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Whole Fruit and Fruit Juice Consumption Related with Obesity and Metabolic Syndrome in Korean Adults

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ABSTRACT

Whole Fruit and Fruit Juice Consumption Related with Obesity and Metabolic Syndrome in Korean Adults

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Background/Objective : Fruit consumption is known to be beneficial to health. However, the health benefits of fruit juice are controversial due to its high sugar content. This study aimed to compare sociodemographic and dietary characteristics by the status of whole fruit and fruit juice consumption and to examine their associations with the risk of obesity and metabolic syndrome.

Subject/Methods : Using data from the 2012–2015 Korea National Health and Nutrition Examination Survey, a total of 10,460 adults (4,082 men and 6,378 women) aged 19–64 years were included in the

study. Frequency of whole fruit and fruit juice consumption were evaluated using a food frequency questionnaire, and dietary sugar intake was calculated using a 24-hour recall. Obesity and abdominal obesity were determined using body mass index and waist circumference. Metabolic syndrome was defined on the basis of the National Cholesterol Education Program Adult Treatment Panel Ⅲ. Multiple logistic regression analysis was performed to examine the associations between frequency of whole fruit or fruit juice consumption and obesity and metabolic syndrome abnormalities.

Results : The percentage of participants who consumed whole fruit daily was 32.6%, while 52.3% consumed fruit juice rarely. The participants who frequently consumed whole fruits tended to be older and have higher education and income levels, whereas those who frequently consumed fruit juice tended to be younger and have higher education level. The average intake of total sugars was 14.9% of total energy which was within the recommended range (< 20% of total energy) for Koreans. The average intake of sugars from processed foods was 8.9% and that from fruits was 3.6% of total energy. Regarding whole fruit consumption, participants who consumed ≥1 time/day were associated with a reduced prevalence of obesity(OR 0.81, 95% CI 0.68 - 0.96, p for trend=0.0088), abdominal obesity(OR 0.81, 95% CI 0.67 - 0.97, p for trend=0.0152), and elevated blood pressure(OR 0.74 95% CI 0.61 - 0.88, p for trend=0.0013) compared to participants who consumed whole fruit ≤1 time/week. However, fruit juice consumption showed no association with obesity, abdominal obesity, and metabolic syndrome.

Conclusions : Frequency of whole fruit consumption was associated with reduced prevalence of obesity and metabolic syndrome abnormalities among Korean adults with dietary sugar intake within the recommended range. Frequency of fruit juice consumption was not associated with obesity and metabolic syndrome.

Keywords : dietary sugar, fruit, fruit juice, obesity, metabolic syndrome

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Ⅰ. INTRODUCTION

In many epidemiological studies, fruit consumption has been reported to confer numerous health benefits, protecting against obesity,[1,2] metabolic diseases such as type 2 diabetes,[3] and cardiovascular diseases.[4] However, public concern regarding fruit consumption has increased because fruits contain high amounts of simple sugars.[5]

Fruit consumption has often been examined in conjunction with vegetable consumption. A study of Spanish adults showed that either high intake of fruits or vegetables at baseline was associated with a reduced risk of 10-year weight gain.[6] However, a study of American women showed that higher intake of fruits, but not vegetables, at baseline was inversely associated with obesity or overweight during a 15.9-year follow-up period.[7]

Fruit consumption should be evaluated on the basis of the form of simple sugars contained therein. According to guidelines issued by the World Health Organization (WHO) in 2015, reduced intake of free sugars is recommended for adults and children throughout their lifetime.[8] Free sugars include simple sugars added to food and beverages, and sugars naturally present in honey, syrups, fruit juice, and its concentrates. Whole fruits contain simple sugars, dietary fiber, minerals, vitamins, and phytochemicals. The processing of fruit juice, however, can result in the loss of dietary fiber and micronutrients, as well as the addition of dietary sugar.[5] Fruit juice can be further classified on the basis of the extent of processing involved.[9]

In a recent review article, whole fruit consumption reportedly contributed to a reduced risk of long-term weight gain in adult

populations; however, fruit juice consumption showed a positive association with long-term weight gain in 11 randomized control trials and 6 cohort studies.[10] However, only a few studies were conducted to examine whole fruits and fruit juice together in a study. Two studies reported that whole fruit consumption had an inverse association with fruit juice consumption in the incidence of type 2 diabetes[11] or 3-year weight change;[12] however, both studies were conducted in American women.

Fruit juice consumption has been often examined in the context of sugar-sweetened beverages (SSBs). A study that included three cohort studies showed that SSBs and fruit juice were associated with weight gain within each 4-year period and substitution of SSBs or fruit juice with water or tea was inversely associated with weight gain.[13] In a meta-analysis of cohort studies, consumption of SSBs or fruit juice was associated with a greater incidence of type 2 diabetes.[14]

In addition, the findings regarding the relationship between fruit juice and metabolic disease are inconsistent. Meta-analyses of randomized controlled trials showed that fruit juice consumption reduced diastolic blood pressure[15] but was not associated with an increased risk of type 2 diabetes.[16] In a large observational study, consumption of 100% fruit juice was associated with lower odds ratios (ORs) of obesity and metabolic syndrome compared with non-consumption, according to National Health and Nutrition Examination Survey data.[17] In a review article, moderate consumption of citrus juices, such as 100% orange or grapefruit juice, conferred important nutritional benefits: citrus juices are an excellent source of vitamin C and other micronutrients.[18]

Fruits are one of major food sources for dietary sugar. However, dietary sugar intake in Asian countries is relatively low. The average intake of total sugar for Korean adults was reported to be 61.4 g/day using data from the Korea National Health and Nutrition Examination Survey (KNHANES) (2008 - 2011).[19] In comparison, using data from the National Health and Nutrition Examination Survey III (1988 - 1994) for US adults, mean daily total sugar intake was reported to be 126 g/day.[20]

Fruit juice consumption seems to be low in Asian countries although few studies have been conducted. A cross-sectional study conducted in Japan reported frequency of 100% fruit juice consumption using a FFQ. The participants who consume 100% fruit juice ≥ 1 time/day, was only 8.7% for men and 4.7% for women.[21] Few studies on the relationship between fruit juice consumption and obesity or metabolic disease have been conducted in Asian population with the exception of previous one which reported that 100% fruit juice and vegetable juice were not associated with an elevated risk of type 2 diabetes in Japanese men and women.[21]

In Asian countries where habitual sugar intake is low, fruit consumption should be evaluated separately as whole fruits and fruit juice in terms of the form of sugar contained therein to better elucidate the potential role of fruit consumption in the prevention and management of metabolic disease. This study aimed to compare sociodemographic and dietary characteristics, including dietary sugar and beverage intakes, by the status of whole fruit and fruit juice consumption and to examine associations of whole fruit and fruit juice consumption with the risk of obesity and metabolic syndrome using data from the KNHANES (2012-2015).

