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Supplementary Materials for

Genomic mapping in outbred mice reveals overlap in genetic susceptibility for HZE ion– and γ-ray–induced tumors

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Table S1. Tumor histotypes and incidence for HS/Npt mice exposed by radiation exposure group.

	Total ♂ = 934 ♀ = 916 n = 1850	**HZE** ♂ = 312 ♀ = 310 n = 622	**γ** ♂ = 313 ♀ = 302 n = 615	**Unirradiated** ♂ = 309 ♀ = 304 n = 613	**HZE Fe** ♂ = 161 ♀ = 153 n = 314	**HZE Si** ♂ = 151 ♀ = 157 n = 308	M:F
Epithelial							
Thyroid							
Follicular Adenoma	43	21	13	9	12	9	21:22
Follicular Carcinoma	5	2	2	1	2	0	2:3
Parathyroid Adenoma	2	0	2	0	0	0	1:1
Ovary							
Granulosa Cell Tumor	45	3	42	0	3	0	0:45
Tubulostromal Adenoma	15	0	15	0	0	0	0:13
Tubulostromal Adenocarcinoma	2	0	2	0	0	0	0:2
Ovarian Carcinoma	2	0	0	2	0	0	0:2
Luteoma	2	1	1	0	0	1	0:2
Thecoma	1	1	0	0	0	1	0:1
Ovarian Cystadenoma	1	0	1	0	0	0	0:1
Dysgerminoma	1	1	0	0	1	0	0:1
Uterus							
Uterine Stromal Sarcoma	6	3	3	0	1	2	0:6
Endometrial Papillary Adenoma	1	0	0	1	0	0	0:1
Endometrial Stromal Polyp	16	12	2	2	4	8	0:16
Mammary Gland							
Adenocarcinoma	28	11	12	5	3	8	2:26
Adenoacanthoma	4	1	0	3	0	1	0:4
Carcinosarcoma	1	0	1	0	0	0	0:1
Pulmonary							
Pulmonary Adenoma	228	60	88	80	34	26	151:77
Pulmonary Adenocarcinoma	353	128	110	115	64	64	243:110
Hepatic							
Hepatocellular Adenoma	314	126	94	94	68	58	218:96
Hepatocellular Carcinoma	251	100	66	85	57	43	187:64
Hepatoblastoma	6	1	4	1	0	1	5:1
Biliary Cystadenoma	9	5	4	0	2	3	9:0
Cholangiocellular Carcinoma	2	0	1	1	0	1	2:0
Harderian Gland							
Adenoma	219	121	77	21	67	54	124:95
Adenocarcinoma	41	20	17	4	10	10	20:21
Unilateral Neoplasm	209	109	80	20	57	52	117:92
Bilateral Neoplasms	51	32	14	5	20	12	27:24
Gastrointestinal Tract							
Adenocarcinoma	3	1	1	1	0	1	0:3
Gastric SCC	2	2	0	0	1	1	1:1
Duodenal Polyp	12	8	3	1	6	2	8:4
Colonic Polyp	1	0	1	0	0	0	1:0
Gastric Adenocarcinoma	1	0	0	1	0	0	1:0

	Total ♂ = 934 ♀ = 916 n = 1850	HZE ♂ = 312 ♀ = 310 n = 622	γ ♂ = 313 ♀ = 302 n = 615	Unirradiated ♂ = 309 ♀ = 304 n = 613	HZE Fe ♂ = 161 ♀ = 153 n = 314	HZE Si ♂ = 151 ♀ = 157 n = 308	M:F
Gastric Polyp	1	0	1	0	0	0	0:1
Other							
Salivary Gland Carcinoma	1	0	1	0	0	0	1:0
Squamous Cell Carcinoma (lingual or laryngeal)	3	1	1	1	1	0	1:2
Squamous Cell Carcinoma (haired skin)	3	1	2	0	1	0	3:0
Adrenocortical Carcinoma	3	3	0	0	2	1	2:1
Pheochromocytoma	3	3	0	0	2	1	0:3
Renal Cell Carcinoma	3	1	1	1	0	1	3:0
Renal Adenoma	1	0	1	0	0	0	1:0
Islet Cell Carcinoma	2	2	0	0	1	1	1:1
Odontogenic Tumor	2	1	1	0	1	0	0:2
Mesothelioma	2	1	1	0	0	1	0:2
Pilomatricoma	1	0	1	0	0	0	1:0
Papillary Adenoma (gall bladder)	1	0	0	1	0	0	1:0
Sebaceous adenoma (skin)	2	1	1	0	0	1	2:0
Basal Cell Carcinoma (skin)	3	1	1	0	1	0	2:1
Nervous							
Pituitary Adenoma	40	15	22	3	10	5	9:31
Pituitary Adenocarcinoma	1	1	0	0	1	0	1:0
Meningioma	2	0	1	1	0	0	1:1
Astrocytoma	1	1	0	0	1	0	1:0
Choroid Plexus Tumor	3	1	2	0	1	0	0:3
Glial Tumor, Olfactory Lobe	1	0	1	0	0	0	1:0
Ependymoma	2	1	1	0	1	0	0:2
Messenchymal							
Hematopoietic System							
Lymphoid	570	172	195	203	84	88	274:307
Follicular B cell	209	66	59	84	34	32	101:108
Diffuse Large B cell	120	39	38	43	20	19	56:64
Lymphoblastic B cell	81	24	16	41	12	12	38:43
Histiocyte Associated B cell	13	3	3	7	1	2	3:10
Anaplasstic Plasmacytoma	4	1	2	1	0	1	2:2
Small B cell	13	6	4	3	2	4	6:7
Marginal Zone B cell	5	3	1	1	2	1	3:2
Precursor T cell	82	13	61	8	6	7	40:42
Small T cell	5	2	1	2	2	0	1:4
Anaplastic T cell	9	4	5	0	0	4	3:6
Other	29	11	5	13	5	6	14:15
Myeloid leukemia	124	18	96	10	5	13	86:38
Histiocytic Sarcoma	37	12	11	14	4	8	21:16
Osteosarcoma	19	12	6	1	8	4	4:14
Osteoma	7	1	3	3	1	0	2:6

	Total ♂ = 934 ♀ = 916 n = 1850	**HZE** ♂ = 312 ♀ = 310 n = 622	**γ** ♂ = 313 ♀ = 302 n = 615	**Unirradiated** ♂ = 309 ♀ = 304 n = 613	**HZE Fe** ♂ = 161 ♀ = 153 n = 314	**HZE Si** ♂ = 151 ♀ = 157 n = 308	M:F
Soft Tissue Sarcoma							
Rhabdomyosarcoma	14	4	4	6	2	2	4:10
Fibrosarcoma	4	2	1	1	2	0	3:1
Hemangiosarcoma	76	32	18	26	16	16	42:34
Hemangioma	22	14	4	4	7	7	31:9
Undifferentiated	29	14	4	11	5	9	5:24
Myxosarcoma	6	1	2	3	0	1	0:6
Myxoma	1	0	0	1	0	0	0:1
Leiomyosarcoma	11	6	2	3	3	3	3:8
Leiomyoma	1	1	0	0	0	1	0:1
Nerve Sheath Tumor	1	1	0	0	1	0	1:0
GIST	4	2	1	1	1	1	3:1
Liposarcoma	1	1	0	0	0	1	1:0

Table S2. Genome wide association mapping loci for tumor incidence in HS/Npt mice.

