

Television Viewing Time and Breast Cancer Incidence for Japanese Premenopausal and Postmenopausal Women: The JACC Study

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Purpose

The evidence on effects of TV viewing time among premenopausal and postmenopausal women for breast cancer risk remains controversial and limited.

Materials and Methods

A prospective study encompassing 33,276 (17,568 premenopausal, and 15,708 postmenopausal) women aged 40-79 years in whom TV viewing time, menstrual, and reproductive histories were determined by a self-administered questionnaire. The follow-up was from 1988 to 2009 and hazard ratios (HRs) with 95% confidence intervals (CIs) of breast cancer incidence were calculated for longer TV viewing time in reference to shorter TV viewing time by Cox proportional hazard models.

Results

During 16.8-year median follow-up, we found positive associations between TV viewing time and breast cancer incidence with a borderline significant trend among total women and a significant trend among postmenopausal women. Among total women, the multivariable HRs (95% CIs) for risk of breast cancer in reference to < 1.5 hr/day of TV viewing time were 0.89 (0.59-1.34) for 1.5 to < 3.0 hr/day, 1.19 (0.82-1.74) for 3.0 to < 4.5 hr/day, and 1.45 (0.91-2.32) for \geq 4.5 hr/day (*p* for trend=0.053) and among postmenopausal women, the corresponding risk estimates were 1.10 (0.42-2.88), 2.54 (1.11-5.80), and 2.37 (0.92-6.10) (*p* for trend=0.009), respectively.

Conclusion

Prolonged TV viewing time was associated with increased risk of breast cancer, especially among postmenopausal women.

Key words

Television viewing time, Breast neoplasms, Incidence, Cohort study, Postmenopausal, Body mass index, Japan

Introduction

Television (TV) viewing time is a sedentary time along with less activity and it is an important leisure behavior in women daily routines [1,2]. The average hours spent in watching TV has been reported to be about 5 hr/day in the US adults and 3-4 hr/day in Japanese adults [3,4].

Breast cancer is the most common cancer among Japanese women (19.0% of female cancers) [5], and have markedly

increased in Asia in recent years [6]. Physical activity has been shown inversely associated with risk of breast cancer [5-10]; whereas sedentary behaviors were associated with the increased risk [7,11]. The increased risk of breast cancer with sedentary behaviors was evident for both occupational sitting time [12,13] and leisure sedentary time including TV watching time [11], with a higher risk with the occupational sitting time than leisure sedentary time, as indicated in a meta-analysis of 21 observational studies [14]. However, another meta-analysis of 43 observational studies confirmed

the associations of prolonged TV viewing times with risks of lung, colon and endometrial cancers, but failed to conclude any association with breast cancer [2]. In addition, findings of the Black Women's Health Study indicated that the association between TV viewing time and risk of breast cancer was evident for total and postmenopausal women, but not for premenopausal women [11], while an Indian case-control study showed no increased risk for both premenopausal and postmenopausal women [9].

Therefore, we thought to assess the association of TV viewing time for premenopausal and postmenopausal Japanese women with risk of breast cancer in a large population-based Japanese study, the Japan Collaborative Cohort (JACC) study. As the mechanisms underlying the increased risk for breast cancer with prolonged TV viewing were more evident after menopause, we hypothesize that long TV viewing time may be associated with increased risk of breast cancer incidence in Japanese postmenopausal women.

Materials and Methods

1. Study population and ascertainment of breast cancer

Details of the study subjects have been described elsewhere [15]. Briefly, the baseline data of the JACC Study were collected from 1988 to 1990 and 64 190 women aged 40 to 79 years in 45 study areas throughout Japan participated in the study. In 24 areas out of the 45 study areas, data on cancer incidence such as the date of diagnosis and the primary site of cancer were collected simultaneously through population-based cancer registries or by reviewing the records of local and major hospitals from the baseline to the end of 2009. Some study areas discontinued the follow-up survey regarding cancer before 2009 (1994 in one study area, 1997 in two areas, 1999 in one area, 2000 in one area, 2002 in one area, 2003 in one area, 2006 in two areas, and 2008 in two areas).

We confined the analysis to women from these 24 areas where cancer incidence information are available ($n=36,255$). Excluding data of women with previous diagnosis of breast cancer ($n=11$), and women with missing data on TV viewing time ($n=2,979$) left a total of 33,276 (17,568 premenopausal and 15,708 postmenopausal) women for the analysis. This study was sponsored by the Ministry of Education, Sports and Science.