Ⅱ. SUBJECTS AND METHODS

2.1. Study Design and Subjects

The KNHANES is a cross-sectional, nationwide survey conducted by the Korea Centers for Disease Control and Prevention (KCDC). The KNHANES recruits a representative sample of non-institutionalized Koreans based on a complex, multi-stage probability sampling design and has three components: health interview, health examination, and nutrition survey.[22]

Participants in this study were Korean adults 19–64 years of age who participated in the 2012–2015 KNHANES (n = 24,327). Participants with incomplete dietary survey data (n = 10,038), missing anthropometric measurements (n = 789), extremely high or low reported energy intake (< 500 or ≥ 5000 kcal/day; n = 236), a diagnosis of (or receiving treatment for) hypertension, diabetes or dyslipidemia (n = 2,522), and pregnancy or lactation (n = 282) were excluded. The final study sample included 10,460 participants.

The Institutional Review Board of the KCDC approved the KNHANES and informed consent was obtained from all participants. Also, this study was approved by the Institutional Review Board of the Catholic University of Korea (IRB No. 1040395-201804-09).

2.2. Assessment of Frequency of Whole Fruit and Fruit Juice Consumption

Frequency of whole fruit and fruit juice consumption was estimated using a validated food frequency questionnaire (FFQ) for the previous year's intake.[23,24] Whole fruit and fruit juice consumption was estimated based on the responses to the following questions: "How often do you consume fruit?" and "How often do you consume fruit juice?" The response options included: rarely, 1 time/month, 2–3 times/month, 1 time/week, 2–4 times/week, 5–6 times/week, 1 time/day, 2 times/day, and 3 times/day. According to the distribution of the responses, these categories were regrouped to ≤ 1 time/week, 2–6 times/week, and 1 ≥ time/day for whole fruits; and rarely, 1–3 times/month, and ≥ 1 time/week for fruit juice. Since the FFQ used in KNHANES does not distinguish among different types of fruit juice, whether the fruit juices consumed were 100% fruit juices were not evaluated in the study.

2.3. Assessment of Macronutrient and Sugar Intake

Daily energy and macronutrient intakes were estimated based on a single 24-h dietary recall. Energy intake was evaluated according to age- and sex-specific estimated energy requirements (EERs), based on the Dietary Reference Intakes for Koreans.[25] Since the KNHANES did not estimate sugar intake, a database which was recently established by Lee et al[19] and expanded in this study was used for the

information on the sugar contents of common Korean food items. The sugar database contained total sugar content data for 2,804 foods, and it encompassed 98.1% of all food items consumed by participants. Daily total sugar intake was calculated by linking the sugar database with the dietary recall data.

To calculate sugar intake by food source, the foods were divided into four major groups: fruits (fresh fruits, dried fruits, and 100% fruit juices), unflavored milk (whole, low-fat, and non-fat), processed foods (all types of beverages, breads and snacks, flavored milk and yogurt, ice cream and frozen confections, sweets, jams, and other similar items) and commodity foods (non-processed ingredients such as grains, potatoes and starches, fish and shellfish, seaweeds, meat, eggs, vegetables, nuts, and mushrooms) according to our previous study.[26]

2.4. Measurement and Definition of Health Outcomes

Anthropometric data, including height, weight, and waist circumference (WC), were measured at a mobile examination center by trained health technicians using calibrated equipment. The body mass index (BMI) was calculated as the weight divided by the square of the height (kg/m^2). Blood pressure was measured three times in the mobile examination center according to a standardized procedure, and the mean of the second and third readings was used in this study.[22] Biochemical markers, including high-density lipoprotein (HDL) cholesterol, triglycerides, and blood glucose were measured by collecting and analyzing blood specimens of participants who fasted for at least 8 h.

In the present study, the health outcomes measured included obesity, abdominal obesity, and metabolic syndrome. Based on the criteria of the WHO for the Asia-Pacific region,[27] obesity was defined as BMI ≥ 25 kg/m^2. Abdominal obesity was defined as WC ≥ 90 cm in men and ≥ 85 cm in women.[28] Metabolic syndrome was diagnosed based on the criteria of the National Cholesterol Education Program Adult Treatment Panel Ⅲ (NCEP ATP Ⅲ),[29] except for WC, for which WHO cut-off values specific to Asian populations were used.[27] Metabolic syndrome was defined as existence of three or more of the following conditions: increased WC (≥ 90 cm for men and ≥ 80 cm for women), elevated blood pressure (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg), reduced HDL cholesterol (< 40 mg/dL (1.04 mmol/L) for men and < 50 mg/dL (1.30 mmol/L) for women), elevated triglycerides (≥ 150 mg/dL (1.70 mmol/L)), and elevated fasting glucose (≥ 100 mg/dL (5.55 mmol/L)).

2.5. Measurement of Sociodemographic Variables and Health Behaviors

Sociodemographic variables including age, sex, education level, and household income, and health behaviors including physical activity, current smoking status, and alcohol consumption were collected during the health interview. Education level was categorized as ≤ middle school, high school, or ≥ college. Household income was categorized as low, middle-low, middle-high, or high, based on quartiles of household income in each survey year. Physical activity, current

smoking status, and regular alcohol consumption were categorized as "yes" or "no". Physical activity was defined as "yes" if participants had walked ≥ 5 times a week for at least 30 min each time. Current smoking status was defined as "yes" if participants had smoked > 100 cigarettes over their lifetime and were still smoking. Alcohol consumption was defined as "yes" if participants drank alcoholic beverages ≥ 1 time/month during the last year.

2.6. Statistical Analyses

All statistical analyses were performed using SAS version 9.4 software.[30] To account for the multi-stage stratified probability sampling method of the KNHANES, the PROC SURVEY procedure, including the sampling weight, stratum, and primary sampling unit data provided by the KCDC,[31] was used in all data analyses. A p-value <0.05 was considered statistically significant.

Categorical variables were evaluated using the chi-square test, and continuous variables were assessed using a generalized linear model. Multiple logistic regression analysis was performed to estimate ORs and 95% confidence intervals (CIs) for obesity, abdominal obesity, and metabolic syndrome according to frequency of whole fruit and fruit juice consumption with the lowest-frequency group as reference. P for trend was measured using the median number of consumption frequencies per week for each category of whole fruits or fruit juice. These models controlled for covariates including age (continuous), sex, household income, education level, alcohol consumption, current smoking status, physical activity, total energy intake, sugar intake

from processed foods and BMI (except for the models of WC and obesity). All analyses were conducted for total population, as the results of interaction tests between whole fruit or fruit juice group and disease outcome by sex were not significant.

