

Risk of incident stroke and heart disease subtypes in a nationwide cohort of Korean radiation workers¹

by Eun Shil Cha, PhD, Kyunghee Chae, PhD, Haesu Jeong, MS, Dalnim Lee, PhD, Soojin Park, PhD, Ga Bin Lee, PhD, Minsu Cho, MD, PhD, Hyeonseok Nam, MD, Songwon Seo, PhD²

1. Supplementary material
2. Correspondence to: Songwon Seo, National Radiation Emergency Medical Center, Korea Institute of Radiological and Medical Sciences, 75 Nowon-gil, Nowon-gu, Seoul, 01812, Republic of Korea. [E-mail: seo@kiram.s.re.kr]

Supplementary Table S1. Procedure and diagnostic insurance claim codes related to stroke and IHD/AMI

Diagnostic test or procedures	Insurance claim code
Stroke-related imaging tests	(CT) HA441, HA451, HA461, HA511, HA521, HA531, HA551, HA561, HA471, HA851 (MRI) HE101, HE102, HE135, HE136, HE501, HE502, HE535, HE201, HE235, HE236, HE301, HE302, HE401, HE202, HE402, HF101, HF102, HF201, HF202, HF103, HF104, HF105, HF106, HF107, HF203, HF305, HF306, HI101, HI135, HI201, HI235, HI301, HI401, HI501, HI535, HJ101, HJ135, HJ201, HJ235, HJ301, HJ401, HJ501, HJ535, HJ601, HJ635, HJ701, HJ735 (Cerebral angiography) HA601, HA602, HA603, HA604, HA605
Stroke-related procedures	(Percutaneous thrombectomy) M6630, M6631, M6632, M6633
IHD/AMI-related diagnostic tests	(Coronary angiography) HA670, HA680, HA681, HA682
IHD/AMI-related procedures	(Percutaneous Coronary Intervention, PCI) M6551, M6552, M6553, M6554, M6561, M6562, M6563, M6564, M6565, M6566, M6567, M6571, M6572 (Percutaneous thrombectomy) M6633, M6634 (Coronary Artery Bypass Graft, CABG) O1641, O1642, O1647, O1648, O1649, OA640, OA641, OA642, OA647, OA648, OA649
Laboratory data	(Creatine kinase-MB, Troponin levels) B2640, C3941, C3942, CY277, CY278, CY279, D4040, D4023, D4021, D402

IHD: ischemic heart disease, AMI: acute myocardial infarction

Supplementary Table S2. Distribution of non-radiation risk factors among the total study population and by subtypes of circulatory diseases