2. Exposure and other covariates assessment

Participants completed a self-administered questionnaire including information on TV viewing time, age, family his-

tory of diseases, histories of hypertension, diabetes mellitus, cardiovascular diseases and cancer, height, weight, education background, smoking status, alcohol drinking habit, physical activity, mental stress, dietary habits, reproductive and menstrual history, menopause, and hormone use. Body mass index (BMI) was calculated by dividing the weight in kilograms by the square of height in meters. We obtained information about the average TV viewing time on weekdays during the preceding year. The average TV viewing time per day was classified into four categories: < 1.5 , 1.5 to < 3.0 , 3.0 to < 4.5 , and ≥ 4.5 hr/day. Fractions hours were rounded off (e.g., 1.5 to < 3 hours represented responses from 1.5 to 2.9 hours).

3. Statistical analysis

Mean values (standard deviations) and proportions of baseline risk characteristics were calculated, and the linear trends in those variables according to TV viewing time were tested by the linear regression analysis for continuous variables and the logistic regression analysis for proportional variables. Person-years of follow-up were calculated from the responding date to the baseline questionnaire until the obtainment of one out of four possible endpoints as follows: (1) incidence of breast cancer event, (2) relocation from the study area, (3) the end of the study on December 31, 2009, or (4) death.

Cox proportional hazard regression age- and multivariable-adjusted models were used to estimate the hazard ratios (HRs) with 95% confidence intervals (CIs) for breast cancer incidence according to TV viewing time categories (1.5 to < 3.0 , 3.0 to < 4.5 , and ≥ 4.5 hr/day) in reference to < 1.5 hr/day. The confounding factors included age (continuous), age of menarche (< 14 , $14-15$, and > 15 years), age of menopause (< 45 , $45-50$, and > 50 years), type of menopause (nature or operation), BMI (continuous), currently married (yes or no), smoking status (never, ex-smoker, and current smoker), alcohol intake (never, ex-drinker, and current drinker of $0.1-22.9$, $23.0-45.9$, and ≥ 46.0 g ethanol/day), parity (0, 1, 2, and ≥ 3), use of sex hormone (yes or no), family history of breast cancer (yes or no), daytime napping (yes or no), sleep duration (≤ 6 , 7 , and ≥ 8 hr/day), stress (high, median, or low), education (≤ 12 , $13-15$, $16-18$, and ≥ 19 years), and history of diabetes (yes or no). In a final model, we adjusted further for sport time per week (never, < 1 , $1-2$, $3-4$, and ≥ 5 hr/wk) and walking time per day (never, < 30 , $30-60$, and ≥ 60 min/day). The stratification analyses were planned to test the effect modification by potential effect modifiers such as menopausal status, BMI, history of diabetes, and smoking status. However, due to limited number of participants or breast cancer cases in the diabetic or smoking women categories, these stratification analyses were performed for menopausal

Table 1. Distributions of potential risk factors in premenopausal and postmenopausal women according to television viewing time