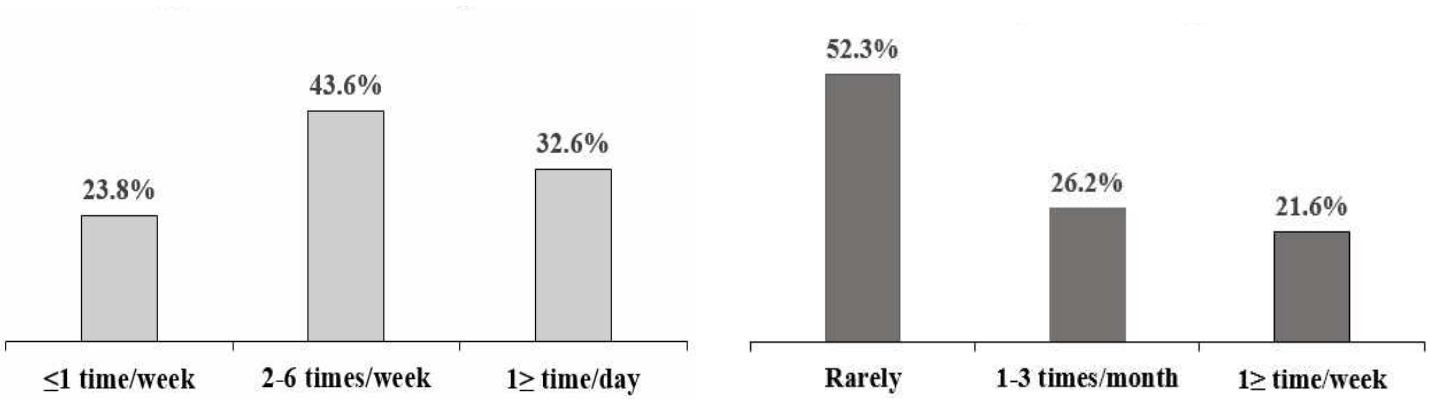
In the multiple logistic regression analysis, dietary pattern was additionally adjusted to fix the effects of dietary habits other than fruit and fruit juice consumption. Dietary pattern was evaluated by principal component analysis based on the percentage of energy from 26 food groups without fruit and fruit juice from the 24-h dietary recall. Two dietary patterns, traditional and modified one, were identified, and the score of each dietary pattern was used as confounding variables (Supplementary Table 1). The 'traditional' dietary pattern was characterized by high consumption of grain and kimchi but low consumption of oils and seasonings. The 'modified' dietary pattern was characterized by high consumption of vegetable and seasonings but low consumption of bread and snacks. The cumulative percentage of explained variance was 13.7%.

Ⅲ. RESULTS

3.1. General Characteristics of Study Subjects According to Whole Fruit and Fruit juice Consumption

The distribution of frequencies of whole fruit consumption and fruit juice consumption is shown in Figure 1. The percentage of participants who consumed whole fruit ≥ 1 time/day was 32.6% while the percentage of participants who consumed fruit juice rarely was 52.3%. The average frequency of whole fruit consumption was 4.2 times/week and fruit juice consumption was 0.7 times/week.

The general characteristics of study participants according to frequency of whole fruit and fruit juice consumption are shown in Table 1-1 and Table 1-2. Whole fruits were more frequently consumed by women than by men, while fruit juice was more frequently consumed by men than by women ($p<0.0001$ for all). The participants who frequently consumed whole fruits tended to be older, whereas those who frequently consumed fruit juice tended to be younger ($p<0.0001$ for all). The higher the frequencies of whole fruit and fruit juice consumption, the higher the household income and educational levels, with the exception of household income level according to fruit juice consumption. The proportion of current smoker and alcohol drinker decreased by frequency of whole fruit consumption ($p<0.0001$ for all), whereas it increased by fruit juice consumption ($p<0.0001$ for all).



(a) Frequency of whole fruit consumption (b) Frequency of fruit juice consumption

Figure 1. Frequency of whole fruit (a) and fruit juice (b) consumption of Korean adults.

Table 1-1. General characteristics of Korean adults according to frequency of whole fruit consumption.

	Frequency of whole fruit consumption			
	≤1/week (n=2,491)	2-6/week (n=4,559)	1≥/day (n=3,410)	*P*-value[a]
Age (y, mean ± standard error)	37.4 ± 0.3	38.6 ± 0.2	41.5 ± 0.3	<.0001
Sex (n,(%))				<.0001
Men	1,308(62.5)	1,905(53.4)	869(34.8)	
Women	1,183(37.5)	2,654(46.6)	2,541(65.2)	
Education (n,(%))				<.0001
≤ Middle school	415(14.2)	618(10.7)	424(11.1)	
High school	1,028(48.1)	1,803(45.6)	1,165(38.9)	
≥ College	822(37.7)	1,798(43.7)	1,586(49.9)	
Household income[b](n,(%))				<.0001
Low	824(35.2)	1,091(23.9)	518(16.5)	
Middle-low	731(28.7)	1,150(25.6)	723(21.6)	
Middle-high	539(20.6)	1,164(26.1)	937(26.6)	
High	385(15.4)	1,118(24.5)	1,210(35.3)	
Current smoker[c](n,(%))				<.0001
Yes	776(36.0)	858(22.8)	330(13.0)	
No	1,715(64.0)	3,701(77.2)	3,080(87.0)	

Table 1-1. (Continued)

	Frequency of whole fruit consumption			
	≤1/week (n=2,491)	2-6/week (n=4,559)	1≥/day (n=3,410)	*P*-value[a]
Alcohol consumption[d](n,(%))				<.0001
Yes	1,519(68.1)	2,645(64.8)	1,633(54.7)	
No	811(31.9)	1,699(35.2)	1,631(45.3)	
Physical activity[e](n,(%))				0.0006
Yes	830(38.3)	1,693(42.7)	1,314(43.9)	
No	1,434(61.7)	2,526(57.3)	1,859(56.1)	

[a]*P*-values are based on chi-square test for categorical variables and a regression model for continuous variables. [b]Household income was categorized as low (first quartile), middle-low (second quartile), middle-high (third quartile), or high (fourth quartile). [c]Current smoker was defined as 'yes' when smoked > 100 cigarettes over the lifetime and still smoking. [d]Alcohol consumption was defined as 'yes' when drinking more than once a month over the past year. [e]Physical activity was defined as 'yes' when walking for ≥ 30 minutes once per day on ≥ 5 days over the past week.

Table 1-2. General characteristics of Korean adults according to frequency of fruit juice consumption.

