risks. Since these statistical classification methods depend on dietary assessment methods and study participants, it is difficult to apply these scores to other locations, or to countries with different dietary habits or socioeconomic characteristics. No international comparative study has been conducted on diet and health outcomes using a common Japanese diet score, since a Japanese diet score that could be objectively used internationally was lacking.

We created a Traditional Japanese Diet Score (TJDS) that can be used internationally. In addition, we examined the relationship between TJDS and obesity rate, incidence of IHD, and HALE as lifestyle-related factors on a global scale, using international databases.

The purpose of this study is to clarify the relationship between TJDS and obesity rate, incidence of IHD, and HALE, adjusted for socioeconomic and lifestyle factors, using global international databases.

Methods

Variables

Foods

The Food and Agriculture Organization of the United Nations Statistics Division database (FAOSTAT) provides food and agriculture data for over 245 countries and territories. It covers all Food and Agriculture Organization of the United Nations (FAO) regional groupings from 1961 to 2013 (12). We used the supply of animal and vegetable foods examined in the most recent data (since 2010) excluding duplicates of all 129 items. The average food supply per capita per day (g/day/capita) and energy supply (kcal/day/capita) by country excluding losses between production and household were obtained.

Traditional Japanese Diet Score (TJDS)

The TJDS was calculated in reference to the most commonly used Mediterranean diet score, created by Trichopoulou et al. (13). This score was calculated using the nine indicated food components characteristic of the Mediterranean diet. We chose nine food components characteristic of traditional Japanese foods from the database. The calculation was made for a supply amount per 1000 kcal. For beneficial food components (rice, fish, soybeans, vegetables, eggs, and seaweeds), the supply of beneficial food components of the highest tertile was assigned a value of 1, their supply of the second highest tertile was assigned a value of 0, and their supply at the lowest tertile was assigned a value of -1. For components not commonly used in the Japanese diet (wheat, milk, and red meat), scoring was conducted in the opposite direction (1, 0, -1). The total score ranged from -9 to 9, with higher scores indicating greater adherence to a traditional Japanese diet. The TJDS is meant to represent the traditional Japanese diet, and thus does not necessarily reflect the current Japanese diet style.

Obesity

Age-standardized obesity rate was identified using the World Health Organization database 2014 (3). Obesity is defined as a BMI of 30 or greater.

Incidence of IHD, and HALE

The Global Burden of Diseases, Injuries, and Risk Factors Study 2015 (GBD 2015) is the most comprehensive source of the burden of diseases, injuries, and risk factors of all global, regional, national, and in some cases subnational regions, including the incidence of IHD and HALE for 195 countries (2). HALE was estimated by the Sullivan method, which draws from age-specific death rates and years of life lived with disability per capita (2). We used the age-standardized incidence of IHD, and HALE per 100,000 people in 2015.

Figure 1

Global distribution of the Traditional Japanese Diet Score according to country. For countries shown in white, no recent data (after 2010) on food supply was obtained
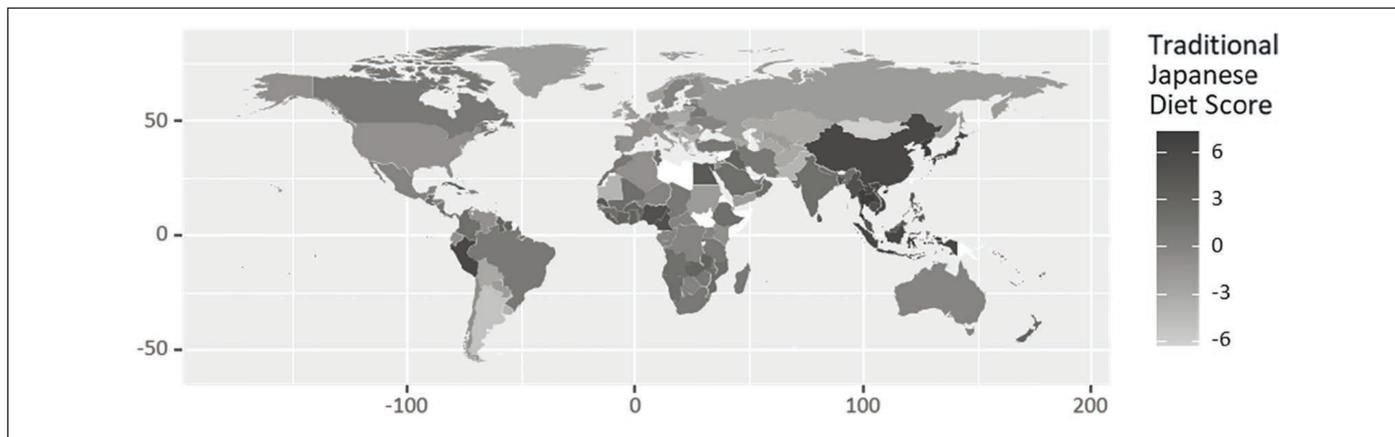
Co-variables