Phenotype	Group	Chr	Max LOD	QTL	QTL 95% Confidence Interval			Percent Variance Explained (Tjur)	Model	Covariates
					Position (BP)		Confidence Interval (Mb)			
B-cell Lymphoma	All mice	1	10.999	73732062.5	73494384	74262978.7	0.77	2.48	glm(binomial, link = "logit")	Sex
BLL Lymphoma	All mice	1	6.420	74343073	73443080	78299617	4.86	1.28	glm(binomial, link = "logit")	Sex
Thyroid adenoma	All mice	1	6.079	73078474	71335224	74931530	3.60	2.35	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Unirradiated	1	6.318	74938971	73640888.9625	77001094.4125	3.36	4.02	glm(binomial, link = "logit")	Sex
Thyroid adenoma	All Irradiated	2	10.836	122584526	120236421	124006948	3.77	4.11	glm(binomial, link = "logit")	Sex
AML	All Irradiated	2	6.995	147914389	147828068.8375	148316130	0.49	5.82	glm(binomial, link = "logit")	Sex
Hepatocellular Carcinoma	All Irradiated	2	6.386	123223410	119805949	124476777.9625	4.67	5.65	glm(binomial, link = "logit")	Sex
Thyroid adenoma	All mice	2	11.204	121483195	120236421	124006948	3.77	3.14	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	All mice	2	8.300	155646718	151758335.85	159294061.825	7.54	2.06	glm(binomial, link = "logit")	Sex
Hepatocellular Carcinoma	All mice	2	6.291	117964768	115943082.975	120564786	4.62	5.37	glm(binomial, link = "logit")	Sex
Thyroid adenoma	HZE	2	7.803	123357336.5	120345725	124006948	3.66	7.00	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Unirradiated	2	6.495	152492554	152492554	155646718	3.15	4.26	glm(binomial, link = "logit")	Sex
PreT Lymphoma	All mice	3	6.095	29822410	28532178.6	33271823.8375	4.74	0.75	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Unirradiated	3	7.436	33476536	32159146	33781730.45	1.62	5.47	glm(binomial, link = "logit")	Sex
PreT Lymphoma	All Irradiated	4	7.085	82878119	82243458	86141326	3.90	3.20	glm(binomial, link = "logit")	Sex
PreT Lymphoma	All mice	4	6.814	82878119	82098201	85953208.2125	3.86	2.10	glm(binomial, link = "logit")	Sex
PreT Lymphoma	Gamma	4	8.413	89196864	85649328	90387054.5	4.74	7.46	glm(binomial, link = "logit")	Sex
PreT Lymphoma	Gamma	4	8.413	96173703	96168780	98871254	2.70	7.46	glm(binomial, link = "logit")	Sex
PreT Lymphoma	Gamma	4	8.131	82622922	82622922	85884363.4	3.26	7.46	glm(binomial, link = "logit")	Sex
BLL Lymphoma	All Irradiated	5	6.848	107760474	106744777.375	107900411	1.16	1.65	glm(binomial, link = "logit")	Sex
Thyroid adenoma	All Irradiated	5	5.850	142141592	142141592	144401281.675	2.26	1.80	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	All mice	5	6.020	107350502	105230836.5	108062273.5625	2.83	1.45	glm(binomial, link = "logit")	Sex
Thyroid adenoma	All mice	5	5.986	142141592	142050181	144399143	2.35	1.25	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Unirradiated	5	5.848	7075383	5683053	8167587.775	2.48	3.97	glm(binomial, link = "logit")	Sex
BLL Lymphoma	All Irradiated	6	6.428	116924770	115490532.1	120212740	4.72	1.98	glm(binomial, link = "logit")	Sex
Pulmonary adenocarcinoma	All Irradiated	6	6.050	148261935	146889257.5	149577033	2.69	4.84	glm(binomial, link = "logit")	Sex
Amyloidosis	All mice	6	5.780	136702296	134007207	136963345	2.96	2.48	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	All mice	8	6.665	72479016.5	70639782.6	74664266	4.02	1.63	glm(binomial, link = "logit")	Sex
Hepatocellular Carcinoma	All mice	8	6.546	30794428	29984337.3	33252747.4	3.27	5.28	glm(binomial, link = "logit")	Sex
Amyloidosis	All Irradiated	9	6.162	35893111	33739192.1875	36832676	3.09	3.96	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	All mice	9	7.860	62452601.5	61606150.875	62993849.175	1.39	1.90	glm(binomial, link = "logit")	Sex
FBL Lymphoma	All mice	9	6.581	122891663	122867671.575	122891663	0.02	0.84	glm(binomial, link = "logit")	Sex
Thyroid adenoma	All mice	9	5.801	3455888	3455888	4254190.5	0.80	1.55	glm(binomial, link = "logit")	Sex
Harderian adenocarcinoma	HZE	9	6.018	102809143	101334669.45	105635973	4.30	2.78	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Unirradiated	9	6.903	75346491	74206387.6375	77507836	3.30	4.82	glm(binomial, link = "logit")	Sex
Thyroid adenoma	HZE	10	5.777	47711287.5	46090331.85	50595803	4.51	5.22	glm(binomial, link = "logit")	Sex
Mammary adenocarcinoma	All Irradiated	11	6.175	111549311	110639949.5	113855208	3.22	4.55	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Gamma	11	6.286	88759037	86219353	90177534	3.96	6.22	glm(binomial, link = "logit")	Sex
Pulmonary adenocarcinoma	All mice	14	6.249	97084001	94070480	99894015.5375	5.82	4.84	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	All mice	15	7.901	98143056	95982213.7	98755939	2.77	1.93	glm(binomial, link = "logit")	Sex
AML	All mice	15	6.312	91425908	88406017.6	94424358.6	6.02	2.98	glm(binomial, link = "logit")	Sex
Hepatocellular Carcinoma	All mice	15	6.146	94246099	90919680.8875	97184622	6.26	5.31	glm(binomial, link = "logit")	Sex
B-cell Lymphoma	Unirradiated	15	6.814	98556922	95073624.6	98745723.575	3.67	4.84	glm(binomial, link = "logit")	Sex
Osteosarcoma	All Irradiated	17	5.962	71019344	69377022	71474706	2.10	2.49	glm(binomial, link = "logit")	Sex
FBL Lymphoma	All Irradiated	17	5.805	86662315	85568114.525	88783444	3.22	2.59	glm(binomial, link = "logit")	Sex
Osteosarcoma	All mice	17	6.013	70394500	69377022	71474706	2.10	1.68	glm(binomial, link = "logit")	Sex
DLBCL Lymphoma	Gamma	17	6.744	83589501	83534674	85336592	1.80	5.76	glm(binomial, link = "logit")	Sex
PreT Lymphoma	Gamma	17	6.154	48674981	48649945	53188104.5	4.54	5.01	glm(binomial, link = "logit")	Sex
Harderian adenoma	HZE	17	5.976	45427448	44081080.2125	45661990.15	1.58	4.43	glm(binomial, link = "logit")	Sex
DLBCL Lymphoma	Gamma	18	6.530	82809869	80244031.5	86347428.35	6.10	4.76	glm(binomial, link = "logit")	Sex

Table S3. Genome wide association mapping loci for tumor latency in HS/Npt mice.