	Frequency of fruit juice consumption			
	Rarely (n=5,452)	1-3/month (n=2,729)	1≥/week (n=2,249)	*P*-value[a]
Age (y, mean ± standard error)	42.3 ± 0.2	37.7 ± 0.3	34.2 ± 0.3	<.0001
Sex (n,(%))				<.0001
Men	1,808(43.8)	1,135(52.8)	1,126(61.5)	
Women	3,644(56.2)	1,594(47.2)	1,123(38.5)	
Education (n,(%))				<.0001
≤ Middle school	1,008(16.6)	290(8.6)	153(5.8)	
High school	2,038(43.5)	1,071(45.4)	875(45.0)	
≥ College	1,956(39.9)	1,176(46.1)	1,065(49.2)	
Household income[b](n,(%))				<.0001
Low	1,321(26.1)	647(25.1)	455(22.1)	
Middle-low	1,333(24.5)	690(25.9)	576(26.4)	
Middle-high	1,365(24.6)	686(24.6)	581(25.3)	
High	1,394(24.9)	691(24.5)	621(26.2)	
Current smoker[c](n,(%))				<.0001
Yes	932(22.2)	493(22.4)	532(27.4)	
No	4,520(77.8)	2,236(77.6)	1,717(72.6)	

Table 1-2. (Continued)

	Frequency of fruit juice consumption			
	Rarely (n=5,452)	1-3/month (n=2,729)	1≥/week (n=2,249)	*P*-value[a]
Alcohol consumption[d](n, (%))				<.0001
Yes	2,795(58.3)	1,575(64.5)	1,412(69.7)	
No	2,380(41.7)	1,014(35.5)	735(30.3)	
Physical activity[e](n,(%))				0.1230
Yes	1,949(40.6)	997(42.5)	877(43.4)	
No	3,052(59.4)	1,538(57.5)	1,216(56.6)	

[a]*P*-values are based on chi-square test for categorical variables and a regression model for continuous variables. [b]Household income was categorized as low (first quartile), middle-low (second quartile), middle-high (third quartile), or high (fourth quartile). [c]Current smoker was defined as 'yes' when smoked > 100 cigarettes over the lifetime and still smoking. [d]Alcohol consumption was defined as 'yes' when drinking more than once a month over the past year. [e]Physical activity was defined as 'yes' when walking for ≥ 30 minutes once per day on ≥ 5 days over the past week.

3.2. The Status of Macronutrient and Sugar Intake According to Whole Fruit and Fruit Juice Consumption.

Table 2-1 and Table 2-2 show the macronutrient and total sugar intakes per day according to frequency of whole fruit and fruit juice consumption. The more frequently whole fruit or fruit juice were consumed, the greater the energy consumed (p for trend<0.0001 for whole fruit and p for trend=0.0006 for fruit juice). Frequency of whole fruit consumption was positively associated with carbohydrate intake (p for trend<0.0001), whereas it was inversely associated with fat (p for trend=0.0001). Frequency of fruit juice consumption was not significantly associated with macronutrient intake.

The average intake of total sugar was 14.9% of total energy (75.6 g/day) and sugars from processed foods was 8.9% of total energy (45.5 g/day) and sugars from fruits was 3.6% of total energy (18.0 g/day) in total participants, which was within the recommend range (< 20% of total energy) for Koreans.[25] In addition, individuals who were assigned in the both of the highest frequency of whole fruit and fruit juice consumption had total dietary sugar intake, 17.4% of total energy (94.5g/day). The percentage of energy from total sugar increased significantly with the frequency of whole fruit and fruit juice consumption (p for trend<0.0001 for all). The food group contributing most to total sugar intake was processed foods, followed by fruits and

commodity foods. As the frequency of whole fruit consumption increased, total sugar intake (% of total energy) from fruits and commodity foods increased (p for trend<0.0001 for all); however, that from processed foods decreased (p for trend<0.0001). For fruit juice consumption, however, total sugar intake by food source showed a different trend. Total sugar intake from processed foods increased as fruit juice consumption increased (p for trend<0.0001).

Table 2-1. Macronutrient and total sugar intake according to frequency of whole fruit consumption among Korean adults[a,b]

	Frequency of whole fruit consumption			
	≤1/week (n=2,491)	2 - 6/week (n=4,559)	1≥/day (n=3,410)	*P* for trend
Energy and Macronutrients				
Energy (% of EER[c])	93.9 ± 1.0	99.1 ± 0.8	101.4 ± 1.0	<.0001
Carbohydrates (%E[d])	64.1 ± 0.3	64.6 ± 0.2	65.5 ± 0.3	<.0001
Protein (%E)	14.8 ± 0.1	14.6 ± 0.1	14.4 ± 0.1	0.0206
Fat (%E)	21.1 ± 0.2	20.8 ± 0.2	20.0 ± 0.2	0.0001
Total sugar (%E)	13.6 ± 0.2	14.7 ± 0.2	16.9 ± 0.2	<.0001
Commodity foods (%E)	1.7 ± 0.0	1.9 ± 0.0	2.1 ± 0.1	<.0001
Fruits (%E)	1.9 ± 0.1	3.4 ± 0.1	6.0 ± 0.2	<.0001
Milk (%E)	0.5 ± 0.0	0.5 ± 0.0	0.6 ± 0.0	0.0083
Processed foods (%E)	9.5 ± 0.2	8.9 ± 0.1	8.2 ± 0.2	<.0001

[a]All values are presented as adjusted means ± standard error after adjusting for age, sex, household income, education level, alcohol consumption, current smoking status, physical activity, and total energy intake (except for E). [b]All analyses were conducted by a generalized linear model and applied appropriate sampling weight. [c]EER=estimated energy requirement. [d]E=Energy.

Table 2-2. Macronutrient and total sugar intake according to frequency of fruit juice consumption among Korean adults[a,b]

	Frequency of fruit juice consumption			
	Rarely (n=5,452)	1 - 3/month (n=2,729)	1≥/week (n=2,249)	*P* for trend
Energy and Macronutrients				
Energy (% of EER[c])	96.3 ± 0.8	99.7 ± 1.0	100.8 ± 1.0	0.0006
Carbohydrates (%E[d])	64.6 ± 0.2	64.8 ± 0.3	64.9 ± 0.3	0.4248
Protein (%E)	14.7 ± 0.1	14.6 ± 0.1	14.6 ± 0.1	0.8315
Fat (%E)	20.8 ± 0.2	20.7 ± 0.2	20.5 ± 0.2	0.3800
Total sugar (%E)	14.6 ± 0.2	14.8 ± 0.2	15.9 ± 0.2	<.0001
Commodity foods (%E)	2.0 ± 0.0	1.8 ± 0.0	1.8 ± 0.0	0.0011
Fruits (%E)	3.6 ± 0.1	3.4 ± 0.1	3.7 ± 0.1	0.2743
Milk (%E)	0.5 ± 0.0	0.5 ± 0.0	0.5 ± 0.0	0.2398
Processed foods (%E)	8.5 ± 0.1	9.1 ± 0.2	9.9 ± 0.2	<.0001

[a]All values are presented as adjusted means ± standard error after adjusting for age, sex, household income, education level, alcohol consumption, current smoking status, physical activity, and total energy intake (except for E). [b]All analyses were conducted by a generalized linear model and applied appropriate sampling weight. [c]EER=estimated energy requirement. [d]E=Energy.

3.3. The Status of Beverage Intake According to Whole Fruit and Fruit Juice Consumption.

Table 3-1 and Table 3-2 show the consumption of different types of beverages according to frequency of whole fruit and fruit juice consumption. The frequency of consumption of all beverages, with the exception of coffee, was significantly higher with higher frequency of fruit juice consumption (p for trend<0.0001 for all). Similarly, frequency of whole fruit consumption was positively associated with the frequency of consumption of beverages including fruit juice (p for trend<0.0001), milk (p for trend<0.0001), liquid yogurt (p for trend<0.0001), soybean milk (p for trend=0.0001), and tea (p for trend=0.0339). However, there was no significant difference in frequency of soft drink consumption according to whole fruit consumption.