Life expectancy and current smoking rate (smoking) were obtained from the GBD database (2). Gross domestic product (GDP) per capita (US$/capita) total population (population), percentage of the population over 65 years old (aging rate), and health expenditure (US$/person) were identified using the World Bank database (14). Education years were obtained from the United Nations Educational, Scientific and Cultural Organization Institute for Statistics. We used the most current data available (since 2010) for all the above.

Statistical Analysis

The global distribution of TJDS was displayed on the world map for 167 countries and regions in which this score could be calculated. We made a partial residual plot (with regression lines) with the size of GDP as the bubble size in order to examine the relationship between TJDS, GDP, and obesity/IHD/HALE controlled for GDP, socioeconomic and lifestyle-related variables. Analysis was conducted for the 132 countries with a population of over 1 million without missing data. The countries were divided into two groups by the TJDS; 66 countries with 0 points or less and 66 countries with more than 0 points. Food supply, and socioeconomic and lifestyle variables were compared using a Student's t test. The relationships between the TJDS and obesity rate, incidence of IHD, and HALE were evaluated using a general linear regression model. Model 1 was a single regression model of TJDS and obesity rate, incidence of IHD, and HALE; Model 2 was a partial regression model controlled for GDP; and Model 3 was a partial regression model controlled for socioeconomic and lifestyle-related variables. $p<0.05$ was considered statistically significant for all analyzes using R 3.3.3. (15).

Results

The global distribution of TJDS by country is shown in Figure 1. TJDS was distributed from -6 to 7 (mean, 0.54; median, 0.50) and it was high in East Asian countries including South Korea, Thailand, China, and Japan. High scoring countries were also distributed in other areas such as Africa and South America. On the other hand, many countries with low scores were identified in Europe, North America, and the former Soviet bloc countries. The scores revealed clear regional differences.

The characteristics of countries with low and high TJDS are shown in Table 1. The supply of rice, fish, and soybeans was significantly higher in high TJDS countries than in low TJDS countries. On the other hand, the supply of wheat, milk, red meat, and eggs was significantly higher in low TJDS countries than in high TJDS countries. The supply of seaweed in low TJDS countries was 0 (g/1000kcal/day), but there were no significant differences in vegetable supply between low and high TJDS countries.

As for socioeconomic variables, GDP, health expenditure, and aging rate were lower in high TJDS countries than in low TJDS countries, and education years and life expectancy were shorter in high TJDS countries than in low TJDS countries. Moreover, for lifestyle variables, smoking rate, energy supply, and obesity rate were lower in high TJDS countries than in low TJDS countries.

Single, and partial regression coefficients for TJDS and co-variables in three general linear models of obesity rate, incidence of IHD, and HALE are shown in Table 2. TJDS showed a significant negative correlation to obesity rate in the single regression model (Model 1), the multiple regression model controlled for GDP (Model 2), and the multiple regression model controlled for co-variables (health expenditure, aging rate, education, smoking, and energy supply) including GDP (Model 3). The single regression equation for TJDS and obesity rate was y = -1.29 x + 18.12, and the

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Table 1
Characteristics of countries with low and high Traditional Japanese Diet Score