Phenotype	Group	Chr	Max LOD	QTL (BP)	QTL 95% Confidence Interval			Percent Variance Explained	Hazard for BB compared to AA Genotype				R^2	Model	Covariates
					Position (BP)		Size (Mb)		Hazard	Hazard Ratio	Standard Error	Pr(>|z|)			
B-cell Lymphoma	**All irradiated**	**1**	**6.193**	73675331	73644645.5	76156729	2.51	2.339	-0.793	0.453	0.340	0.020	0.023	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**1**	**11.885**	73732062.5	73644645.5	75527460.5	1.88	2.911	-1.004	0.366	0.293	0.001	0.029	coxph(surv ~ addcovar)	Sex
BLL Lymphoma	**All mice**	**1**	**7.036**	74343073	73443080	78275804.0875	4.83	1.286	2.625	13.807	1.009	0.009	0.013	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Gamma**	**1**	**5.940**	154533061	154053089.1375	157068396	3.02	3.821	1.277	3.588	0.279	0.000	0.038	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Unirradiated**	**1**	**7.512**	73671405.5	73494384	76186572.5	2.69	5.113	-1.229	0.292	0.272	0.000	0.051	coxph(surv ~ addcovar)	Sex
AML	**All irradiated**	**2**	**6.547**	148081727	147808999	148316130	0.51	2.289	3.553	34.904	0.728	0.000	0.023	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All irradiated**	**2**	**6.216**	119093112	116762788	122163058	5.40	1.580	-1.350	0.259	0.710	0.057	0.016	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All irradiated**	**2**	**5.991**	123096335	120896801	125682132.925	4.79	1.719	-0.841	0.431	0.456	0.065	0.017	coxph(surv ~ addcovar)	Sex
Thyroid adenoma	**All irradiated**	**2**	**7.574**	122584526	120235551.9875	124006948	3.77	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**2**	**8.309**	155646718	151688481	159364801.15	7.68	1.877	0.729	2.073	0.142	0.000	0.019	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All mice**	**2**	**7.922**	116811190	115944687	118326331	2.38	1.516	-1.437	0.238	0.582	0.013	0.015	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All mice**	**2**	**6.150**	106661333	105153951	106750991	1.60	1.243	0.721	2.056	0.169	0.000	0.012	coxph(surv ~ addcovar)	Sex
Thyroid adenoma	**All mice**	**2**	**9.948**	120418990.5	120236421	123716967	3.48	2.212	2.431	11.372	0.455	0.000	0.022	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Unirradiated**	**2**	**6.419**	152243135	151688481	155646718	3.96	4.418	-1.058	0.347	0.214	0.000	0.044	coxph(surv ~ addcovar)	Sex
Harderian Tumor	**All mice**	**3**	**5.997**	23109161	19658371	27013788	7.36	1.442	0.965	2.624	0.182	0.000	0.014	coxph(surv ~ addcovar)	Sex
Harderian adenocarcinoma	**All irradiated**	**4**	**6.706**	15987949	15232129	16503035.45	1.27	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
PreT Lymphoma	**All irradiated**	**4**	**7.339**	82622922	82336059.4	85649328	3.31	2.396	1.989	7.309	0.339	0.000	0.024	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**4**	**7.727**	149549045.5	148766129.5	152805928	4.04	1.954	-0.730	0.482	0.273	0.007	0.020	coxph(surv ~ addcovar)	Sex
Harderian adenocarcinoma	**All mice**	**4**	**6.894**	16498679	15232129	16672937	1.44	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
PreT Lymphoma	**All mice**	**4**	**6.884**	82622922	81987887.5	86145148.9	4.16	1.518	1.863	6.446	0.321	0.000	0.015	coxph(surv ~ addcovar)	Sex
PreT Lymphoma	**Gamma**	**4**	**8.413**	89196864	85649328	90387054.5	4.74	5.453	2.243	9.423	0.357	0.000	0.055	coxph(surv ~ addcovar)	Sex
PreT Lymphoma	**Gamma**	**4**	**8.413**	96173703	95289711	98770176	3.48	5.453	2.243	9.423	0.357	0.000	0.055	coxph(surv ~ addcovar)	Sex
PreT Lymphoma	**Gamma**	**4**	**8.131**	82622922	82622922	85949860	3.33	5.453	2.243	9.423	0.357	0.000	0.055	coxph(surv ~ addcovar)	Sex
Harderian adenocarcinoma	**HZE**	**4**	**6.026**	16498679	15232129	16896271	1.66	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**5**	**8.653**	31249669.5	30911677	31286278	0.37	2.148	-0.919	0.399	0.149	0.000	0.021	coxph(surv ~ addcovar)	Sex
Harderian Tumor	**All mice**	**5**	**6.383**	39081520	37450602.3875	41615415	4.16	1.366	0.932	2.539	0.183	0.000	0.014	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All mice**	**5**	**6.219**	38483317	37535263	40555253	3.02	1.216	1.029	2.798	0.226	0.000	0.012	coxph(surv ~ addcovar)	Sex
PreT Lymphoma	**Gamma**	**5**	**5.819**	139776662	135811213	141609050	5.80	4.169	-17.453	0.000	2363.034	0.994	0.042	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Unirradiated**	**5**	**6.499**	31286278	30527389.1375	31331455.5875	0.80	4.328	-1.156	0.315	0.235	0.000	0.043	coxph(surv ~ addcovar)	Sex
BLL Lymphoma	**All irradiated**	**6**	**6.316**	116425643	115696271.6	119462570	3.77	1.995	-18.749	0.000	4031.944	0.996	0.020	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All irradiated**	**6**	**7.055**	92859721	92631195.5	94131082	1.50	2.232	-2.294	0.101	1.004	0.022	0.022	coxph(surv ~ addcovar)	Sex
Harderian Tumor	**All irradiated**	**7**	**6.241**	112491829	109861463	115478241	5.62	2.232	-0.808	0.446	0.208	0.000	0.022	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All irradiated**	**7**	**7.482**	112130962	111094882	113740999	2.65	2.304	1.243	3.464	0.269	0.000	0.023	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**7**	**7.623**	140480630	137126507	143776516.6375	6.65	1.617	-0.990	0.372	0.273	0.000	0.016	coxph(surv ~ addcovar)	Sex
Harderian adenoma	**All mice**	**7**	**5.833**	113864569	110698131	116131134.7875	5.43	1.152	-0.698	0.498	0.203	0.001	0.012	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All mice**	**7**	**6.079**	113659296	109979745	113740999	3.76	1.317	0.828	2.289	0.198	0.000	0.013	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Gamma**	**7**	**7.211**	40246302	40078510	40371104	0.29	5.793	2.165	8.715	0.343	0.000	0.058	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All irradiated**	**8**	**6.081**	71333049	71030886.825	73078950	2.05	1.963	0.858	2.359	0.189	0.000	0.020	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**8**	**7.601**	72326900	70783484.5	74167817.1375	3.38	1.719	0.732	2.079	0.140	0.000	0.017	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All irradiated**	**9**	**7.452**	77651694	74262311.5	80174106	5.91	2.714	-0.993	0.371	0.185	0.000	0.027	coxph(surv ~ addcovar)	Sex
DLBCL Lymphoma	**All irradiated**	**9**	**5.896**	61740072	60199542	64717662	4.52	2.048	-2.144	0.117	0.722	0.003	0.020	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All irradiated**	**9**	**6.188**	42454683	42218208	43296200.4875	1.08	2.140	0.486	1.626	0.583	0.405	0.021	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**9**	**13.490**	77651694	74261739.7375	80174106	5.91	3.157	-1.042	0.353	0.139	0.000	0.032	coxph(surv ~ addcovar)	Sex
DLBCL Lymphoma	**All mice**	**9**	**6.954**	61740072	60264034	64268841.9375	4.00	1.764	-2.161	0.115	0.589	0.000	0.018	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Gamma**	**9**	**7.143**	77651694	74217435.0125	81322535	7.11	4.804	-1.444	0.236	0.286	0.000	0.048	coxph(surv ~ addcovar)	Sex
Harderian adenocarcinoma	**HZE**	**9**	**5.902**	102548277	101340795	103625549.9375	2.28	3.589	-19.933	0.000	18378.247	0.999	0.036	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Unirradiated**	**9**	**7.705**	77507836	74239441	80778575.4625	6.54	4.933	1.174	3.235	0.212	0.000	0.049	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All irradiated**	**10**	**6.296**	91864700	89674477.3375	92621230	2.95	1.521	0.924	2.519	0.216	0.000	0.015	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All mice**	**10**	**5.947**	92621230	89176542.5	94876655	5.70	1.197	0.863	2.370	0.195	0.000	0.012	coxph(surv ~ addcovar)	Sex
DLBCL Lymphoma	**All irradiated**	**11**	**6.701**	71739994	69450261	72909553.0125	3.46	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
Mammary adenocarcinoma	**All irradiated**	**11**	**6.643**	111549311	110681119	113667011	2.99	1.995	19.250	229103533	5865.572	0.997	0.020	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**11**	**7.736**	52250226	48448172	56039468	7.59	1.752	0.896	2.449	0.157	0.000	0.018	coxph(surv ~ addcovar)	Sex
DLBCL Lymphoma	**Gamma**	**11**	**7.512**	71739994	69450261	72907737.5	3.46	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Unirradiated**	**11**	**5.894**	49589121	46319591	52250226	5.93	3.805	1.249	3.485	0.254	0.000	0.038	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**12**	**5.911**	16742376.5	16521324.9125	17049168	0.53	1.224	-0.626	0.535	0.152	0.000	0.012	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All mice**	**12**	**6.745**	103255981.5	102868327.675	104913631.9875	2.05	1.351	-0.691	0.501	0.165	0.000	0.014	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All irradiated**	**13**	**6.908**	111692554	110302374	112885502	2.58	2.208	2.024	7.568	0.587	0.001	0.022	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All irradiated**	**14**	**6.023**	86043426	85612342.5	88761729	3.15	1.928	0.890	2.435	0.199	0.000	0.019	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All mice**	**14**	**5.902**	119983205	119173497	123365220.35	4.19	1.043	0.722	2.059	0.168	0.000	0.010	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All mice**	**14**	**5.913**	97084001	94137982.175	99920147	5.78	1.502	-0.824	0.439	0.412	0.046	0.015	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Gamma**	**14**	**6.750**	88398605.5	85978449.5	90408596	4.43	4.215	-1.337	0.263	0.271	0.000	0.042	coxph(surv ~ addcovar)	Sex
AML	**All mice**	**15**	**5.982**	91001963	88406017.6	93620314	5.21	1.439	-1.458	0.233	1.004	0.147	0.014	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**15**	**8.926**	97593420.5	94584056	98932548	4.35	2.004	0.899	2.458	0.181	0.000	0.020	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All mice**	**15**	**5.971**	40258684.5	40195208.5	41652518.5	1.46	1.388	1.942	6.969	0.386	0.000	0.014	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**Unirradiated**	**15**	**7.568**	98097859	96211856.0875	98692322.5	2.48	4.948	1.131	3.098	0.224	0.000	0.049	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**16**	**7.046**	48588285	48224219.5	49493665	1.27	1.972	0.564	1.758	0.212	0.008	0.020	coxph(surv ~ addcovar)	Sex
FBL Lymphoma	**All irradiated**	**17**	**7.040**	86859140	85595945	87606186	2.01	2.336	-1.976	0.139	0.424	0.000	0.023	coxph(surv ~ addcovar)	Sex
DLBCL Lymphoma	**Gamma**	**17**	**6.360**	83599869	83565880	85336592	1.77	3.968	2.448	11.564	0.519	0.000	0.040	coxph(surv ~ addcovar)	Sex
Hepatocellular Carcinoma	**All irradiated**	**18**	**6.722**	60537671	60102377.4125	64122158	4.02	1.692	1.011	2.749	0.273	0.000	0.017	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**18**	**6.766**	70839373.5	70618816.45	72863718	2.24	1.491	-2.313	0.099	1.004	0.021	0.015	coxph(surv ~ addcovar)	Sex
Pulmonary adenocarcinoma	**All mice**	**18**	**6.980**	54802127.5	51817892	56397454.275	4.58	1.309	0.763	2.145	0.160	0.000	0.013	coxph(surv ~ addcovar)	Sex
FBL Lymphoma	**All irradiated**	**19**	**6.256**	59265936	58600768	59844770.5	1.24	NA	NA	NA	NA	NA	NA	coxph(surv ~ addcovar)	Sex
B-cell Lymphoma	**All mice**	**19**	**5.899**	59261441.5	55748310.3	60116307.45	4.37	1.293	3.012	20.325	0.716	0.000	0.013	coxph(surv ~ addcovar)	Sex
BLL Lymphoma	**All mice**	**19**	**6.645**	45120113.5	42018221	46653474	4.64	1.482	1.621	5.059	0.332	0.000	0.015	coxph(surv ~ addcovar)	Sex