	Total population	IS	HS	IHD	AMI	VHD	HF
	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Population at risk	186 233 (100.0)	186 030 (100.0)	186 079 (100.0)	184 522 (100.0)	185 908 (100.0)	185 966 (100.0)	185 559 (100.0)
Cases	-	1888	775	8562	1713	788	5892
Income ^a							
Missing	330 (0.2)	2 (0.1)	1 (0.1)	7 (0.1)	3 (0.2)	2 (0.2)	7 (0.1)
Low	34 556 (18.6)	379 (19.8)	166 (21.1)	1431 (15.9)	333 (18.8)	118 (14.1)	1038 (17.3)
Medium	66 423 (35.7)	635 (33.2)	268 (34.0)	2656 (29.5)	522 (29.5)	241 (28.8)	1861 (31.1)
High	84 924 (45.6)	895 (46.8)	353 (44.8)	4913 (54.5)	914 (51.6)	476 (56.9)	3079 (51.4)
Smoking							
Missing	17 304 (9.3)	203 (10.6)	113 (14.3)	542 (6.0)	160 (9.0)	53 (6.3)	413 (6.9)
Never	75 796 (40.7)	631 (33.0)	247 (31.3)	3057 (33.9)	517 (29.2)	392 (46.8)	2148 (35.9)
Former	24 015 (12.9)	278 (14.5)	109 (13.8)	1491 (16.6)	252 (14.2)	136 (16.2)	938 (15.7)
Current	69 118 (37.1)	799 (41.8)	319 (40.5)	3917 (43.5)	843 (47.6)	256 (30.6)	2486 (41.5)
BMI							
Missing	17 253 (9.3)	203 (10.6)	112 (14.2)	539 (6.0)	161 (9.1)	53 (6.3)	410 (6.9)
< 18.5	6 536 (3.5)	27 (1.4)	13 (1.6)	163 (1.8)	24 (1.4)	27 (3.2)	119 (2.0)
18.5-24.9	107 236 (57.6)	1009 (52.8)	395 (50.1)	4726 (52.5)	854 (48.2)	483 (57.7)	3098 (51.8)
25.0-29.9	47 781 (25.7)	604 (31.6)	231 (29.3)	3176 (35.3)	653 (36.9)	246 (29.4)	2023 (33.8)
≥ 30.0	7427 (4.0)	68 (3.6)	37 (4.7)	403 (4.5)	80 (4.5)	28 (3.3)	335 (5.6)
Blood pressure ^b							
Missing	17 261 (9.3)	205 (10.7)	112 (14.2)	544 (6.0)	160 (9.0)	53 (6.3)	414 (6.9)
Normal	63 554 (34.1)	327 (17.1)	140 (17.8)	1925 (21.4)	340 (19.2)	196 (23.4)	1291 (21.6)
Pre-hypertension	82 941 (44.5)	789 (41.3)	319 (40.5)	4048 (44.9)	774 (43.7)	363 (43.4)	2664 (44.5)
Hypertension	22 477 (12.1)	590 (30.9)	217 (27.5)	2490 (27.6)	498 (28.1)	225 (26.9)	1616 (27.0)
Blood glucose (mg/L)							
Missing	17 261 (9.3)	204 (10.7)	112 (14.2)	544 (6.0)	159 (9.0)	53 (6.3)	415 (6.9)
< 100	128 795 (69.2)	1000 (52.3)	447 (56.7)	5482 (60.9)	992 (56.0)	570 (68.1)	3624 (60.6)
100~125	34 236 (18.4)	475 (24.9)	175 (22.2)	2194 (24.4)	422 (23.8)	168 (20.1)	1444 (24.1)
≥ 126	5941 (3.2)	232 (12.1)	54 (6.9)	787 (8.7)	199 (11.2)	46 (5.5)	502 (8.4)

^a0(medical aid and beneficiary)–6th quantile of insurance amount, low; 7th–13th quantiles, medium; and 14th–20th quantiles, high.

^b<120 mm Hg of systolic BP and <80 mm Hg for diastolic BP, normal; 120–140 mm Hg of systolic BP or 80–90 mm Hg for diastolic BP, pre-hypertension; and ≥140 mm Hg of systolic BP or ≥90 mm Hg for diastolic BP, hypertension

IS: ischemic stroke, HS: hemorrhagic stroke, IHD: ischemic heart disease, AMI: acute myocardial infarction, VHD: valvular heart disease, HF: heart failure, BMI: body mass index

Supplementary Table S3. Relative rate (RR)^a and excess relative risk (ERR)^b for combined stroke and heart disease outcomes by cumulative heart or brain absorbed dose (10-year lag)

	Stroke		Heart disease	
Cases	2481		12 836	
Person-years	2 398 240		2 387 123	
Cumulative dose (mGy)	RR	95% CI	RR	95% CI
0	1		1	
≤ 1	0.82	0.74–0.92	0.87	0.83–0.91
>1–2.5	0.84	0.73–0.95	0.84	0.79–0.89
>2.5–5.0	0.85	0.74–0.99	0.84	0.78–0.89
>5.0–10.0	0.96	0.83–1.12	0.86	0.80–0.92
>10.0–20.0	0.86	0.71–1.04	0.85	0.77–0.92
>20.0–50.0	0.96	0.77–1.19	0.87	0.78–0.96
>50.0	0.83	0.60–1.15	0.84	0.72–0.97
	ERR	95 % CI	ERR	95 % CI
ERR per 10 mGy with 10-y lagged	-0.008	-0.040–0.023	-0.016	-0.228–0.002