		Low score countries	High score countries	p value*
Number of countries		66	66	
Traditional Japanese Diet Score		0 or less than 0	more than 0	
		-1.76 (1.47)	2.83 (1.77)	<0.001
Food supply				
	Rice (g/1000 kcal/day)	8.5 (10.5)	54.7 (49.9)	<0.001
	Fish (g/1000 kcal /day)	12.5 (10.6)	16.6 (13.3)	0,049
	Soybeans (g/1000 kcal /day)	0.13 (0.31)	1.17 (1.97)	<0.001
	Vegetables (g/1000 kcal /day)	100.2 (56.8)	89.7 (54.9)	0,282
	Wheat (g/1000 kcal /day)	88.3 (42.6)	43.5 (35.9)	<0.001
	Milk (g/1000 kcal /day)	160.9 (69.4)	56.6 (47.5)	<0.001
	Red meat (g/1000 kcal /day)	40.4 (15.6)	19.9 (13.3)	<0.001
	Eggs (g/1000 kcal /day)	7.82 (4.13)	5.22 (4.60)	0,001
	Seaweeds (g/1000 kcal /day)	0.00 (0.00)	0.42 (2.47)	0,172
Socioeconomic variables				
	Population (milion)	27.9 (50.3)	77.00 (231.0)	0,094
	GDP (1000 US$/capita)	17.8 (19.5)	7.0 (10.2)	<0.001
	Aging rate (%)	12.0 (6.5)	6.0 (4.5)	<0.001
	Health expenditure (1000 US$/capita)	1.90 (2.50)	0.52 (1.02)	<0.001
	Education (years)	9.8 (2.7)	6.6 (2.9)	<0.001
	Life expectancy (years)	74.9 (7.3)	69.5(8.0)	<0.001
Life style variables				
	Smoking (%)	20.2 (7.5)	14.6 (7.2)	<0.001
	Energy supply (kcal/day)	3001.3 (462.7)	2707.0 (428.0)	<0.001
	Obesity (%)	20.4 (6.7)	14.5 (10.3)	<0.001

mean (SD)   *Student's t test

regression coefficient and standard error ($\beta \pm SE$) for TJDS and obesity rate in Model 3 was -0.70± 0.19 (p<0.001). Also, the incidence of IHD showed a significant negative correlation to TJDS in the single regression model (Model 1), the multiple regression model controlled for GDP (Model 2), and the multiple regression model controlled for co-variables (health expenditure, aging rate, education, smoking, energy supply, and obesity rate) including GDP (Model 3). In Model 3, the partial regression coefficient for TJDS and incidence of IHD was -19.4 ± 4.3 (p <0.001). On the other hand, HALE was significantly negatively correlated with TJDS in the single regression model (Model 1), but not in the multiple regression model controlled for GDP (Model 2), and was significantly positively correlated in Model 3. The partial regression coefficient for TJDS and HALE in the multiple regression model controlled for co-variables (health expenditure, aging rate, education, smoking, energy supply, and obesity rate) including GDP

(Model 3) was 0.40±0.1 (p<0.01).

The partial residual of TJDS and obesity rate in the 132 countries is shown in Figure 2A. The TJDS of Japan was six points. The countries with the highest score of 7 were South Korea and Thailand, while China, Indonesia, Peru, and Vietnam had six points. On the other hand, the lowest score was in Mongolia (score=-6), followed by Argentina (-5), and Bulgaria, Croatia, Pakistan, Slovakia, and Uruguay (-4). After adjusting for co-variables (GDP, aging rate, health expenditure, energy supply, and education years), countries with high TJDS were plotted below the partial regression line and obesity rates were lower than the other countries, except for Peru. For low TJDS countries, variation was seen in the plot area, but the obesity rate was higher than that of high TJDS countries.

Partial residual of TJDS and incidence of IHD and HALE are shown in Figure 2B and C, respectively. After adjusting for co-variables (GDP, aging rate, health expenditure, energy

Figure 2
Partial residual of Traditional Japanese Diet Score and age-standardized A; obesity rate (left), B; IHD incidence (middle), and C; healthy life expectancy controlled for GDP, socioeconomic and lifestyle-related variables of 132 countries. Bubble size indicates GDP of each country

supply, education years, and obesity rate), countries with high TJDS were plotted below the partial regression line and the incidence of IHD was lower than the other countries, except for Indonesia and Thailand. For HALE, more than half of the countries with high TJDS were plotted above the partial regression line, and variation was seen in the plot area compared to those of obesity and IHD. As for low TJDS countries, there were variations in the plot area; however, a higher incidence of IHD and shorter HALE were noted compared to high TJDS countries.

Discussion

We created a TJDS that can be used globally, and this study is the first evidence that TJDS was significantly related to obesity rate, incidence of IHD, and HALE using global international databases. The association between TJDS and obesity rate or IHD remained after controlling for socioeconomic and lifestyle-related variables. On the other hand, HALE was negative correlated with TJDS in the single regression model, but positively correlated in the multiple regression model controlled for co-variables. This study revealed that the traditional Japanese diet might be useful for preventing noncommunicable diseases such as obesity and IHD, and for promoting HALE.