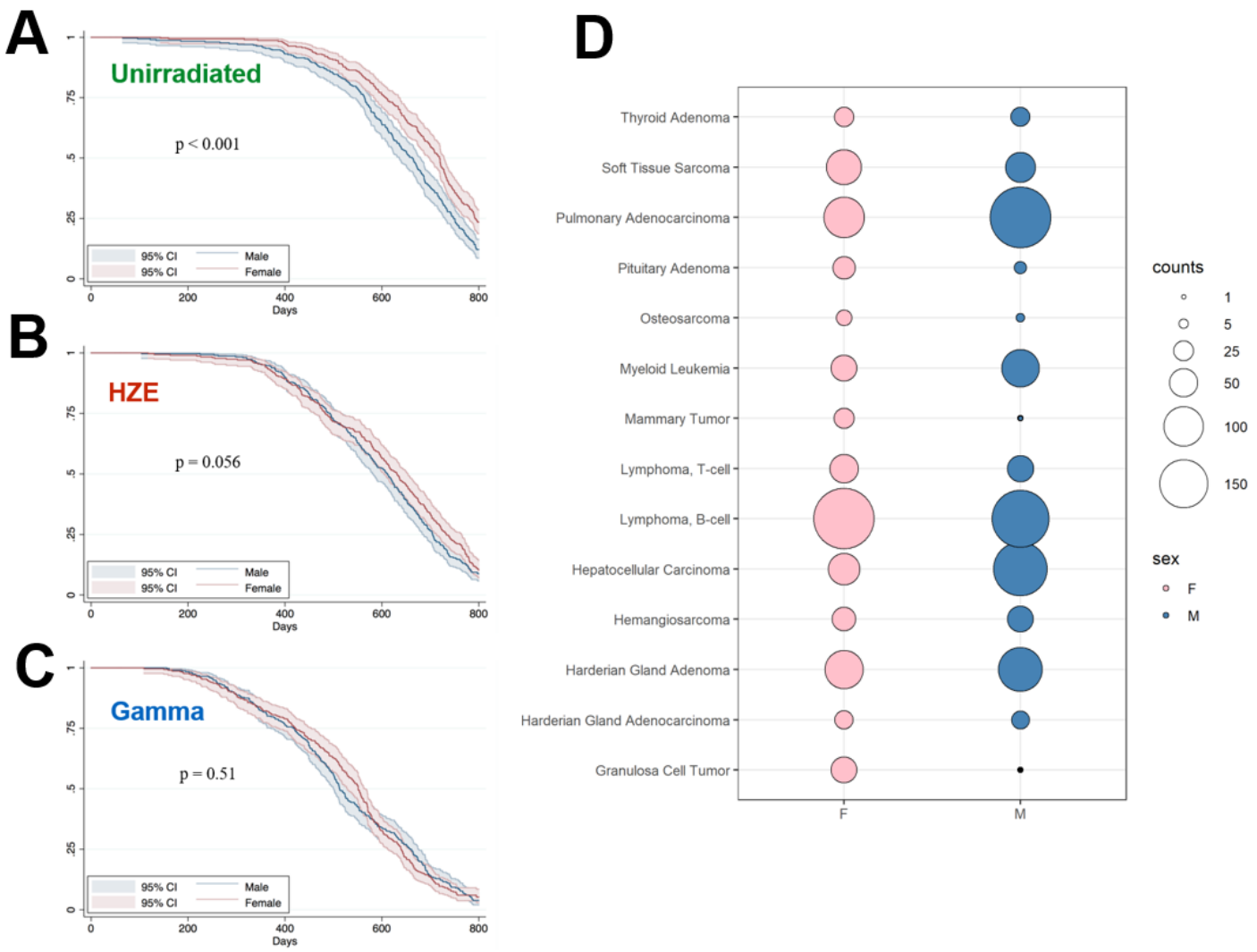

Fig. S1: Unirradiated HS/Npt females have significantly increased survival compared to males (**A**). In contrast, HZE ion irradiated (**B**) and gamma-irradiation (**C**) females do not have increased survivals. Distribution of tumor histotypes by sex show the relative incidences of specific tumor histotypes by sex (**D**).

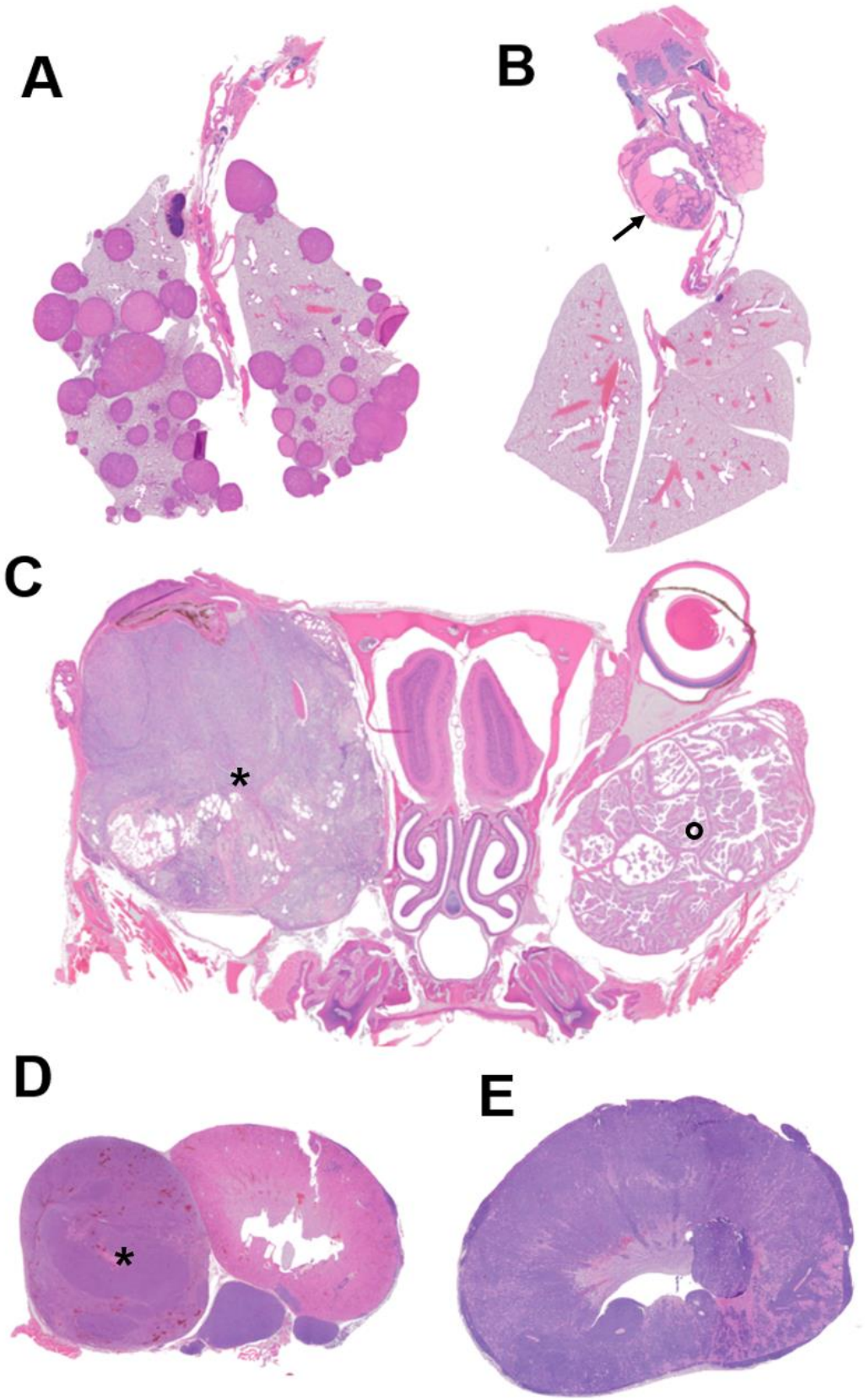

Fig. S2: Representative histologic images for pulmonary metastases from a hepatocellular carcinoma (**A)**, thyroid follicular adenoma with numerous dilated follicular structures (arrow) (**B**), Harderian gland adenocarcinoma (*) and adenoma (°) (**C**), adrenal pheochromocytoma (*) adjacent to kidney (**C**), neoplastic lymphocytes infiltrate and efface the kidney in a case of renal lymphoma (**E**).

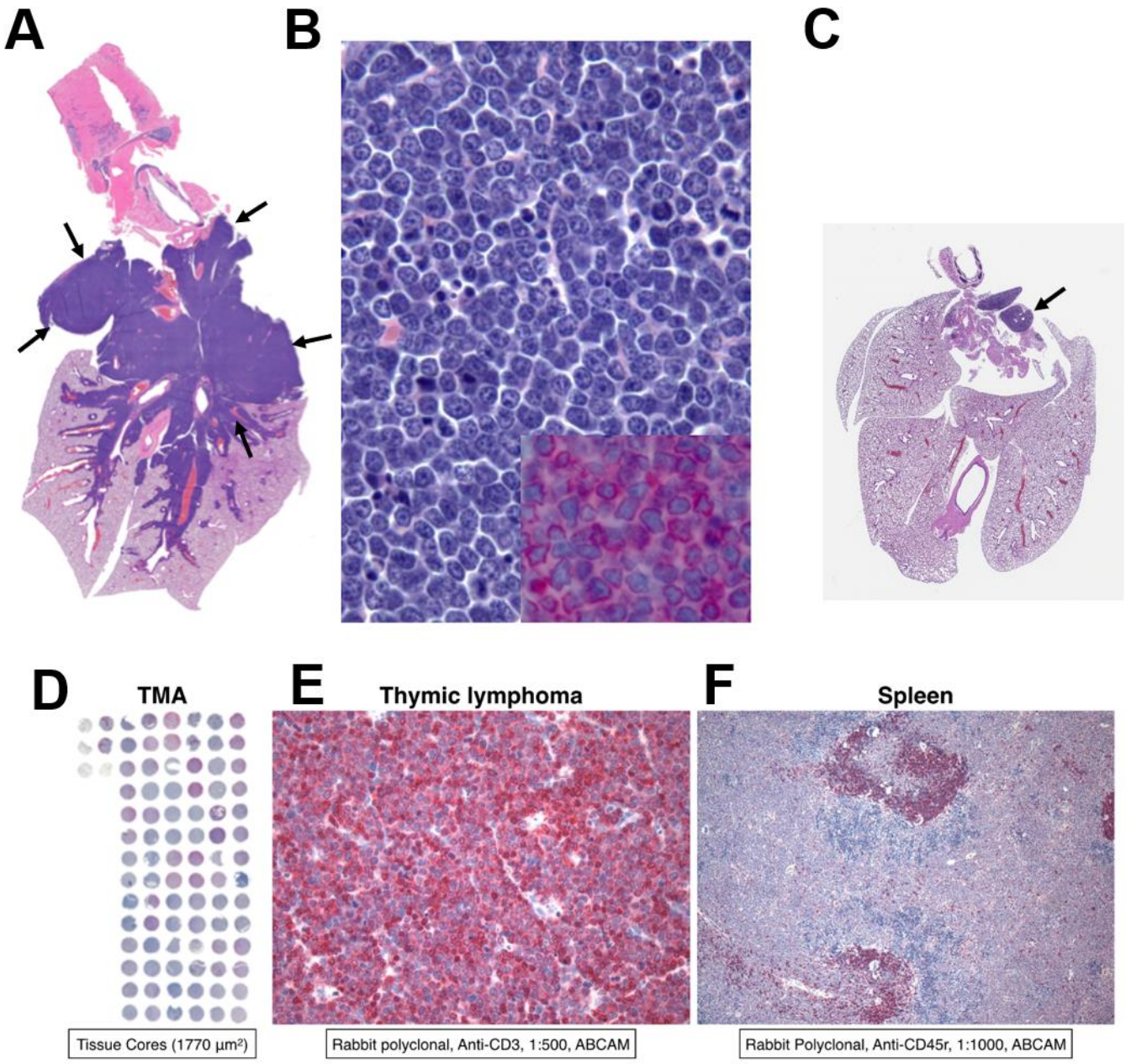

Fig. S3: Gross, histologic, and immunohistochemical features of precursor T-cell lymphoblastic lymphoma: a grossly enlarged thymus is present (arrows) with invasion into pulmonary parenchyma (**A**) and the thymic architecture is effaced by neoplastic lymphocytes that are CD3-positive via immunohistochemistry (inset) (**B**). For comparison, normal thymus is relatively small (arrow) and localized in the anterior portion of the thoracic cavity (**C**). Immunophenotyping lymphoid neoplasms was performed using Tissue microarrays (**D**) and immunohistochemistry for CD3 (**E**) and CD45R (**F**). All cases of lymphoma were examined in duplicate.