^aAdjusted for sex, attained age, calendar year, and birth year

^bEstimates based on linear model, adjusted for sex, attained age, calendar year, and birth year

Supplementary Table S4. Estimated dose coefficients in linear (per 10 mGy with 10-y lagged) and linear-quadratic ERR^a models for circulatory disease subtypes

	Linear		Linear quadratic				P-value
			Linear		Quadratic		
	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI	
IS	-0.016	-0.050–0.018	-0.020	-0.117–0.077	0.005	-0.114–0.124	> 0.50
HS	0.014	-0.049–0.076	0.094	-0.079–0.266	-0.115	-0.330–0.101	0.283
IHD	-0.008	-0.025–0.009	-0.054	-0.099– -0.010	0.065	0.007–0.123	0.028
AMI	-0.013	-0.049–0.023	-0.056	-0.152–0.041	0.059	-0.066–0.184	0.344
VHD	-0.019	-0.075–0.037	-0.043	-0.196–0.109	0.033	-0.162–0.228	> 0.50
HF	-0.020	-0.039– -0.001	-0.073	-0.125– -0.021	0.071	0.004–0.137	0.035

^aAdjusted for sex, attained age, calendar year, and birth year

Supplementary Table S5. Risks for circulatory disease subtypes by working duration

	IS		HS		IHD		AMI		VHD		HF	
	SIR	95% CI	SIR	95% CI	SIR	95% CI	SIR	95% CI	SIR	95% CI	SIR	95% CI
Full cohort	0.73	0.70–0.77	0.70	0.65–0.75	0.96	0.93–0.98	0.90	0.85–0.95	0.98	0.91–1.06	0.89	0.86–0.91
Duration < 1 year (mean dose: heart 0.87, brain 0.85 mGy)	0.94	0.87–1.01	0.93	0.83–1.04	1.07	1.03–1.11	1.04	0.96–1.13	1.10	0.97–1.25	1.00	0.96–1.05
Duration ≥ 1 year (mean dose: heart 5.81, brain 5.53 mGy)	0.63	0.59–0.67	0.58	0.53–0.65	0.90	0.87–0.92	0.82	0.77–0.88	0.92	0.84–1.02	0.83	0.80–0.86
	ERR ^a per 10 mGy	95% CI	ERR ^a per 10 mGy	95% CI	ERR ^a per 10 mGy	95% CI	ERR ^a per 10 mGy	95% CI	ERR ^a per 10 mGy	95% CI	ERR ^a per 10 mGy	95% CI
Full cohort	-0.02	-0.05–0.02	0.01	-0.05–0.08	-0.01	-0.03–0.01	-0.01	-0.05–0.02	-0.02	-0.08–0.04	-0.02	-0.04–0.001
Duration < 1 year (mean dose: heart 0.87, brain 0.85 mGy)	0.34	-0.13–0.80	0.40	-0.29–1.08	-0.06	-0.11–0.02	-0.06	-0.22–0.10	-0.05	-0.54–0.44	-0.06	-1.16–0.10
Duration ≥ 1 year (mean dose: heart 5.81, brain 5.53 mGy)	0.02	-0.02–0.07	0.07	-0.02–0.15	0.01	-0.01, 0.03	0.002	-0.04–0.04	-0.01	-0.07–0.05	-0.01	-0.03–0.02

^aEstimates based on linear model, adjusted for sex, attained age, calendar year, and birth year

IS: ischemic stroke, HS: hemorrhagic stroke, IHD: ischemic heart disease, AMI: acute myocardial infarction, VHD: valvular heart disease, HF: heart failure, ERR: excess relative risk, SIR: standardized incidence ratio, CI: confidence interval