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# Correlation between radiographic knee osteoarthritis and cigarette smoking in a Korean population

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## Objectives

Although cigarette smoking has been known as a risk factor for degenerative arthritis, recent studies showed a negative correlation between smoking and degenerative arthritis. This study aimed to investigate the correlation of knee radiographic osteoarthritis (ROA) according to smoking amount in general population.

## **Materials and Methods**

This cross-sectional study used public data from the Fifth and Sixth Korean National Health and Nutrition Examination Survey (2010 to 2013). Subjects included 11,638 community-dwelling adults aged ≥50 years. Knee ROA were defined as a Kellgren/Lawrence grade ≥2 on the plain radiographic study. The lifetime cigarette smoking amount was calculated as quartiles in terms of pack-year. Independent correlation of smoking on knee ROA was determined using odds ratios (OR) adjusted for age group, sex, obesity, physical activity, and household income on multivariate logistic regression analysis.

#### Results

Prevalence of knee ROA was 37.3% and lifetime cigarette smokers was 24.0% of the target population. Subjects with knee ROA had higher mean age, female sex ratio, and body mass index in contrast with lower physical activity (Table 1). The adjusted logistic regression model revealed that female sex (OR 2.110, 95% CI 1.895-2.349) was significantly associated knee ROA. Older age, obesity and lower household income showed positive correlations with knee ROA. Second and fourth quartile of smoker had the lower prevalence of ROA compared to never-smoker (OR 0.800, 95% CI 0.643-0.994 and OR 0.812, 95% CI 0.684-0.965) (Table 2).

#### Conclusion

Negative correlation with knee ROA was confirmed only in moderate to high smokers. Prospective studies will be needed to reveal the effect of smoking on knee ROA.

			Radiographic knee OA	<i>P</i> -value*
		( <i>n</i> = 7294)	( <i>n</i> = 4344)	
Age (years)		61.52 ± 8.60	68.36 ± 8.81	<0.001
Sex (Female %)		50.2%	69.4%	<0.001 <sup>†</sup>
Region (Urban %)		76.5%	67.2	0.001 <sup>†</sup>
BMI (kg/m²)		23.62 ± 2.95	24.66 ± 3.33	<0.001
Waist circumference (cm	)	82.41 ± 8.93	84.71 ± 9.28	<0.001
Obesity (%)	Low (BMI < 18.5)	3.3	1.89	<0.001 <sup>†</sup>
	Normal (BMI 18.5-22.9)	38.73	28.89	
	Overweight (BMI 23-24.9)	27.73	25.19	
	Obese I (BMI 25-29.9)	28.15	38.07	
	Obese II (BMI ≥ 30)	2.13	5.96	
Household income (%)	1Q (Low)	24.75	44.07	<0.001 <sup>†</sup>
	2Q (Mid-low)	26.38	24.92	
	3Q (Mid-high)	22.63	16.96	
	4Q (High)	26.25	14.04	
Physical activity (METs/week)		2121.93 ± 3336.29	1848.29 ± 3380.78	<0.001
Physical activity	1Q (Low)	25.61	33.35	<0.001 <sup>†</sup>
_quartile (%)	2Q (Mid-low)	23.79	24.68	
	3Q (Mid-high)	24.46	20.20	
	4Q (High)	26.14	21.77	
Cigarette smoking	Never smoker	74.02	81.94	<0.001 <sup>†</sup>
(%)	1Q (Low)	3.71	3.59	
	2Q (Mid-low)	5.45	3.42	
	3Q (Mid-high)	7.62	4.53	
	4Q (High)	9.20	6.51	

Table 1. Characteristics of subjects by radiographic knee osteoarthritis

OA, osteoarthritis; BMI, body mass index; METs, metabolic equivalents

P value by \*independent T-test and †Chi-square test.