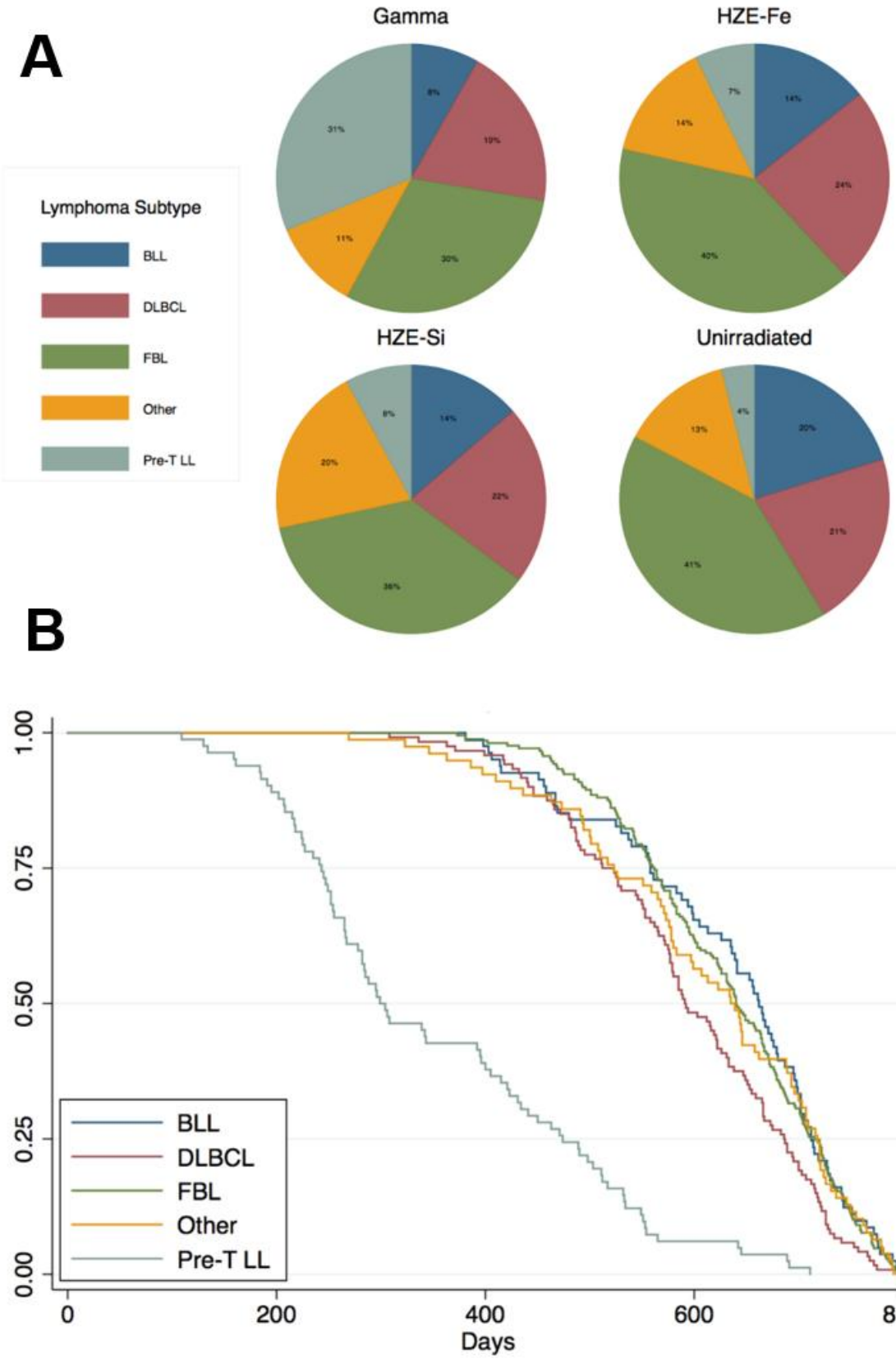

Fig. S4: Lymphoma subtype data: A. distribution of lymphoma subtype by treatment group, B. Kaplan-Meier survival for mice diagnosed with each lymphoma subtype, including B-cell lymphoblastic lymphoma (BLL), Diffuse large B-cell lymphoma (DLBCL), follicular B cell lymphoma (FBL), Precursor T cell lymphoblastic lymphoma (PreT LL), and all other observed lymphomas combined.

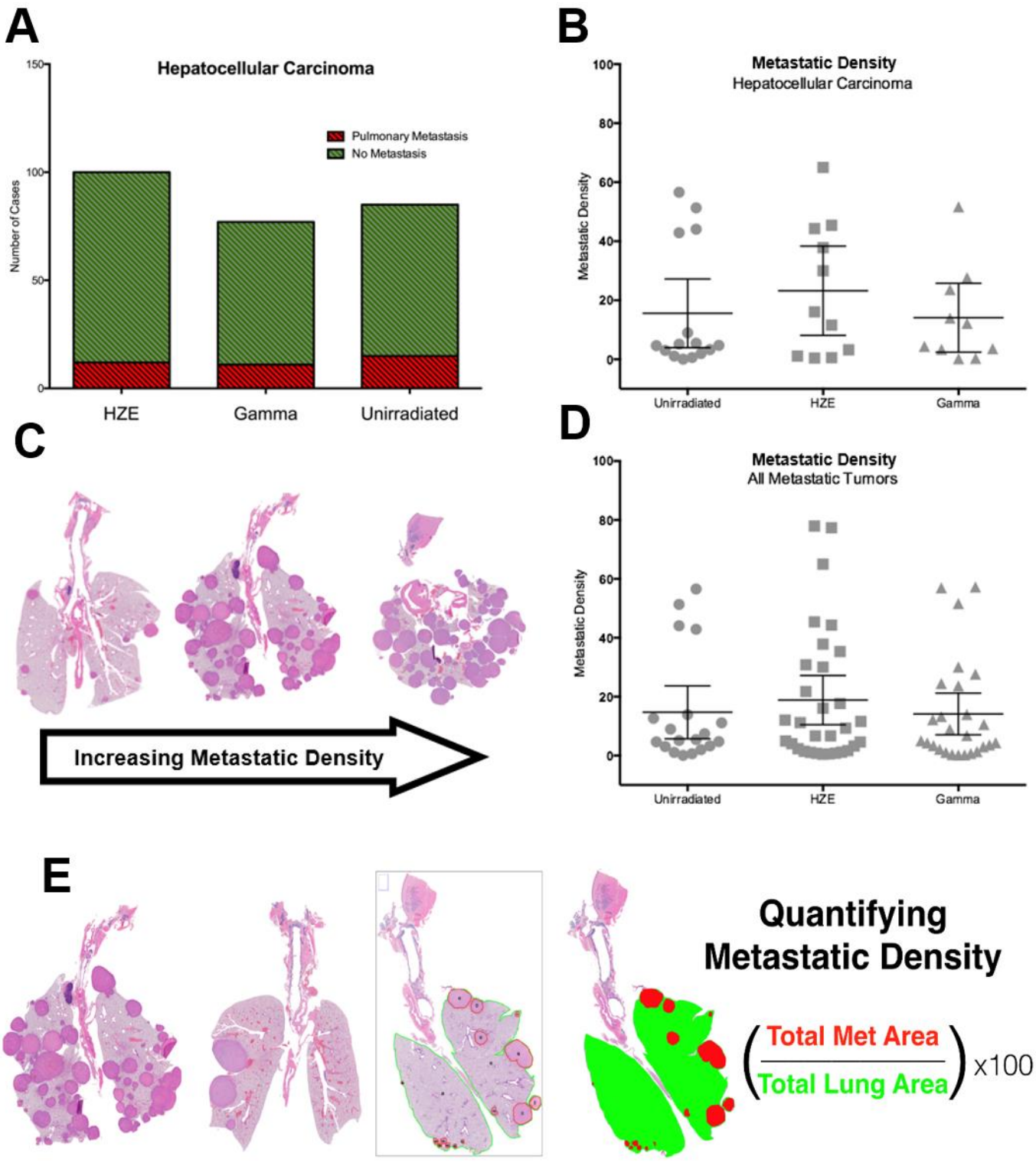

Fig. S5: Metastatic characterization: Incidence of metastases in mice diagnosed with hepatocellular carcinoma for each exposure group (HZE, n = 100; γ, n = 66; Unirradiated, n = 85) (**A**). No significant difference in incidence of metastatic disease was observed in populations bearing hepatocellular carcinomas. Examples of varying in metastatic densities for individual mice with hepatocellular carcinoma (lung, whole slide imaging) (**B**), Hepatocellular carcinoma metastatic densities for each exposure group (Unirradiated, n = 15; HZE, n = 11; γ, n = 10) (**C**). Metastatic density for all neoplasms for each exposure group (Unirradiated, n = 19; HZE, n = 28; γ, n = 25) (**D**). Metastatic densities were highly variable between individual mice. Quantifying metastatic densities was accomplished with whole slide image analysis (**E**).