Parameter	Television viewing time (hr)				p for trend
	< 1.5	1.5 to < 3.0	3 to < 4.5	≥ 4.5	
Total women					
No. at risk	8,756	9,615	12,908	4,976	
Age, mean±SD (yr)	56.6±10.5	56.3±9.9	58.4±9.7	62.2±9.4	< 0.001
Menarche age, mean±SD (yr)	14.9±1.8	14.8±1.7	15.0±1.7	15.0±1.8	< 0.001
Body mass index, mean±SD (kg/m ²)	22.6±3.0	22.8±3.0	23.0±3.1	23.3±3.4	< 0.001
Parity (number of children) (%)					
0	5.2	3.6	4.5	7.0	< 0.001
1	6.4	6.5	8.0	9.5	
2	34.6	38.9	37.7	33.4	
≥ 3	53.9	51.0	49.9	50.1	
Family history of breast cancer in mother or sisters (%)	1.3	1.5	1.4	1.3	0.152
Education < 15 yr (%)	23.4	22.6	25.7	32.6	< 0.001
Currently married (%)	85.8	86.8	82.2	72.6	< 0.001
Sleep duration, mean±SD (hr/day)	7.0±1.1	7.0±1.0	7.1±1.1	7.1±1.2	< 0.001
Daytime napping (%)	27.1	27.7	30.6	36.9	< 0.001
Sport time ≥ 3 hr/wk (%)	8.8	9.6	9.9	10.5	0.121
Walking time ≥ 60 min/day (%)	52.0	52.2	50.1	43.1	< 0.001
Smoking (%)					
Never smoker	86.8	86.1	83.6	76.3	< 0.001
Former smoker	1.1	1.0	14.0	2.4	
Current smoker	3.3	3.7	4.6	7.3	
Alcohol intake, mean±SD (g ethanol/day)	9.5±12.8	9.4±12.7	9.2±12.1	11.0±13.8	< 0.001
High stress (%)	15.7	16.8	18.8	21.4	< 0.001
Hormone use (%)	5.1	4.8	4.8	5.3	0.096
History of diabetes (%)	3.6	3.3	4.2	7.7	< 0.001
Premenopausal women					
No. at risk	4,371	4,964	6,241	1,992	
Age, mean±SD (yr)	52.3±10.7	52.7±10.2	55.2±10.4	59.8±10.8	< 0.001
Menarche age, mean±SD (yr)	14.6±1.7	14.6±1.7	14.8±1.7	15.1±1.8	< 0.001
Body mass index, mean±SD (kg/m ²)	22.4±2.9	22.7±2.9	23.0±3.1	23.2±3.3	< 0.001
Parity (number of children) (%)					
0	5.4	3.6	4.4	6.9	< 0.001
1	5.9	6.4	7.9	9.6	
2	39.9	43.6	41.2	34.9	
≥ 3	39.9	43.6	41.2	34.9	
Family history of breast cancer in mother or sisters (%)	1.4	1.7	1.5	0.9	0.019
Education < 15 yr (%)	16.8	16.5	20.0	29.0	< 0.001
Currently married (%)	89.2	89.7	85.8	77.6	< 0.001
Sleep duration (hr/day)	7.0±1.0	7.0±1.0	7.1±1.0	7.2±1.2	< 0.001
Daytime napping (%)	23.9	25.4	28.5	36.8	< 0.001
Sport time ≥ 3 hr/wk (%)	7.9	8.3	8.4	9.7	0.022
Walking time ≥ 60 min/day (%)	52.1	50.2	48.3	42.8	< 0.001
Smoking (%)					
Never smoker	89.2	87.8	86.1	79.8	< 0.001
Former smoker	1.0	0.9	1.3	2.0	
Current smoker	3.7	4.6	5.3	8.9	
Alcohol intake, mean±SD (g ethanol/day)	9.2±12.8	10.0±14.2	9.9±12.5	12.2±17.1	< 0.001

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Table 1. Continued

Parameter	Television viewing time (hr)				p for trend
	< 1.5	1.5 to < 3.0	3 to < 4.5	≥ 4.5	
High stress (%)	14.1	15.5	17.0	19.0	< 0.001
Hormone use (%)	5.5	5.2	5.1	5.3	0.953
History of diabetes (%)	2.6	2.3	3.2	5.7	< 0.001
Postmenopausal women					
No. at risk	3,666	3,914	5,608	2,520	
Age, mean±SD (yr)	61.0±7.8	60.3±7.3	61.3±7.5	63.5±7.4	< 0.001
Menarche age, mean±SD (yr)	15.4±1.8	15.1±1.8	15.1±1.7	15.0±1.8	< 0.001
Menopause age, mean±SD (yr)	48.5±4.8	48.6±4.6	48.7±4.7	48.7±4.8	0.662
Natural menopause (%)	87.3	87.5	87.1	87.2	0.915
Body mass index, mean±SD (kg/m ²)	22.8±3.1	22.9±3.1	23.0±3.1	23.3±3.5	< 0.001
Parity (number of children) (%)					
0	2.9	2.5	2.9	5.1	< 0.001
1	6.7	6.5	8.3	9.7	
2	29.6	34.2	33.5	33.4	
≥ 3	60.8	56.9	54.0	51.7	
Family history of breast cancer in mother or sisters (%)	1.2	1.2	1.3	1.6	0.652
Education < 15 yr (%)	26.4	27.7	29.2	32.5	< 0.001
Currently married (%)	82.1	83.5	78.7	69.5	< 0.001
Sleep duration, mean±SD (hr/day)	7.1±1.1	7.1±1.1	7.1±1.1	7.1±1.1	0.379
Daytime napping (%)	30.3	30.7	32.4	35.7	< 0.001
Sport time ≥ 3 hr/wk (%)	10.8	11.0	11.3	10.8	0.372
Walking time ≥ 60 min/day (%)	52.0	52.2	50.1	43.1	< 0.001
Smoking (%)					
Never smoker	86.5	84.6	82.0	75.2	< 0.001
Former smoker	1.3	1.2	1.6	2.5	
Current smoker	2.8	2.5	3.6	6.0	
Alcohol intake, mean±SD (g ethanol/day)	9.7±13.1	8.2±10.0	8.2±11.1	10.1±11.2	0.005
High stress (%)	19.2	19.1	21.8	23.8	< 0.001
Hormone use (%)	4.5	4.3	4.5	5.4	0.006
History of diabetes (%)	4.6	4.4	5.4	9.3	< 0.001