(95% C1)     (95% C1)       Sex     1.000     1.000       Female     6692     2.249 (2.033-2428)     <0.01     2.110 (1.895-2.349)     <0.001       Age     1.000     1.000           50-59     4262     1.000     1.000           60-69     3802     2.753 (2.504-3.047)     <0.011     2.559 (2.648-3.053)     <0.011       70-79     2885     5.616 (5.665-6.227)     <0.010     5.844 (5.171-6.605)     <0.011       280     0.255     9.886 (8.304-11.769)     <0.010     1.0859 (5.01-14.371)     <0.011       Cheshy     314     1.000     1.000           Normal     4044     1.288 (1.01-1.656)     0.49     2.198 (1.560-2.929)     <0.011       Obese 1     3124     1.568 (1.217-2.020)     0.011     3.230 (2.415-4.320)     <0.011       Obese 1     3174     1.020     4.031     4.031     4.031     4.031       Quedwight     3124 <td< th=""><th></th><th>Ν</th><th>Unadjusted OR</th><th>P-value</th><th>Adjusted OR<sup>+</sup></th><th>P-value</th></td<>		Ν	Unadjusted OR	P-value	Adjusted OR <sup>+</sup>	P-value
Sex     Male     4946     1.000     1.000       Female     6692     2.249 (2.083-2.428)     <0.001     2.110 (1.895-2.349)     <0.001       Age     50-59     4326     1.000     1.000       60-69     3802     2.763 (2.504-3.047)     <0.001     2.750 (2.469-3.063)     <0.001       70-79     2885     5.616 (5.065-6.227)     <0.001     5.844 (5.171-6.605)     <0.001       280     625     9.886 (8.304-11.769)     <0.001     1.0855 (9.501-14.371)     <0.001       280     625     9.886 (8.304-11.769)     <0.001     1.0885 (9.501-14.371)     <0.001       Obesity     -     -			(95% CI)		(95% CI)	
Male49461.0001.000Female66922.249 (2.083-2.428)<0.0112.110 (1.895-2.349)<0.011Age50-5943261.0001.00060-6943022.763 (2.504-3.047)<0.0112.570 (2.469-3.063)<0.01170-7928855.616 (5.056-52.27)<0.0115.844 (5.171-6.05)<0.0112806.2629.886 (3.04-11.76)<0.0101.00070-7928855.616 (5.056-52.27)<0.0111.685 (9.501-14.37)<0.01160eshy3141.0001.000<0.001Normal40441.288 (1.011-1656)0.0492.198 (1.550-2.929)<0.001Overweight3141.686 (1.217-2.020)0.0103.230 (2.415-4.320)<0.001Obese I31421.588 (1.617-6.50)<0.013.230 (2.415-4.320)<0.001Obese I31421.383 (3.456-602)<0.013.230 (2.415-4.320)<0.01Obese I31421.383 (3.456-602)<0.013.230 (2.415-4.320)<0.01Obese I31401.600<1.000<0.01<0.01I (Luow)31301.000<1.000<0.01I (Quow)32090.531 (0.420-5.80)<0.01<0.431I (Luow)36371.000<1.001<0.01I (Quow)36471.000<0.01<0.01I (Quow)36970.531 (0.420-5.80)<0.01<0.01I (Quow)36970.301 (3.012, 3.01<0.	Sex					
Female66922.249 (2.083-2.428)<0.0012.110 (1.895-2.349)<0.001Age50-5943281.0001.000 <td>Male</td> <td>4946</td> <td>1.000</td> <td></td> <td>1.000</td> <td></td>	Male	4946	1.000		1.000	
Áge150-594261.001.000160-693022.763 (2.504.304)6.0012.570 (2.469.306)<.0.01	Female	6692	2.249 (2.083-2.428)	<0.001	2.110 (1.895-2.349)	<0.001
50-5943261.0001.00060-6930022.763 (2.504-3.047)<0.01	Age					
b0-6930022.763 (2.504-3.047)<0.012.750 (2.469-3.053)<0.0170-7928555.616 (5.056-6.227)<0.01	50-59	4326	1.000		1.000	