Table 3-1. Consumption of different types of beverages according to frequency of whole fruit consumption among Korean adults[a,b]

	Frequency of whole fruit consumption			
	≤1/week (n=2,491)	2 - 6/week (n=4,559)	1≥/day (n=3,410)	*P* for trend
Beverage consumption (times/week)				
Milk	1.8 ± 0.1	2.4 ± 0.1	3.0 ± 0.1	<.0001
Liquid yogurt	0.8 ± 0.0	1.1 ± 0.0	1.3 ± 0.1	<.0001
Soybean milk	0.3 ± 0.0	0.5 ± 0.0	0.6 ± 0.0	0.0001
Soft drink	1.0 ± 0.1	1.0 ± 0.0	1.0 ± 0.1	0.9837
Fruit juice	0.5 ± 0.0	0.8 ± 0.0	0.8 ± 0.0	<.0001
Sweet rice drink	0.3 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.0056
Tea	0.8 ± 0.1	0.9 ± 0.1	1.0 ± 0.1	0.0339
Coffee	14.4 ± 0.4	14.2 ± 0.3	13.3 ± 0.4	0.0029
All beverages	20.0 ± 0.4	21.2 ± 0.3	21.4 ± 0.4	0.0091

[a]All values are presented as adjusted means ± standard error after adjusting for age, sex, household income, education level, alcohol consumption, current smoking status, physical activity, and total energy intake. [b]All analyses were conducted by a generalized linear model and applied appropriate sampling weight.

Table 3-2. Consumption of different types of beverages according to frequency of fruit juice consumption among Korean adults[a,b]

	Frequency of fruit juice consumption			
	Rarely (n=5,452)	1 - 3/month (n=2,729)	1≥/week (n=2,249)	*P* for trend
Beverage consumption (times/week)				
Milk	2.2 ± 0.1	2.3 ± 0.1	2.8 ± 0.1	<.0001
Liquid yogurt	0.9 ± 0.0	1.1 ± 0.1	1.5 ± 0.1	<.0001
Soybean milk	0.4 ± 0.0	0.5 ± 0.0	0.6 ± 0.0	<.0001
Soft drink	0.9 ± 0.0	0.9 ± 0.1	1.6 ± 0.1	<.0001
Fruit juice	0.0 ± 0.0	0.4 ± 0.0	2.5 ± 0.1	<.0001
Sweet rice drink	0.3 ± 0.0	0.3 ± 0.0	0.5 ± 0.0	<.0001
Tea	0.8 ± 0.1	0.8 ± 0.1	1.2 ± 0.1	<.0001
Coffee	14.3 ± 0.3	13.4 ± 0.3	13.8 ± 0.4	0.3647
All beverages	19.8 ± 0.4	19.8 ± 0.4	24.6 ± 0.4	<.0001

[a]All values are presented as adjusted means ± standard error after adjusting for age, sex, household income, education level, alcohol consumption, current smoking status, physical activity, and total energy intake. [b]All analyses were conducted by a generalized linear model and applied appropriate sampling weight.

3.4. Association of Whole Fruit and Fruit Juice Consumption with Obesity, Abdominal Obesity, and Metabolic Syndrome.

Multivariable-adjusted ORs and 95% CIs for obesity, abdominal obesity, and metabolic syndrome according to whole fruit and fruit juice consumption are presented in Table 4-1 and Table 4-2. After adjusting for confounders, the participants who consumed whole fruits ≥ 1 time/day showed a lower prevalence of obesity (OR 0.81, 95% CI 0.68 - 0.96, p for trend=0.0088) and abdominal obesity (OR 0.81, 95% CI 0.67 - 0.97, p for trend=0.0152) compared with those who consumed whole fruits ≤ 1 time/week. Although frequency of whole fruit consumption was not associated with the prevalence of metabolic syndrome, it was inversely associated with the prevalence of several metabolic syndrome components. The participants with the highest frequency of whole fruit consumption (≥ 1 time/day) showed a 26% decreased prevalence of elevated blood pressure (OR 0.74, 95% CI 0.61 - 0.88, p for trend=0.0013) and a 19% decreased prevalence of increased waist circumference (OR 0.81, 95% CI 0.69 - 0.95, p for trend=0.0048) compared with those with the lowest frequency of consumption (≤ 1 time/week). However, frequency of fruit juice consumption showed no association with obesity, abdominal obesity, and metabolic syndrome.

Table 4-1. Multivariable-adjusted odds ratios and 95% confidence intervals for obesity, abdominal obesity, and metabolic syndrome based on frequency of whole fruit consumption among Korean adults[a]

	Frequency of whole fruit consumption			
	≤1/week (n=2,491)	2 - 6/week (n=4,559)	1≥/day (n=3,410)	*P* for trend
Median(times/week)	0.6	3.0	7.0	
Obesity[b]	1.00(ref)	1.10(0.94-1.27)[b]	0.81(0.68-0.96)	0.0088
Abdominal obesity[c]	1.00(ref)	0.99(0.84-1.16)	0.81(0.67-0.97)	0.0152
Metabolic syndrome[d]	1.00(ref)	0.86(0.71-1.05)	0.85(0.68-1.05)	0.1699
Increased waist circumference	1.00(ref)	0.98(0.86-1.13)	0.81(0.69-0.95)	0.0048
Elevated blood pressure	1.00(ref)	0.85(0.72-1.01)	0.74(0.61-0.88)	0.0013
Reduced HDL[e]cholesterol	1.00(ref)	0.89(0.77-1.04)	1.03(0.88-1.21)	0.3709
Elevated triglycerides	1.00(ref)	0.88(0.76-1.03)	0.84(0.70-1.00)	0.0657
Elevated fasting glucose	1.00(ref)	0.90(0.77-1.06)	0.84(0.70-1.01)	0.0706

[a]All values were obtained from a multivariable logistic regression model applied appropriate sampling weight after adjusting for age, sex, household income, education level, alcohol consumption, current smoking status, physical activity, total energy intake, sugar intake from processed foods, dietary pattern

score 1, dietary pattern score 2 and body mass index (BMI; except for the models of waist circumference [WC] and obesity). [b]Obesity was defined as BMI ≥ 25 kg/m^2 [c]Abdominal obesity was defined as WC ≥ 90 cm in men and ≥ 85 cm in women [d]For diagnosis of metabolic syndrome, the presence of three or more of the following components was required: increased WC (≥ 90 cm for men and ≥ 80 cm for women); elevated blood pressure (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg); reduced HDL cholesterol (< 40 mg/dL for men and <50 mg/dL for women); elevated triglyceride levels (≥ 150 mg/dL); and elevated fasting glucose (≥ 100 mg/dL). [e]HDL=high-density lipoprotein.