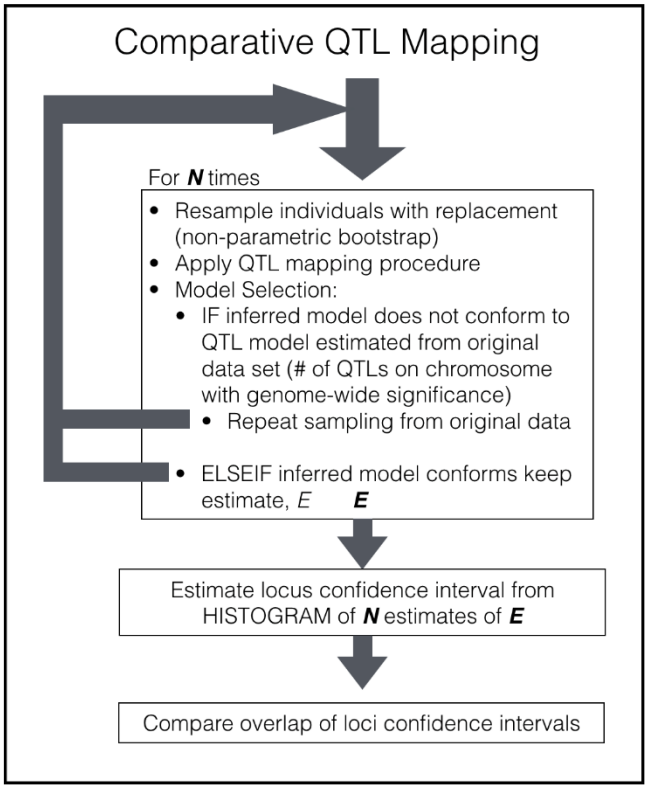

Fig. S6: Diagram of a nonparametric resample model averaging procedure for comparative QTL mapping.

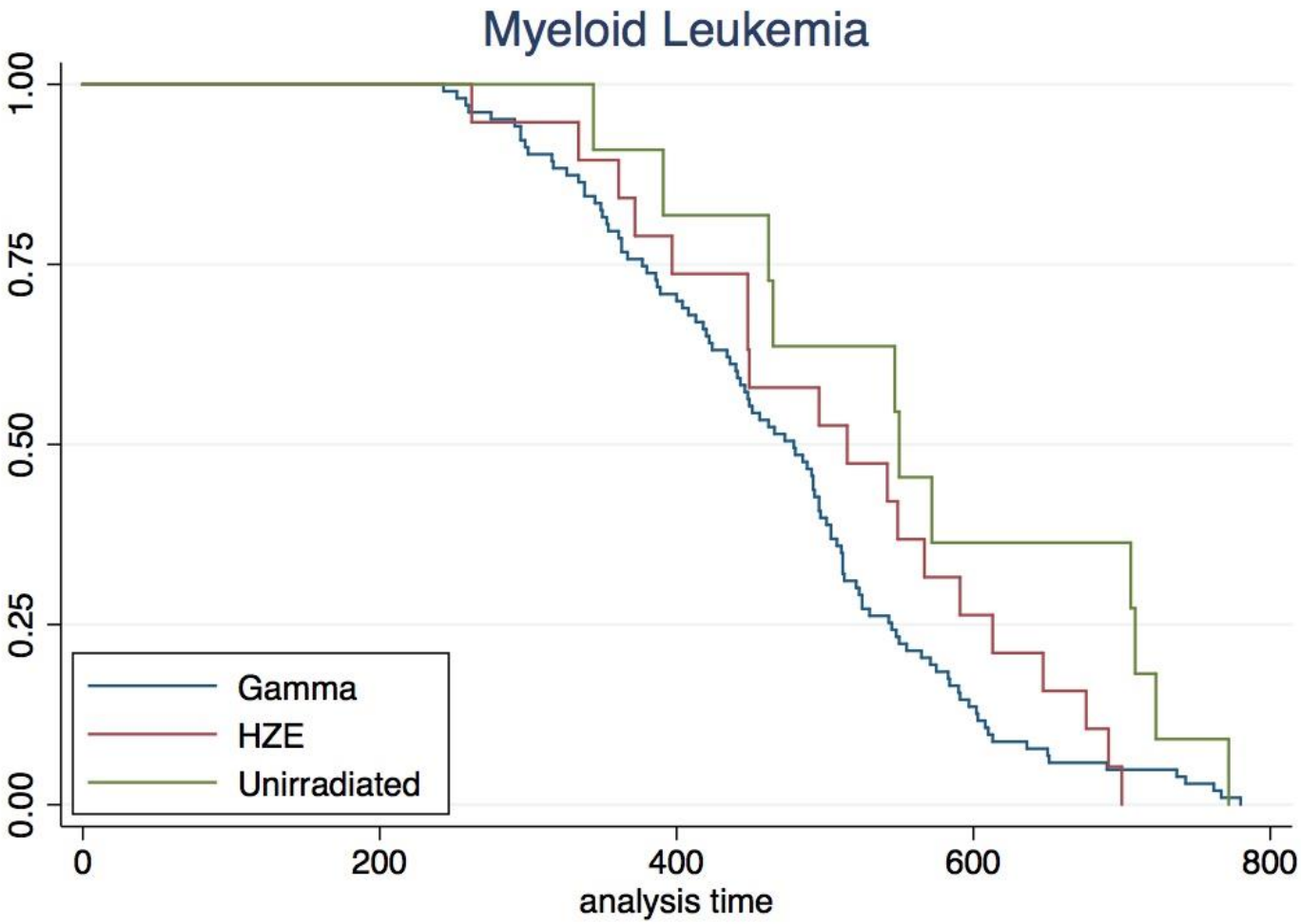

Fig. S7: Kaplan-Meier survival estimates for myeloid leukemia by exposure group.

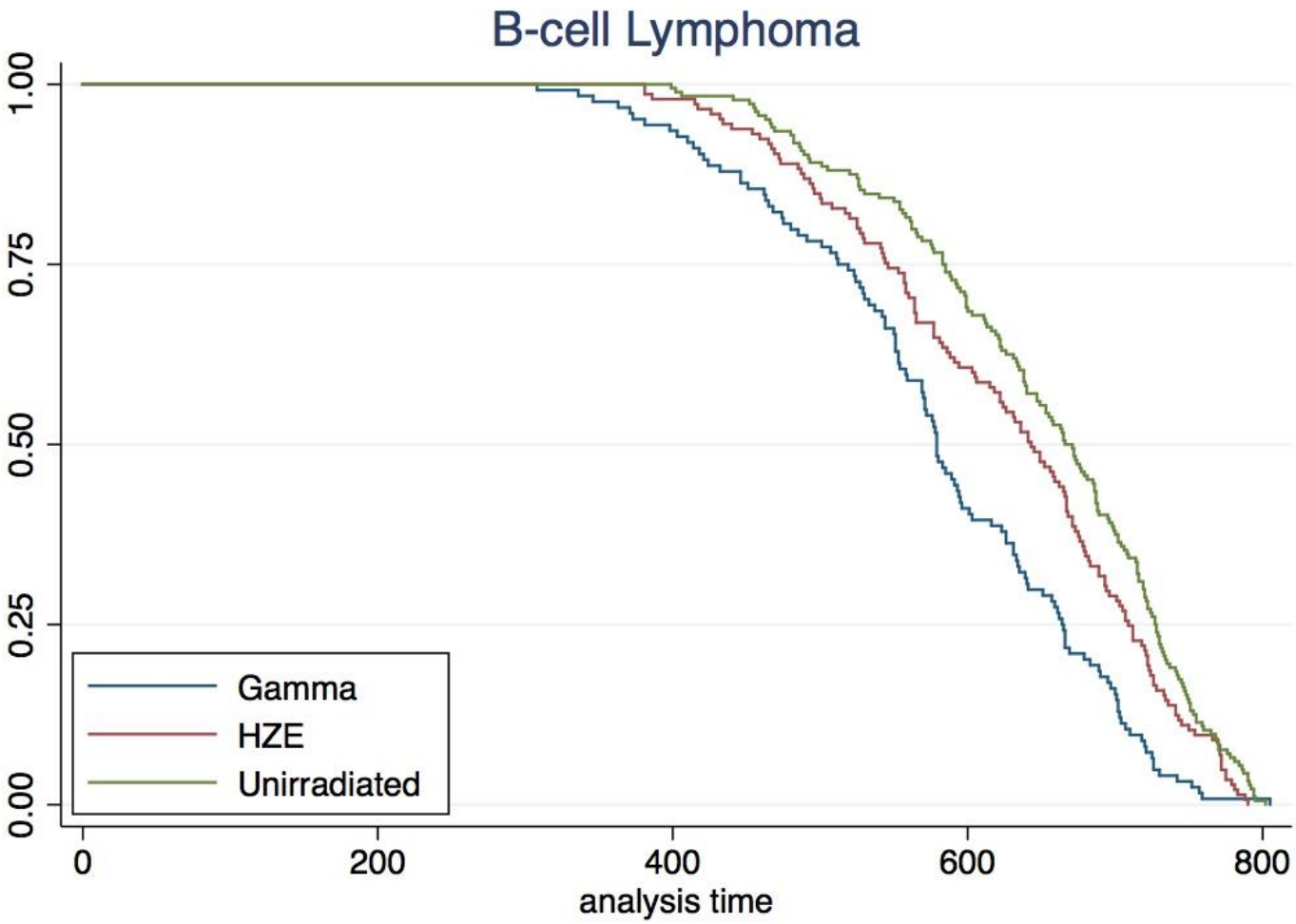

Fig. S8: Kaplan-Meier survival estimates for all B-cell lymphoma subtypes by exposure group.