70-79     2885     5.616 (5.065-6.227)     <0.001     5.844 (5.171-6.05)     <0.001       280     625     9.886 (8.304-11.769)     <0.001     11.685 (9.501-14.37)     <0.001       Obesity     .     .     .     .       Low     314     1.000     0.049     2.198 (1.602-9.29)     <0.001       Normal     4044     1.288 (1.017-1.200     0.01     3.230 (2.415-4.320)     <0.01       Overweight     3126     1.568 (1.217-2.020     0.001     4.921 (3.884-6.572)     <0.001       Obese 1     3742     2.335 (1.816-3.001)     <0.001     9.637 (6.747-13.766)     <0.001       Obese 1     412     4.838 (3.545-6.602)     <0.001     9.637 (6.747-13.766)     <0.001       Obese 1     314     1.000     1.000     0.231     <0.001       QC (Mid-low)     3310     1.000     0.932 (0.831-1.046)     0.231       JQ (Mid-ligh)     2660     0.640 (0.577-0.709)     <0.01     0.849 (0.753-0.956)     0.007       JQ (Mid-low)     3677     1.000     1.000     0.010	60-69	3802	2.763 (2.504-3.047)	<0.001	2.750 (2.469-3.063)	<0.001
$\geq 80$ $625$ $9.88(8.304-11.769)$ $< 0.001$ $11.685(9.501-14.371)$ $< 0.001$ <b>Dbesity</b> Low $314$ $1.000$ $1.000$ $< 0.001$ Normal $4044$ $1.288(1.001-1.656)$ $0.049$ $2.188(1.650-2.929)$ $< 0.001$ Ovenweight $3126$ $1.568(1.217-2.020)$ $0.01$ $3.230(2.415-4.320)$ $< 0.001$ Obese I $3726$ $2.335(1.816-3.001)$ $< 0.011$ $4.921(3.684-6.572)$ $< 0.001$ Obese II $412$ $4.383(3.545-6.602)$ $< 0.01$ $4.921(3.684-6.572)$ $< 0.001$ Obese II $412$ $4.383(3.545-6.602)$ $< 0.01$ $4.921(3.684-6.572)$ $< 0.001$ Obese II $412$ $4.383(3.545-6.602)$ $< 0.01$ $4.921(3.684-6.572)$ $< 0.001$ Obese II $412$ $4.383(3.545-6.602)$ $< 0.01$ $4.921(3.684-6.572)$ $< 0.001$ Obese II $412$ $4.383(3.545-6.602)$ $< 0.01$ $4.921(3.684-6.572)$ $< 0.001$ Obese II $412$ $4.383(3.545-6.602)$ $< 0.01$ $0.537(6.747-13.766)$ $< 0.001$ Obese II $612$ $6.301(0.571-0.705)$ $< 0.01$ $0.392(0.631-1.046)$ $0.021$ $2Q$ (Mid-logh) $2669$ $6.301(0.577-0.709)$ $< 0.01$ $1.040(0.928-1.75)$ $< 0.011$ $10$ (Low) $367$ $1.001$ $1.001$ $1.001$ $1.001$ $1.001$ $10$ (Low) $269$ $0.301(0.429-3.635)$ $< 0.01$ $0.503(0.574-0.72)$ $< 0.011$ $10$ (Mid-logh) $2640$	70-79	2885	5.616 (5.065-6.227)	<0.001	5.844 (5.171-6.605)	<0.001
Obesity-Low3141.001.00Normal40441.288 (1.01-1.650)0.0492.198 (1.650-2.92)4.001Oreweight31201.588 (1.27-2.02)0.013.230 (2.415-4.32)4.001Obese I37422.335 (1.816-3.001)4.0014.921 (3.684-6.57)4.001Obese II4.124.388 (3.545-6.62)4.0014.921 (3.684-6.57)4.001Obese II4.124.383 (3.545-6.62)4.0014.921 (3.684-6.57)4.001Obese II4.124.383 (3.545-6.62)4.0016.367 (3.71-3.766)4.001Obese II4.126.383 (3.574-6.57)4.0011.007Obese II5.311.0011.0011.0114.012Obese II5.696.40 (5.77-0.769)4.0011.644 (0.92-81-1.67)0.403Obese II6.634 (0.571-0.769)4.0011.0014.0114.012Obese II6.634 (0.571-0.769)4.0011.0014.011Obese II6.634 (0.571-0.769)4.0011.0014.011Obese II6.634 (0.571-0.769)4.0111.0014.011Obese II5.631.0011.0014.011Obese II5.631.0011.0014.011Obese II6.634 (0.571-0.768)4.0110.761 (0.690-0.851)Obese II6.634 (0.570-0.768)4.0110.761 (0.690-0.851)Obese II6.634 (0.570-0.768)4.0110.761 (0.690-0.851)Obese II6.634 (0.570-0.768)6.011 <td>≥80</td> <td>625</td> <td>9.886 (8.304-11.769)</td> <td>&lt;0.001</td> <td>11.685 (9.501-14.371)</td> <td>&lt;0.001</td>	≥80	625	9.886 (8.304-11.769)	<0.001	11.685 (9.501-14.371)	<0.001
Low3141.0001.000Normal4041.288 (1.001-1.656)0.0492.198 (1.650-2.929)<0.001	Obesity				-	
Normal     4044     1.288 (1.001-1.656)     0.049     2.198 (1.650-2.929)     <.0.01       Overweight     3126     1.568 (1.217-2.020)     0.01     3.230 (2.415-4.320)     <.0.01	Low	314	1.000		1.000	
Overweight     3126     1.568 (1.217-2.020)     0.001     3.230 (2.415-4.320)     <0.001       Obese I     3742     2.335 (1.816-3.001)     <0.001	Normal	4044	1.288 (1.001-1.656)	0.049	2.198 (1.650-2.929)	<0.001