Table 4-2. Multivariable-adjusted odds ratios and 95% confidence intervals for obesity, abdominal obesity, and metabolic syndrome based on frequency of fruit juice consumption among Korean adults[a]

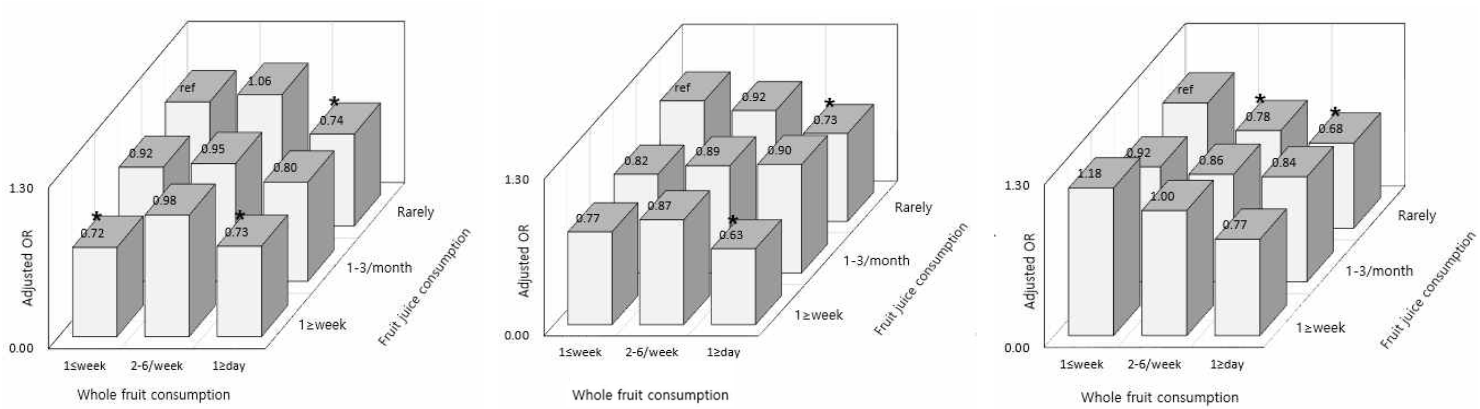
	Frequency of fruit juice consumption			
	Rarely (n=5,452)	1 - 3/month (n=2,729)	1≥/week (n=2,249)	*P* for trend
Median	0.0	0.2	1.2	
Obesity[b]	1.00(ref)	0.96(0.84-1.10)	0.90(0.77-1.05)	0.4138
Abdominal obesity[c]	1.00(ref)	0.98(0.84-1.15)	0.88(0.74-1.05)	0.1432
Metabolic syndrome[d]	1.00(ref)	1.07(0.88-1.31)	1.18(0.96-1.44)	0.1161
Increased waist circumference	1.00(ref)	0.97(0.84-1.11)	0.90(0.77-1.04)	0.1935
Elevated blood pressure	1.00(ref)	1.07(0.91-1.26)	1.20(1.00-1.43)	0.0524
Reduced HDL[e]cholesterol	1.00(ref)	1.08(0.93-1.25)	0.99(0.86-1.15)	0.6147
Elevated triglycerides	1.00(ref)	1.10(0.95-1.27)	1.10(0.93-1.31)	0.3330
Elevated fasting glucose	1.00(ref)	1.01(0.86-1.19)	1.13(0.94-1.35)	0.1775

[a]All values were obtained from a multivariable logistic regression model applied appropriate sampling weight after adjusting for age, sex, household income, education level, alcohol consumption, current smoking status, physical activity, total energy intake, sugar intake from processed foods, dietary pattern

score 1, dietary pattern score 2 and body mass index (BMI; except for the models of waist circumference [WC] and obesity). [b]Obesity was defined as BMI ≥ 25 kg/m^2 [c]Abdominal obesity was defined as WC ≥ 90 cm in men and ≥ 85 cm in women [d]For diagnosis of metabolic syndrome, the presence of three or more of the following components was required: increased WC (≥ 90 cm for men and ≥ 80 cm for women); elevated blood pressure (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg); reduced HDL cholesterol (< 40 mg/dL for men and <50 mg/dL for women); elevated triglyceride levels (≥ 150 mg/dL); and elevated fasting glucose (≥ 100 mg/dL). [e]HDL=high-density lipoprotein.

3.5. Association of Obesity, Abdominal Obesity, and Blood Pressure According to Combined Consumption of Whole Fruit and Fruit Juice.

Finally, participants were divided into nine groups by combining frequency of the whole fruit and fruit juice consumption, and examined the associations of obesity, abdominal obesity, and elevated blood pressure (Figure 2). When compared with the participants with the lowest frequencies of whole fruit and fruit juice consumption, the participants with the highest frequency of whole fruit consumption (≥ 1 time/day) showed lower ORs of obesity and abdominal obesity, regardless of whether the frequency of fruit juice consumption was the lowest or the highest. The prevalence of elevated blood pressure was significantly lower in those who consumed fruit juice rarely, but consumed whole fruit more than 2 times per week, than those who consumed both whole fruit and fruit juice less frequently.



(a) Obesity[a] (b) Abdominal obesity[a] (c) Elevated blood pressure[a]

Figure 2. Multivariable-adjusted odds ratios (ORs) for obesity, abdominal obesity and elevated blood pressure according to the combined frequency of consumption of whole fruits and fruit juice.

[a]All values were obtained from a multivariable logistic regression model applied appropriate sampling weight after adjusting for age, household income, education level, alcohol consumption, current smoking status, physical activity, total energy intake, sugar intake from processed foods, dietary pattern score 1, dietary pattern score 2 and body mass index (BMI; except for the models of waist circumference and obesity). * indicate the statistical significant.

Ⅳ. DISCUSSION

In this large-scale cross-sectional study based on a national survey of Koreans, frequency of whole fruit consumption was inversely associated with obesity and metabolic syndrome abnormalities; however, frequency of fruit juice consumption was not associated with obesity, abdominal obesity, and metabolic syndrome.

Because people tend to consume whole fruits, fruit juice, or both daily, differentiating between the effects of whole fruit and fruit juice is difficult. Therefore, in the present study, participants who reported consuming whole fruits or fruit juice were identifie d and their respective dietary sugar and beverage intakes were evaluated.

Fruit consumption is known to be associated with sociodemographic characteristics. In this study, frequency of whole fruit consumed more frequently among participants with higher income and education levels. It is in agreement with previous studies which reported that higher income and education level were also associated with higher consumption of fruits in Dutch,[32] Australian,[33] and Chinese adults.[34] With regard to age, frequency of whole fruit consumption was associated with older age; however, frequency of fruit juice consumption was associated with younger age. This was also in agreement with a study of French adults which showed that fruit juice

consumption increased with education level and income; however, it decreased with age.[35]

The present study found that frequency of whole fruit consumption was inversely associated with obesity or metabolic disease abnormalities. This is in agreement with most other studies. In a meta-analysis of cohort studies, higher fruit consumption was inversely associated with weight change in 17 cohort studies[1] and risk of type 2 diabetes.[36] A large cohort study reported that fruit consumption was inversely related to coronary heart disease in the US[2] and all-cause mortality in Australia.[37] However, those cohort studies were often conducted in the Western population, and few data were available for the Asian population.