SD, standard deviation.

status and BMI only. Values for p-interaction were calculated for cross-product terms of menopausal status (dichotomous) or BMI (continuous) with TV viewing time (hr/day). We used SAS ver. 9.4 software (SAS Institute Inc., Cary, NC) for the statistical analyses. All statistical tests were 2-tailed and values of $p < 0.05$ were regarded as significant.

4. Ethical statement

Informed consent was obtained from participants asking their will to participate to the JACC study in the baseline questionnaire; but in some areas, it was obtained from the representative of those areas. The ethics committees of Nagoya University School of Medicine and Osaka University approved the protocol of this study.

Results

In 607,295 person years of follow-up for 33,276 women, 247 (170 premenopausal and 77 postmenopausal) cases of breast cancer were newly diagnosed. The most frequent self-reported daily TV viewing time was 2.0 hours among our sample of women, with an average of 2.9 hours. Table 1 shows the baseline characteristics of women according to TV viewing time. Among total women, those with longer TV viewing time were more likely to be older and to have higher BMI, lower educational level and longer daytime napping. They were also more likely to be currently smokers and diabetics and to have high mental stress. Although premenopausal and postmenopausal women showed similar trends

Table 2. Hazard ratios of breast cancer incidence according to television viewing time for total women

	Television viewing time (hr)				p for trend
	< 1.5	1.5 to < 3.0	3 to < 4.5	≥ 4.5	
Person-years	147,018	166,514	216,718	77,045	
Breast cancer	46	58	100	43	
Age-adjusted HR (95% CI)	1.00	1.13 (0.77-1.67)	1.57 (1.11-2.23)	2.03 (1.33-3.09)	< 0.001
Multivariable HR (95% CI) ^{a)}	1.00	0.93 (0.62-1.40)	1.25 (0.86-1.81)	1.55 (0.98-2.46)	0.028
Multivariable HR (95% CI) ^{b)}	1.00	0.89 (0.59-1.34)	1.19 (0.82-1.74)	1.45 (0.91-2.32)	0.053

HR, hazard ratio; CI, confidence interval. ^{a)}Adjusted for age, age of menarche, body mass index, parity, family history of breast cancer, education level, married status, daytime napping, sleep duration, mental stress, alcohol intake, hormone use, smoking status, and history of diabetes, ^{b)}Adjusted further for sport time (never, 1-2, 3-4, and ≥ 5 hr/wk) and walking time (never, < 30, 30-60, and ≥ 60 min/day).

Table 3. Hazard ratios of breast cancer incidence according to television viewing time, stratified by menopausal status and body mass index