Obese I     3742     2.335 (1.816-3.001)     <0.001     4.921 (3.684-6.572)     <0.001       Obese II     412     4.838 (3.545-6.602)     <0.001	Overweight	3126	1.568 (1.217-2.020)	0.001	3.230 (2.415-4.320)	<0.001
Obese II4124.838 (3.545-6.602)<0.0019.637 (6.747-13.766)<0.001Physical activity1\(\Low)33101.0001.0002\(\Low)33101.0000.932 (0.831-1.046)0.2313\(\Low)26600.634 (0.571-0.705)<0.001	Obese I	3742	2.335 (1.816-3.001)	<0.001	4.921 (3.684-6.572)	<0.001
Physical activity     3310     1.000     1.000       1Q (Low)     3810     0.797 (0.719-0.882)     <0.001	Obese II	412	4.838 (3.545-6.602)	<0.001	9.637 (6.747-13.766)	<0.001
1Q (Low)33101.0001.0002Q (Mid-low)28090.797 (0.719.0.882)<0.01	Physical activity					
2Q (Mid-low)     2809     0.797 (0.719-0.882)     <0.001     0.932 (0.831-1.046)     0.231       3Q (Mid-high)     2660     0.634 (0.571-0.705)     <0.001	1Q (Low)	3310	1.000		1.000	
3Q (Mid-high)   2660   0.634 (0.571-0.705)   <0.001	2Q (Mid-low)	2809	0.797 (0.719-0.882)	<0.001	0.932 (0.831-1.046)	0.231
4Q (High)28590.640 (0.577-0.709)<0.0011.044 (0.928-1.175)0.473Household income1Q (Low)36771.0001.0002Q (Mid-low)29990.531 (0.482-0.584)<0.001	3Q (Mid-high)	2660	0.634 (0.571-0.705)	<0.001	0.849 (0.753-0.956)	0.007
Household income     1.000     1.000       1Q (Low)     3677     1.000     1.000       2Q (Mid-low)     2999     0.531 (0.482-0.584)     <0.001	4Q (High)	2859	0.640 (0.577-0.709)	<0.001	1.044 (0.928-1.175)	0.473
1Q (Low)   3677   1.000   1.000     2Q (Mid-low)   2999   0.531 (0.482-0.584)   <0.001	Household income					
2Q (Mid-low)   2999   0.531 (0.482-0.584)   <0.001	1Q (Low)	3677	1.000		1.000	
3Q (Mid-high)   2407   0.421 (0.379-0.468)   <0.001	2Q (Mid-low)	2999	0.531 (0.482-0.584)	<0.001	0.799 (0.715-0.892)	<0.001
4Q (High)   2555   0.300 (0.269-0.335)   <0.001   0.653 (0.574-0.742)   <0.001     Cigarette smoking           Never smoker   8846   1.000   1.000   1.000      1Q (Low)   449   0.875 (0.719-1.064)   0.179   1.035 (0827-1.294)   0.764     2Q (Mid-low)   569   0.566 (0.470-0.683)   <0.001	3Q (Mid-high)	2407	0.421 (0.379-0.468)	<0.001	0.791 (0.699-0.895)	<0.001
Cigarette smoking     State     State <td>4Q (High)</td> <td>2555</td> <td>0.300 (0.269-0.335)</td> <td>&lt;0.001</td> <td>0.653 (0.574-0.742)</td> <td>&lt;0.001</td>	4Q (High)	2555	0.300 (0.269-0.335)	<0.001	0.653 (0.574-0.742)	<0.001
Never smoker     8846     1.000     1.000       1Q (Low)     449     0.875 (0.719-1.064)     0.179     1.035 (0827-1.294)     0.764       2Q (Mid-low)     569     0.566 (0.470-0.683)     <0.001	Cigarette smoking					
1Q (Low)   449   0.875 (0.719-1.064)   0.179   1.035 (0827-1.294)   0.764     2Q (Mid-low)   569   0.566 (0.470-0.683)   <0.001	Never smoker	8846	1.000		1.000	
2Q (Mid-low) 569 0.566 (0.470-0.683) <0.001 0.800 (0.643-0.994) 0.044	1Q (Low)	449	0.875 (0.719-1.064)	0.179	1.035 (0827-1.294)	0.764
	2Q (Mid-low)	569	0.566 (0.470-0.683)	<0.001	0.800 (0.643-0.994)	0.044
3Q (Mid-high) 780 0.537 (0.457-0.632) <0.001 0.835 (0.688-1.013) 0.068	3Q (Mid-high)	780	0.537 (0.457-0.632)	<0.001	0.835 (0.688-1.013)	0.068
4Q (High) 994 0.640 (0.556-0.736) <0.001 0.812 (0.684-0.965) 0.018	4Q (High)	994	0.640 (0.556-0.736)	<0.001	0.812 (0.684-0.965)	0.018

# Table 2. Odds Ratios of radiographic knee osteoarthritis

\*Unadjusted odds ratios by logistic regression analysis.

<sup>†</sup>Adjusted odds ratios by multivariate logistic regression analysis; adjusted for all other variables