According to the Fact Sheet on Obesity and Overweight (3) reviewed October 2017 by WHO, more than 1.9 billion adults, 18 years and older, are overweight; of these, over 650 million are obese. In other words, 39% of adults were overweight and 13% were obese in 2016. The annual incidence rate of IHD in GBD 2015 (2) was estimated to be 369.5 persons per 100,000 people world-wide. From these values and the results of this study, by increasing the TJDS by 1 point, decreases of 0.7% and 5.3% can be expected in the obesity rate and the incidence

of IHD, respectively, and HALE is projected to increase by 0.4 years. This result indicates that a traditional Japanese diet focusing on rice, fish and soybeans etc. can be considered a healthy diet to prevent lifestyle-related diseases and increase longevity.

The basic style of the traditional Japanese diet was established during the Meiji period. While this style of Japanese diet has been passed down to the present, it has been actively incorporating new foodstuffs, recipes and cooking methods from abroad with the introduction of Western culture during the Meiji period and thereafter (3). In 1980, the energy from protein, fat, and carbohydrate (PFC balance) of the Japanese diet was balanced (1). Subsequently, however, the Japanese tended to consume too much meat and fat, and there was a decrease in the intake of rice and fish. At present, the Japanese diet style has been approaching a more Western style, and is not generally regarded as well balanced (3). Tada et al. reported that serum total cholesterol levels in the Japanese showed a gradual increase and reached a similar level to that of the USA population in 2000 due to dietary changes (16). While the TJDS is not an indicator of the current Japanese diet style, it is an indicator of the traditional Japanese diet. In other words, using a typical Japanese dish combination of "rice as a staple food, mainly fish and soybeans as the protein source (rather than meat), and vegetables etc. as side dishes", we developed a score using nine food groups that are characteristic of the ideal Japanese diet style. As a result, Asian countries including South Korea, Thailand, China, Indonesia and Japan and some non-Asian countries showed high scores, which overall ranged from -6 to 7. High TJDS countries had significantly greater supplies of rice, fish, and soybeans than the low TJDS countries; in contrast, wheat, milk, red meat, and eggs were in significantly greater supply in low TJDS countries than in high TJDS countries. Trichopoulou et al. (13) developed a Mediterranean

Table 2
Partial regression coefficients of the Traditional Japanese Diet Score and co-variables in three general linear models of obesity rate, incidence of IHD, and healthy life expectancy

	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Obesity rate						
(Intercept)	18,117	0,746***	15,190	0,870***	-19,158	3,895***
TJDS	-1,289	0,261***	-1,001	0,243***	-0,700	0,189***
GDP			0,223	0,042***	0,295	0,122*
Health expenditure					-2,667	0,944**
Aging rate					-0,376	0,143**
Education					1,292	0,266***
Smoking					-0,178	0,089*
Energy supply					0,011	0,002***
AIC	941,1		916,5		840,4	
BIC	949,7		928,0		863,4	
Incidence of ischemic heart disease						
(Intercept)	387,704	12,309***	442,502	13,872***	202,08	91,127*
TJDS	-13,320	4,309**	-18,709	3,879***	-19,399	4,270***
GDP			-4,183	0,664***	-7,177	2,665**
Health expenditure					19,035	20,857
Aging rate					-6,162	3,139
Education					12,763	6,243*
Smoking					2,42	1,932
Energy supply					0,088	0,041*
Obesity rate					-5,039	1,922**
AIC	1661,1		1647,7		1643,7	
BIC	1689,7		1659,2		1672,5	
Healthy life expectancy						
(Intercept)	63,411	0,624***	59,957	0,642***	43,194	3,071***
TJDS	-0,508	0,219*	-0,169	0,179	0,401	0,144**
GDP			0,264	0,031***	0,150	0,090
Health expenditure					-0,930	0,703
Aging rate					0,372	0,106***
Education					0,408	0,210
Smoking					0,103	0,065
Energy supply					0,003	0,001*
Obesity rate					0,133	0,065*
AIC	893,3		836,4		748,7	
BIC	902,6		847,9		777,5	

SE: standard error, *** p < 0.001, ** p < 0.01, * p <0.05; IHD: ischemic heart disease; TJDS: Traditional Japanese Diet Score

diet score ranging from 0 to 9 using nine food groups, which has been applied not only in the Mediterranean area, but also in the United States (17) and Australia (18). We suggest that the TJDS can also be used as a diet score for international comparison.