	Television viewing time (hr)				p for trend
	< 1.5	1.5 to < 3.0	3 to < 4.5	≥ 4.5	
Premenopausal wom					
Person-years	91,678	104,460	132,916	42,948	
No. of breast cancers	34	44	63	29	
Age-adjusted HR (95% CI)	1.00	1.17 (0.75-1.83)	1.39 (0.91-2.11)	2.13 (1.28-3.53)	0.005
Multivariable HR (95% CI) ^{a)}	1.00	0.88 (0.55-1.41)	0.95 (0.60-1.49)	1.41 (0.80-2.49)	0.388
Multivariable HR (95% CI) ^{b)}	1.00	0.85 (0.58-1.43)	0.91 (0.58-1.43)	1.34 (0.76-2.36)	0.493
Postmenopausal women					
Person-years	55,340	62,053	83,802	34,097	
No. of breast cancers	12	14	37	14	
Age-adjusted HR (95% CI)	1.00	1.04 (0.48-2.25)	2.04 (1.06-3.91)	1.92 (0.88-4.16)	0.015
Multivariable HR (95% CI) ^{a)}	1.00	1.09 (0.45-2.63)	2.49 (1.94-5.20)	2.38 (1.01-5.64)	0.005
Multivariable HR (95% CI) ^{b)}	1.00	1.10 (0.42-2.88)	2.54 (1.11-5.80)	2.37 (0.92-6.10)	0.009
P_{interaction}					0.287
Body mass index < 23.0 kg/m²					
Person-years	91,438	96,675	118,411	40,682	
No. of breast cancers	23	30	50	15	
Age-adjusted HR (95% CI)	1.00	1.26 (0.73-2.17)	1.86 (1.13-3.06)	1.85 (1.13-3.06)	0.009
Multivariable HR (95% CI) ^{a)}	1.00	1.05 (0.59-1.87)	1.68 (1.00-2.83)	1.25 (0.58-2.70)	0.099
Multivariable HR (95% CI) ^{b)}	1.00	1.06 (0.59-1.90)	1.68 (0.98-2.87)	1.24 (0.57-2.72)	0.105
Body mass index ≥ 23.0 kg/m²					
Person-years	55,580	69,838	98,307	36,363	
No. of breast cancers	23	28	50	28	
Age-adjusted HR (95% CI)	1.00	0.99 (0.57-1.72)	1.26 (0.77-2.07)	1.92 (1.10-3.36)	0.018
Multivariable HR (95% CI) ^{a)}	1.00	0.47 (0.12-1.86)	1.92 (0.75-4.89)	1.98 (0.67-5.83)	0.048
Multivariable HR (95% CI) ^{b)}	1.00	0.80 (0.44-1.47)	0.97 (0.56-1.70)	1.26 (0.65-2.44)	0.076
P_{interaction}					0.348

HR, hazard ratio; CI, confidence interval. ^{a)}Adjusted for age, age of menarche, body mass index, parity, family history of breast cancer, education level, married status, daytime napping, sleep duration, mental stress, alcohol intake, hormone use, smoking status and history of diabetes (for postmenopausal women adjusted further for age of menopause, type of menopause), ^{b)}Adjusted further for sport time (never, 1-2, 3-4, and ≥ 5 hr/wk) and walking time (never, < 30, 30-60, and ≥ 60 min/day).

as total women, postmenopausal women who watch TV for longer duration were more likely to have earlier menarche.

With reference to women whose TV viewing time was < 1.5 hr/day, those with longer TV viewing time had a higher risk of breast cancer. The associations were slightly attenuated after controlling for indices of physical activity; sport time per week and walking time per day (Table 2). In total women, the multivariable HRs (95% CIs) of breast cancer in reference to TV viewing time < 1.5 hr/day were 0.89 (0.59-1.34) for 1.5 to < 3.0 hr/day, 1.19 (0.82-1.74) for 3.0 to < 4.5 hr/day, and 1.45 (0.91-2.32) for \geq 4.5 hr/day, but the trend was of a borderline statistical significance (p for trend = 0.053).

Table 3 shows the stratification analyses by menopausal status and BMI. The positive associations between TV viewing time and risk of breast cancer were found only among postmenopausal women: the multivariable HRs (95% CIs) of breast cancer were 1.10 (0.42-2.88) for 1.5 to < 3.0 hr/day, 2.54 (1.11-5.80) for 3.0 to < 4.5 hr/day, and 2.37 (0.92-6.10) for \geq 4.5 hr/day TV viewing time (p for trend = 0.009). We found no significant trend for TV viewing time and breast cancer incidence among premenopausal women (p for trend = 0.493); however, the interaction by menopausal status was also not statistically significant ($p_{\text{interaction}} = 0.287$). On the other hand, baseline BMI levels did not significantly modify the association between TV viewing time and breast cancer incidence (p for trend = 0.105 in women with BMI < 23 kg/m², and p for trend = 0.076 in women with BMI \geq 23 kg/m²) ($p_{\text{interaction}} = 0.348$).