In contrast, the results from existing literature regarding the relationship of fruit juice consumption with obesity or metabolic disease were inconsistent. In a meta-analysis of cohort studies, the replacement of fruit juice by water was inversely associated with long-term weight gain in three cohort studies[17] and consumption of fruit juice was associated with a greater incidence of type 2 diabetes.[38] However, cross-sectional studies that focused on 100% fruit juice consumption with no added sugar reported that it contributed daily intake of various vitamins, including vitamin C (32%) in French adults using the data from a nationally representative survey[35] and adults who consumed fruit juice showed lower ORs for obesity and metabolic syndrome compared with non-consumers in the United States.[17]

These inconsistencies may be attributable to the study design, and the type of fruit juice as well as the amount of fruit juice consumption. A single serving per day of 100% fruit juice was associated with a 3-year weight gain in postmenopausal women in the United States,[12] and two or more servings per week being associated with an increased risk of type 2 diabetes in the Singapore Chinese Health Study.[38] In the present study, frequency of fruit juice consumption was relatively low compared with other studies in Western populations.[11] The proportion of participants in the high consumer group, i.e., that which consumed fruit juice ≥ 1 time/day, was only 1.9% for men and 1.4% for women. It is clear that excessive intake of simple sugars affects the nutritional quality of the diet by providing significant amounts of energy without specific nutrients;[39] however, in Koreans with a low intake of dietary sugars, consumption of fruit juice may not contribute to weight gain to that extent.

The amounts of fruit juice should be considered importantly in the context of overall dietary sugar intake as well as beverage consumption. As KNHANES provides data on both dietary recall and FFQ, dietary sugar intake was examined from a dietary recall and beverage consumption amounts from FFQ according to frequency of whole fruit and fruit juice consumption. The results showed that dietary total sugar intake (75.6 g/day, 14.9% of total energy) was within the recommended range (< 20% of total energy) for Koreans,[25] even in groups with the highest frequencies of whole fruit and fruit juice consumption (94.5

g/day, 17.4% of total energy), which are also relatively low compared to those in US adults (126 g/day).[20] Due to no database for free sugar or added sugar, total sugar intake by food source was evaluated and found that the sugar intake from processed foods was 45.5 g/day and the sugar intake from fruits was 18.0 g/day. Among all beverages, coffee was the most frequently consumed (approximately 50–60% of all beverages); other beverages, including soft drinks, were not frequently consumed.

Considering the current study's findings regarding dietary sugar intake and beverage consumption frequency, Koreans may not be consuming fruit juice in sufficient quantities to indicate a meaningful association between fruit juice and disease outcomes. However, younger generation was reported to consume considerably[19] and dietary environment is quickly changing. Thus, fruit juice consumption should be carefully monitored in relation with chronic diseases, and further longitudinal studies on fruit juice, considering the type and amount of fruit juice for Asian population, are needed.

The association of fruit consumption and weight change is considered to be due to a decrease in total energy intake, because fruit contains large amounts of water and thus increases satiety.[5] However, in the present study, energy intake of the participants who consumed whole fruits daily was slightly higher than energy requirements (101.4% of EER) and sugar accounted for 16.9% of their total energy, which is within the recommended range for Koreans.[25] In addition, the inverse associations between

frequency of whole fruit and disease outcome were not changed regardless of total energy intake in the disease models in the sensitivity analyses(supplementary table 2-1 and 2-2). These results indicate that increasing frequency of whole fruit consumption may reduce the consumption of other, more energy-dense foods, thus contributing to the inverse association between frequency of whole fruit consumption and obesity.

This study had several limitations. First, we could not evaluate whether the fruit juices consumed were 100% fruit juices, because the FFQ used in KNHANES does not distinguish among different types of fruit juice. In addition, whole fruit and fruit juice consumption were defined as frequencies on the basis of a single question. Although fruit juice was asked with portion size, 52% of participants did not respond that only frequency was used. It could represent a limitation with respect to estimating the volume of whole fruits or fruit juices consumed, thus leading to misclassification of the participants. Moreover, there is a possibility of dietary misreporting of whole fruit or fruit juice consumption and daily energy and macronutrient intakes were estimated using a single 24-hour recall which may not be an accurate of usual intake. Finally, this study used a cross-sectional design, rendering confirmation of a causal relationship between whole fruit or fruit juice consumption and the risk of obesity and metabolic syndrome difficult.

Despite these limitations, a strength of the current study is that this was the first study to evaluate the associations of the frequency of whole fruit and fruit juice consumption with obesity

and components of metabolic syndrome in Korean adults who consume relatively low amount of dietary sugar. Furthermore, this study included a large number of participants selected from among a nationally representative population. Prospective studies are needed to build upon these results and identify associations between whole fruit and fruit juice consumption and obesity and metabolic syndrome over time as well as explore potential underlying mechanisms of action. In addition, important variables such as energy density, energy content, fruit and vegetable consumption, forms of fruit (fresh fruits, dried fruits, and 100% fruit juices), and preparation methods should be included in future studies.

Ⅴ. CONCLUSION

In conclusion, whole fruit consumption was associated with reduced prevalence of obesity as well as metabolic syndrome abnormalities among Korean adults with a dietary sugar intake within the recommended range. Fruit juice consumption was not associated with obesity and metabolic syndrome.

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Supplementary Table 1. The factor loading matrix for the food groups consumed by Korean adults[a]

	Factor1 (Traditional)	Factor2 (Modified)
Food groups (%E[b])		
Grains	0.81	0.26
Flour and Noodles	-0.31	-0.31
Breads and Snacks		-0.51
Potatoes and Starch		
Sweets	-0.23	
Legumes	0.27	
Seeds and Nuts		
Vegetable		0.62
Salted vegetable (Kimchi)	0.42	
Mushrooms		
Meats	-0.46	
Eggs		
Fishes and Shellfishes		0.33
Seaweeds	0.35	
Milk		-0.27
Dairy products		
Ice cream		
Powdered milk		
Oils	-0.46	0.35
Sugar sweetened beverage	-0.27	-0.21
Tea		
Coffee		
Alcohol	-0.28	
Seasonings	-0.40	0.43
Prepared foods		
Others		
% variance explained	7.8	5.9

[a]Factor-loading score of -0.20 and +0.20 are not shown.

[b]E=Energy.