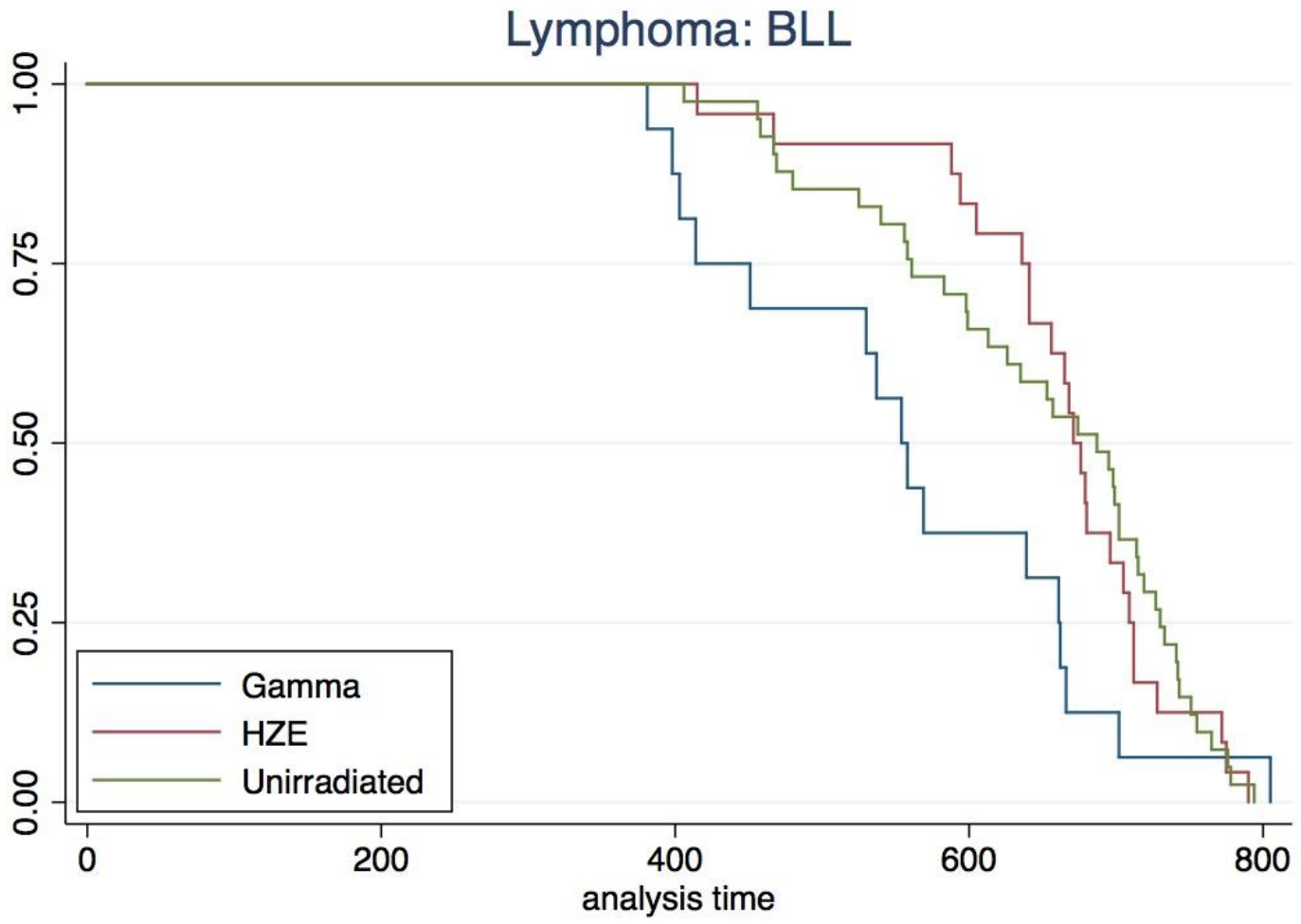

Fig. S9: Kaplan-Meier survival estimates for B-cell lymphoblastic lymphoma by exposure group.

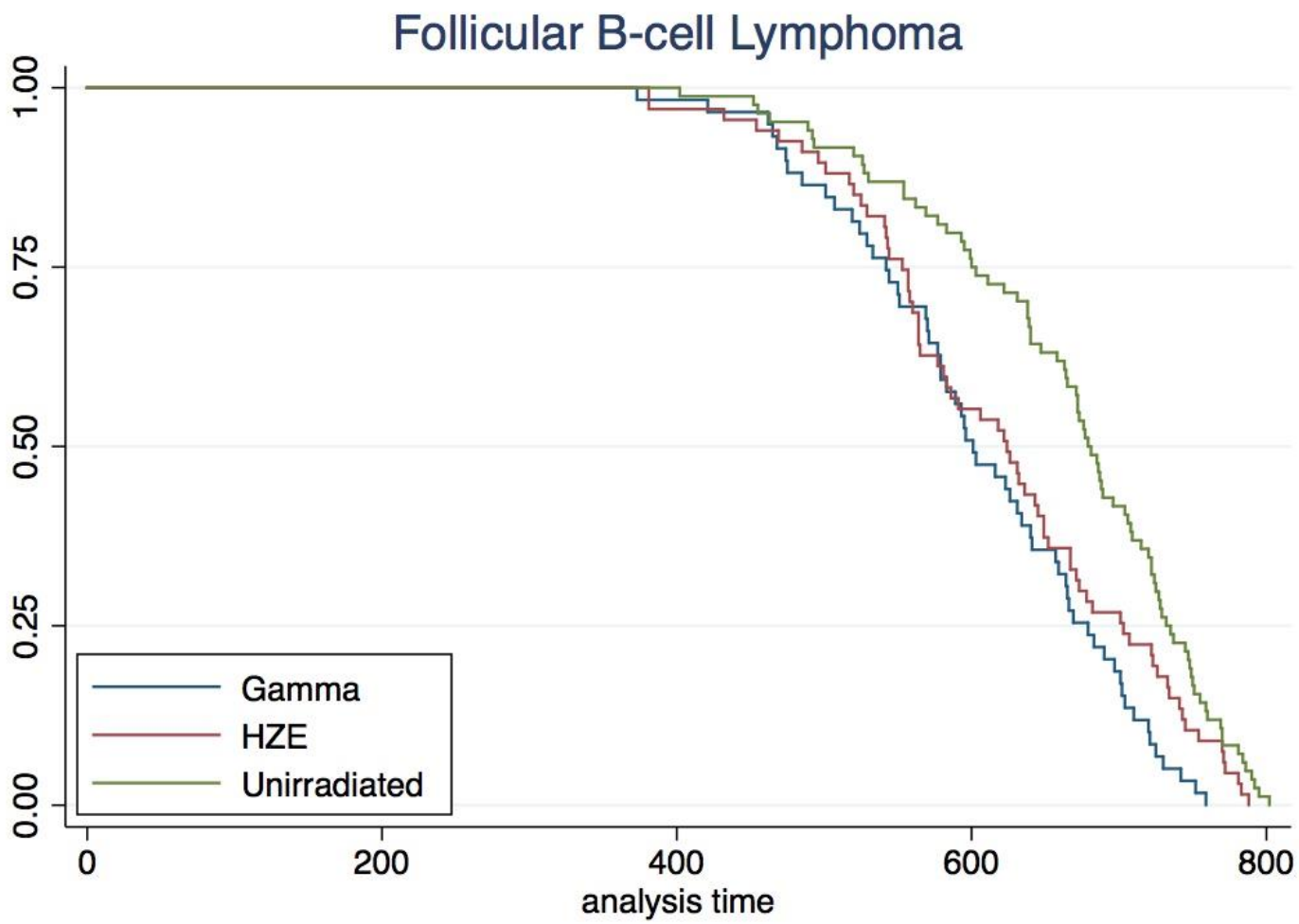

Fig. S10: Kaplan-Meier survival estimates for follicular B-cell lymphoma by exposure group.