Discussion

In the current study, we observed a positive trend for higher risk of breast cancer incidence across increasing TV viewing time categories with a borderline significance among total women and reached a level of significance among postmenopausal women after adjusting for physical activity and other potential confounders.

In the past few decades, a large number of epidemiological studies have been conducted to elaborate the impact of physical activity [7-10], sedentary time [11-13], and specifically TV viewing time [11] on women's risk of breast cancer. The findings have suggested a protective effect of physical activity against risk of breast cancer [7-10], but non-conclusive findings were reported regarding the impact of sedentary time including TV viewing hours [2,14]. A meta-analysis of 21 studies with 34 reports showed that the odds ratio (ORs) for breast cancer were 1.08 (95% CI, 0.98 to 1.19) for the longest (\geq 9 hr/day) vs. shortest (\leq 1 hr/day) categories of

leisure sedentary behavior including TV viewing time, and 1.10 (95% CI, 1.02 to 1.18) for the longest (\geq 5 hr/day) vs. shortest (\leq 1 hr/day) categories of occupational sedentary behaviour [14]. Schmid and Leitzmann [2] reported in a meta-analysis of 43 observational studies that the relative risks of breast cancer were 1.07 (95% CI, 0.92 to 1.23) for the longest (\geq 9 hr/day) vs. shortest (0 hr/day) TV viewing time categories, and 1.20 (95% CI, 0.98 to 1.48) for the highest (\geq 12 hr/day) vs. lowest (0 hr/day) sitting time categories. The report from the Southern Community Cohort Study showed the OR for risk of breast cancer was 0.97 (95% CI, 0.70 to 1.35; p for trend = 0.31) for \geq 5 hr/day TV viewing time compared with \leq 2 hr/day [7]. In that report, white women in the longest (\geq 12 hr/day) vs. shortest (< 5.5 hr/day) quartiles of sedentary behaviour had higher risk of breast cancer (OR, 2.04; 95% CI, 1.07 to 3.86); however, this association was attenuated slightly after adjusting for physical activity (OR, 1.94; 95% CI, 1.01 to 3.70) [7]. The adjustment for physical activity attenuated the association between longer TV viewing time and risk of breast cancer in total women of our study to a borderline significant trend but the association remained significant in postmenopausal women. Our findings were consistent with the results from a cohort study of African American women which indicated positive trends for breast cancer risk across TV viewing time among total and postmenopausal women, but not among premenopausal women. In reference to watching TV for < 1 hr/day, the multivariable HRs (95% CIs) were 0.89 (0.73-1.09) for 1-2 hr/day, 0.96 (0.79-1.17) for 3-4 hr/day and 1.11 (0.89-1.38) for \geq 5 hr/day in total women (p for trend = 0.04); the respective HRs were 0.83 (0.60-1.14), 0.95 (0.69-1.30), and 1.10 (0.79-1.53) in postmenopausal women (p for trend = 0.05); and 0.80 (0.61-1.05), 0.84 (0.65-1.12), and 1.03 (0.76-1.41) (p for trend = 0.42) in premenopausal women [11].

Several studies have suggested biological pathways (obesity and metabolic dysfunction) by which less active behaviors at occupational and leisure times can associate with augmented risk of breast cancer [16,17]. For example, each hourly increment in TV viewing time was associated with a 0.5 kg/m² higher BMI and 1.18 cm greater waist circumference from the Australian Diabetes, Obesity and Lifestyle (AusDiab) study [17]. Higher levels of adiposity, particularly central adiposity which is common in postmenopausal women due to lack of estrogen [18,19] have been associated with estrogen receptor-positive carcinogenic tumors [19]. In JACC study, weight gain since age 20 was associated with increased risk of breast cancer for postmenopausal women, the multivariable HRs (95% CIs) of breast cancer in reference to weight gain since age 20 for < 3.3 kg were 1.45 (0.78-2.70) for 3.3-6.6 kg, 2.48 (1.40-4.41) for 6.7-9.9 kg, and 2.94 (1.84-4.70) for \geq 10.0 kg (p for trend < 0.001) [20]. Women in the longest TV viewing time category had higher BMI levels, and

in an additional analysis of our data, we found each 1-SD increment of BMI (3.11 kg/m²) was associated with 43% increased risk of breast cancer; yet, interactions with BMI or weight gain since age 20 in the association between TV viewing time and risk of breast cancer were not statistically significant.