Various publications have demonstrated that characteristic Japanese food stuffs and/or a Japanese dietary style can prevent lifestyle-related diseases. In regards to fish, Yamagishi et al. (19) reported an inverse association between fish and polyunsaturated fatty acids intakes and cardiovascular mortality, especially heart failure, in a Japanese prospective study consisting of 57,972 men and women. Mozaffarian et al. reviewed the relationship between dietary and endogenous sources of eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), and docosahexaenoic acid (DHA) as components of fish or fish oil and cardiovascular effects on biological pathways, physiological risk factors, and clinical endpoints. Based on current evidence from a Japanese study, increasing consumption of fish or even either fish Functional component would be advantageous compared to little or no consumption (20).

Soybean is a source of vegetable protein and contains isoflavonoids as antioxidant components. Rivas et al. conducted a Randomized Controlled Trial (RCT) to study the relationship between soy milk intake and blood pressure. The trial showed a modest, but significant hypotensive action in essential hypertensive subjects (21). Ramdath et al. summarized the systematic evidence on the cardiovascular benefits of non-protein soy components in relation to known CVD risk factors such as hypertension, hyperglycemia, inflammation, and obesity (beyond its cholesterol-lowering effects). They reported that the available evidence suggests non-protein soy constituents improve markers of cardiovascular health; however, additional studies are needed to independently confirm these effects (22).

In regards to red meat, which is frequently eaten by western countries, Kim et al. reported the results of a systematic review and meta-analysis of the relationship between red meat and stroke incidence and mortality. The relationship between meat intake and the risk of stroke may differ according to the type of meat. However, recommending replacing the intake of red and processed meats with white meat for stroke prevention may be considered in clinical practice (23).

The intake of protein from fish and soybeans may improve the amount and quality of lipids, and provide antioxidant substances effective for lifestyle-related disease prevention. Li et al. (24) reported on the effect of plant-based protein, such as from soy, barley, and walnut etc., on blood lipids through a systematic review and meta-analysis of RCTs. Substitution of plant protein for animal protein decreased the levels of low-density lipoprotein cholesterol, non–high-density lipoprotein cholesterol, and apolipoprotein B.

Fat intake can be reduced by following a traditional Japanese diet in which rice is the staple food. In a study of 2,006 male factory employees, Sakurai et al. (25) reported that obese

participants with a carbohydrate intake > 65% energy should reduce their intake level within the recommended carbohydrate energy proportion for Japan (50–65% energy) to prevent the development of type 2 diabetes. Several studies have focused on the relationship between diet and health outcomes in Asian countries where rice is the staple food. Xu et al. reported that a traditional dietary pattern (high intake of rice, pork and vegetables) was inversely associated with general/central obesity among older Chinese people (26). In Koreans, Cho et al. reported that low intake of whole grains and fruits, and high intake of sodium were major metabolic risk factors for cardio-metabolic disease deaths in Korean adults, data obtained from the Korea National Health and Nutrition Examination Survey and Statistics Korea (27).

The basic style of a traditional Japanese diet (i.e., combination of dishes) could be applicable for mitigating obesity and IHD, extending HALE, as well as other health benefits (28, 29), similar to other dietary scores used throughout the world, such as the Mediterranean diet score (30), Healthy Eating Index (HEI) (31), and Dietary Approaches to Stop Hypertension (DASH) (18).

This study has several limitations. The first is that we used national data, not personal data, and thus it is not possible to analyze according to gender or age group. Second, the TJDS was calculated based on average food supply data, not on actual food consumption data. While the amount of food waste in the home was not taken into consideration, the disposal rate does not differ greatly depending on the food. Thus, we thought that the effect of the difference between supply and consumption amounts of food per 1000 kcal would be not large. Third, it is possible that an overlooked factor(s) needed to be controlled in the analysis of this study. We used objective official data obtained in almost all countries in the world. While we could not obtain physical activity data, we controlled for GDP, aging rate, education years, smoking, and energy supply in the analysis. Furthermore, it is possible that the accuracy of the data collected differs by country. However, we successfully created a TJDS that can be used globally, and this is the first evidence that this score was significantly negatively correlated to obesity rate, and incidence of IHD, and positively correlated to HALE using global international databases. In conclusion, this study revealed that our TJDS is applicable as a novel indicator of a healthy diet for preventing lifestyle-related diseases.

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