Supplementary Table 2-1. Multivariable-adjusted odds ratios and 95% confidence intervals for obesity, abdominal obesity, and metabolic syndrome based on frequency of whole fruit consumption among Korean adults[a]

	Frequency of whole fruit consumption			
	≤1/week (n=2,491)	2 - 6/week (n=4,559)	1≥/day (n=3,410)	*P* for trend
Median(times/week)	0.6	3.0	7.0	
Obesity[b]	1.00(ref)	1.10(0.95-1.28)[b]	0.81(0.69-0.97)	0.0088
Abdominal obesity[c]	1.00(ref)	0.99(0.85-1.17)	0.82(0.68-0.99)	0.0152
Metabolic syndrome[d]	1.00(ref)	0.87(0.71-1.05)	0.85(0.68-1.06)	0.1699
Increased waist circumference	1.00(ref)	0.99(0.86-1.14)	0.82(0.69-0.96)	0.0048
Elevated blood pressure	1.00(ref)	0.87(0.74-1.02)	0.75(0.63-0.91)	0.0013
Reduced HDL[e]cholesterol	1.00(ref)	0.88(0.76-1.03)	1.01(0.86-1.18)	0.3709
Elevated triglycerides	1.00(ref)	0.89(0.76-1.04)	0.84(0.70-1.01)	0.0657
Elevated fasting glucose	1.00(ref)	0.91(0.77-1.07)	0.85(0.70-1.02)	0.0706

[a]All values were obtained from a multivariable logistic regression model applied appropriate sampling weight after adjusting for age, sex, household income, education level, alcohol consumption, current

smoking status, physical activity, sugar intake from processed foods, dietary pattern score 1, dietary pattern score 2 and body mass index (BMI; except for the models of waist circumference [WC] and obesity). [b]Obesity was defined as BMI ≥ 25 kg/m² [c]Abdominal obesity was defined as WC ≥ 90 cm in men and ≥ 85 cm in women [d]For diagnosis of metabolic syndrome, the presence of three or more of the following components was required: increased WC (≥ 90 cm for men and ≥ 80 cm for women); elevated blood pressure (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg); reduced HDL cholesterol (< 40 mg/dL for men and <50 mg/dL for women); elevated triglyceride levels (≥ 150 mg/dL); and elevated fasting glucose (≥ 100 mg/dL). [e]HDL=high-density lipoprotein.

Supplementary Table 2-2. Multivariable-adjusted odds ratios and 95% confidence intervals for obesity, abdominal obesity, and metabolic syndrome based on frequency of fruit juice consumption among Korean adults[a]

	Frequency of fruit juice consumption			
	Rarely (n=5,452)	1 - 3/month (n=2,729)	1≥/week (n=2,249)	*P* for trend
Median	0.0	0.2	1.2	
Obesity[b]	1.00(ref)	0.96(0.84-1.10)[b]	0.90(0.77-1.05)	0.4127
Abdominal obesity[c]	1.00(ref)	0.98(0.84-1.15)	0.88(0.74-1.05)	0.1416
Metabolic syndrome[d]	1.00(ref)	1.08(0.88-1.31)	1.18(0.96-1.44)	0.1166
Increased waist circumference	1.00(ref)	0.97(0.84-1.11)	0.90(0.77-1.04)	0.1931
Elevated blood pressure	1.00(ref)	1.08(0.91-1.26)	1.20(1.00-1.43)	0.0540
Reduced HDL[e]cholesterol	1.00(ref)	1.08(0.93-1.24)	0.99(0.85-1.15)	0.6157
Elevated triglycerides	1.00(ref)	1.10(0.95-1.27)	1.10(0.93-1.31)	0.3335
Elevated fasting glucose	1.00(ref)	1.01(0.86-1.19)	1.13(0.94-1.35)	0.1774

[a]All values were obtained from a multivariable logistic regression model applied appropriate sampling weight after adjusting for age, sex, household income, education level, alcohol consumption, current

smoking status, physical activity, sugar intake from processed foods, dietary pattern score 1, dietary pattern score 2 and body mass index (BMI; except for the models of waist circumference [WC] and obesity). [b]Obesity was defined as BMI ≥ 25 kg/m^2 [c]Abdominal obesity was defined as WC ≥ 90 cm in men and ≥ 85 cm in women [d]For diagnosis of metabolic syndrome, the presence of three or more of the following components was required: increased WC (≥ 90 cm for men and ≥ 80 cm for women); elevated blood pressure (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg); reduced HDL cholesterol (< 40 mg/dL for men and <50 mg/dL for women); elevated triglyceride levels (≥ 150 mg/dL); and elevated fasting glucose (≥ 100 mg/dL). [e]HDL=high-density lipoprotein.

Ⅶ. ABSTRACT IN KOREAN

한국 성인의 과일 및 과일주스 섭취와 비만 및 대사증후군과의 연관성

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과일은 식이섬유와 비타민이 풍부하여 건강에 유익한 것으로 알려져 있지만, 동시에 많은 양의 당을 함유하고 있다. 과일을 가공하여 만든 과일주스는 과일에 비해 식이섬유와 비타민이 적고 당류 함량이 높기 때문에, 과일주스가 건강에 미치는 영향은 과일과 다를 것이라 예상된다. 그러나 아직까지 과일 및 과일주스가 건강에 미치는 영향에 대한 차이가 명확히 밝혀지지 않았으며, 과일 및 과일주스 섭취와 비만 및 비만 관련 질환에 관한 논의는 계속해서 진행 중이다. 본 연구는 과일 및 과일주스 섭취에 따른 대상자의 특성을 파악하여 비교하고, 과일 및 과일주스 섭취와 비만 및 대사증후군과의 연관성을 분석하고자 수행되었다.

본 연구는 2012-2015년 국민건강영양조사에 참여한 만19세~64세 성인 10,460명(남성 4,082명, 여성 6,378명)을 대상으로 하였다. 과일 및 과일주스 섭취량은 식품섭취빈도조사지를 활용하여 산출하였고, 당류 섭취량은 24시간 식사조사 자료와 기구축된 총 당류 함량 데이터베이스를 연계하여 산출하였다. 비만 및 복부비만은 체질량 지

수(BMI, kg/m^2)와 허리둘레를 기준으로 분류되었다. 대사증후군은 NCEP ATP Ⅲ (National Cholesterol Education Program Adult Treatment Panel Ⅲ)의 기준을 따라 정의되었다. 다중 로지스틱 회귀분석을 통해 과일 및 과일주스 섭취와 비만 및 대사증후군과의 연관성을 분석하였다.

과일을 매일 섭취하는 대상자의 비율은 32.6%였고, 과일주스를 거의 먹지 않는 대상자의 비율은 52.3%였다. 본 연구에 포함된 10,460명의 총 당류 섭취량은 총 에너지 섭취량의 14.9%였고, 가공식품을 통한 당류 섭취량은 총 에너지 섭취량의 8.9%로 한국인의 권장 섭취기준(총 에너지 섭취량의 20% 미만) 안에 있었다. 과일섭취는 비만, 복부비만, 고혈압과 유의한 음의 상관관계를 가지는 것으로 나타난 반면, 과일주스 섭취는 비만, 복부비만, 대사증후군과 관련이 없었다.

본 연구의 결과 당류 섭취량이 권장 섭취기준 안에 있는 한국 성인의 경우 과일 섭취가 비만 및 대상증후군 위험요인에 보호적인 효과를 나타냄을 알 수 있다.

주요어 : 당류 섭취, 과일, 과일주스, 비만, 대사증후군
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