The metabolic dysfunctions (higher levels of fasting glucose, C-reactive protein, insulin, and HOMA-IR), that have been evident with longer duration in front of TV [16,17], serve as another biological pathway between TV viewing time and risk of breast cancer. Phosphorylation of both insulin receptor-B and insulin growth factor 1 receptor by insulin binding leads to cellular and tumor growth via the activation of the mitogen-activated protein kinase (MAPK-ERK) pathway [21]. Also, insulin can interact with estrogen to stimulate tumor growth via the estrogen receptor pathway [22]. HOMA-IR, the biomarker of insulin resistance, has been implicated in the development and progression of breast cancer [23]. A study from the Australian Diabetes, Obesity and Lifestyle Study suggested that long TV viewing time can be associated with breast cancer risk by greater HOMA-IR [17]. In our study, since a history of diabetes was more prevalent among women in the longer TV viewing time categories, women viewing TV for longer time may be more likely to have pre-clinical metabolic dysfunctions that enhance the development of breast cancer.

TV viewing has been also associated with higher consumption of unhealthy foods such as fast foods, sugar-sweetened beverages and sweets [24]. Consumption of energy-dense foods and sugary drinks could enhance carcinogenesis not only via promoting weight gain and adiposity [25], but also via increasing circulating levels of insulin-like growth factor 1, sex hormone-binding globulin and estrogen [26]. A case-control study of 1 456 postmenopausal European Americans showed that breast cancer risk was higher with frequent consumptions of energy-dense foods (OR, 2.95; 95% CI, 1.66 to 5.22, for the highest [> 11 times/wk] vs. lowest [≤ 3 times/wk] quartiles of intake), fast foods (OR, 2.35; 95% CI, 1.38 to 4.00, for the highest [> 5 times/wk] vs. lowest [≤ 1 time/wk] quartiles of intake), and sugary drinks (OR, 2.05; 95% CI, 1.13 to 3.70, for > 3 times/wk vs. none) [25]. On the other hand, postmenopausal Japanese women in the highest quartile of vegetable fat intake demonstrated two-fold increase in breast cancer risk (95% CI, 1.05 to 4.13) compared with those in the lowest quartile of intake [27]. Postmenopausal Japanese women in the highest vs. lowest quintiles of westernised dietary pattern had a 29 % increased risk of breast cancer (95% CI, 0.99 to 1.76; p for trend=0.04) [28]. Last, TV viewing time is related to likelihood of smoking initiation [29] that can increase the risk of breast cancer [30]. The proportion of current smokers was higher with longer TV viewing time in the current study.

The strengths of our study were recruiting women from the general population, the large sample size to satisfy the statistical power and the availability of the control for information on other risk factors for breast cancer and potential confounding factors. Moreover, this study was derived from prospective cohort design, which is less subjective to recall and selection bias compared to case-control studies.

There are several limitations in this study: First, because we collected information about menopausal status at the baseline survey, the possibility of misclassification of menopausal status at the onset of breast cancer should be considered. Second, the self-reported nature of both TV viewing time measure and important covariates such as reproductive factors and physical activity, collected only at baseline and not updated during the follow-up is susceptible to reporting error and biases [24]. This may have reduced the true magnitude of the association between the exposure and outcome variables due to regression dilution bias. However, the misclassification would be non-differential regarding the exposure and confounding variables because participants could not foresee subsequent events at baseline. Third, TV viewing time is not always a good indicator of total sedentary time, using a questionnaire covering broad domains of sedentary behaviors such as the IPAQ (the International Physical Activity Questionnaire), which is used widely in international studies is suggested for future studies. Last, in our stratified analysis by BMI, we used 23 kg/m² (the World Health Organization Western Pacific Regional Office criteria for overweight) [31] as a cut-off point instead of the cut off point for obesity in Asians, 25 kg/m² because the median BMI of our sample was 22.98 kg/m² and to assure reasonable number of cases in each category of TV viewing time. However, stratified analysis by 25 kg/m² BMI showed the same results.

In summary, prolonged TV viewing time was associated with increased risk of breast cancer incidence among Japanese women, especially postmenopausal women. Health education to women about the need for shorter TV viewing time is suggested, and further research is needed to confirm the observed associations.

Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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