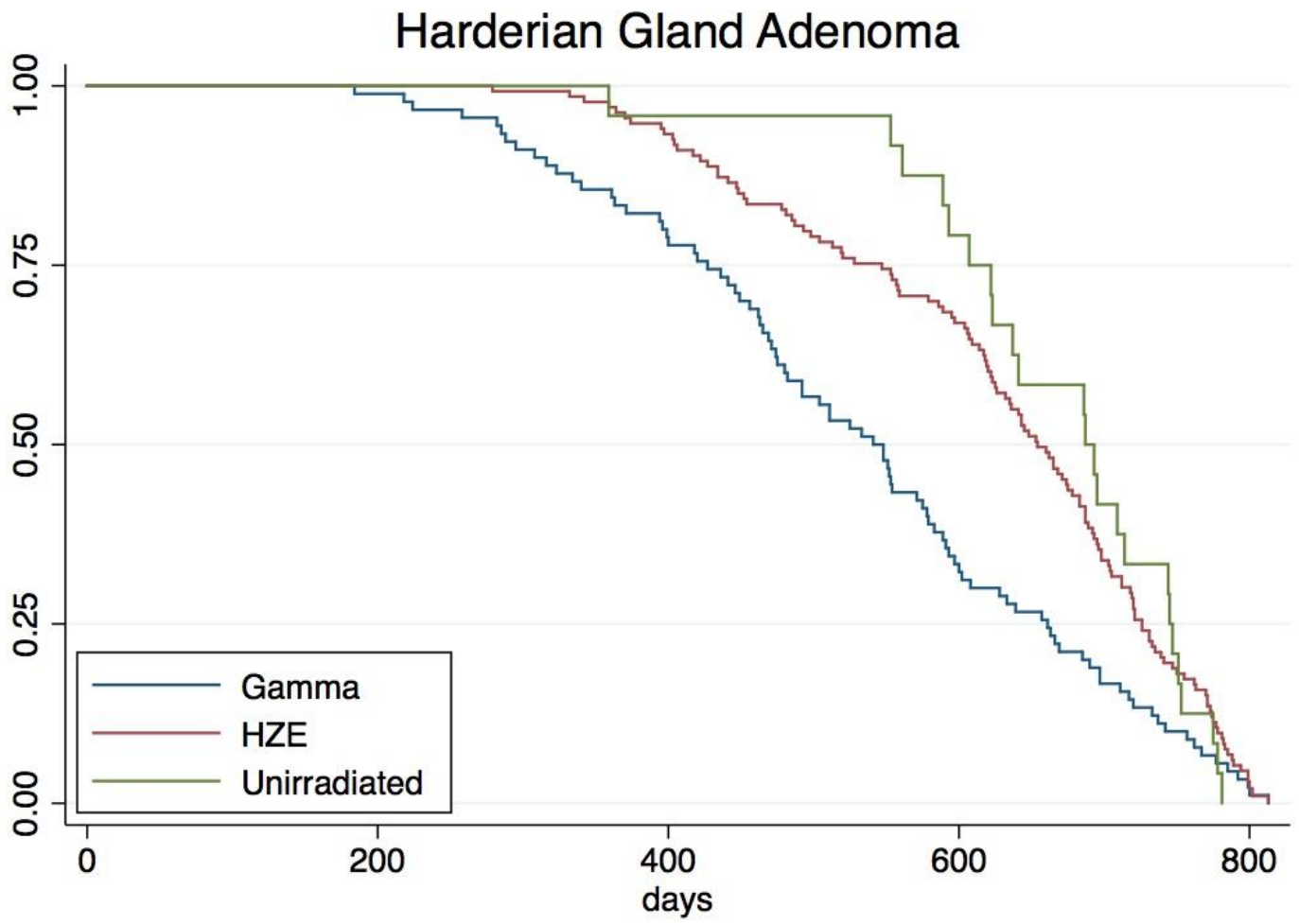

Fig. S11: Kaplan-Meier survival estimates for Harderian gland adenoma by exposure group.

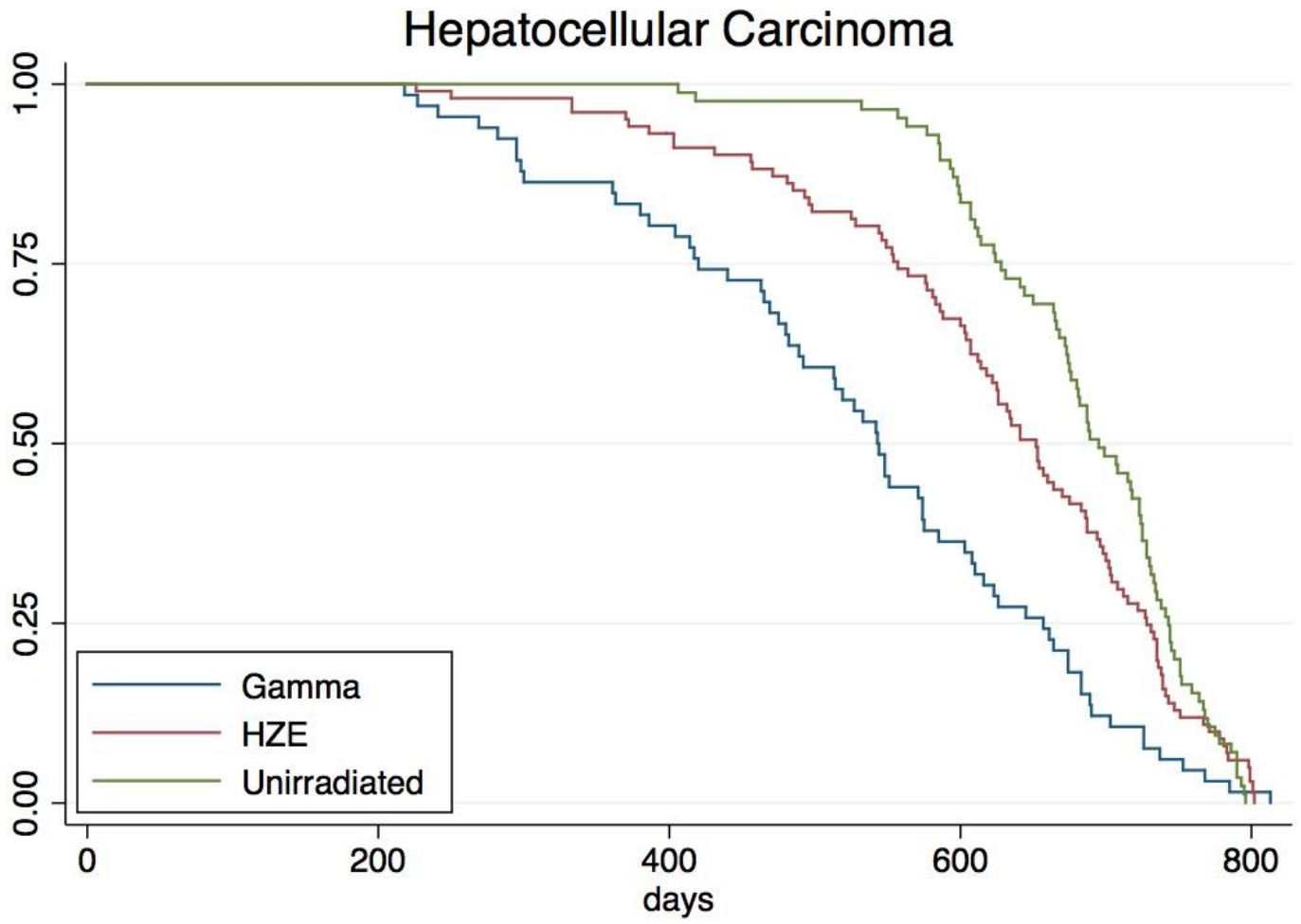

Fig. S12: Kaplan-Meier survival estimates for hepatocellular carcinoma by exposure group.

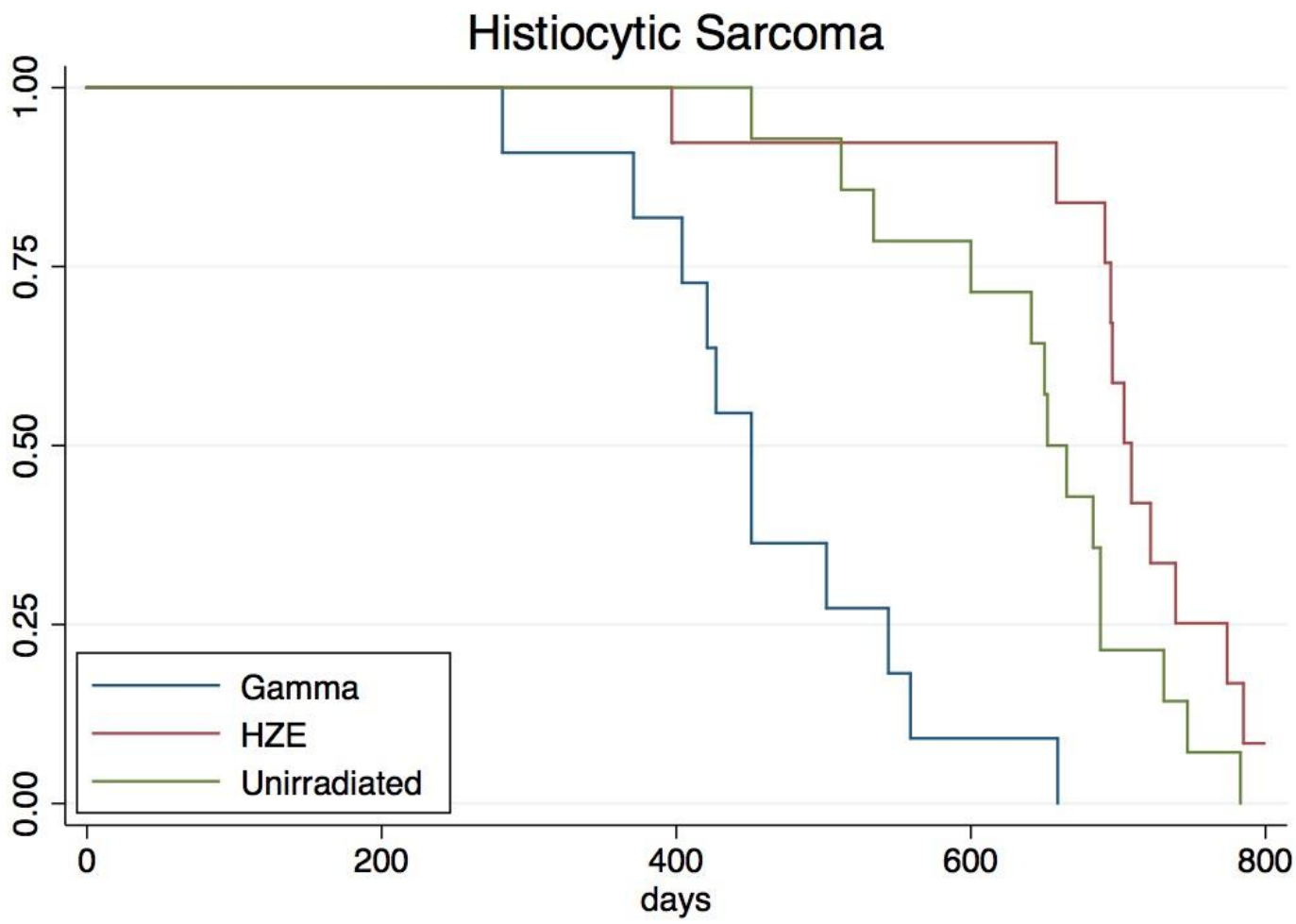

Fig. S13: Kaplan-Meier survival estimates for histiocytic sarcoma by exposure group.

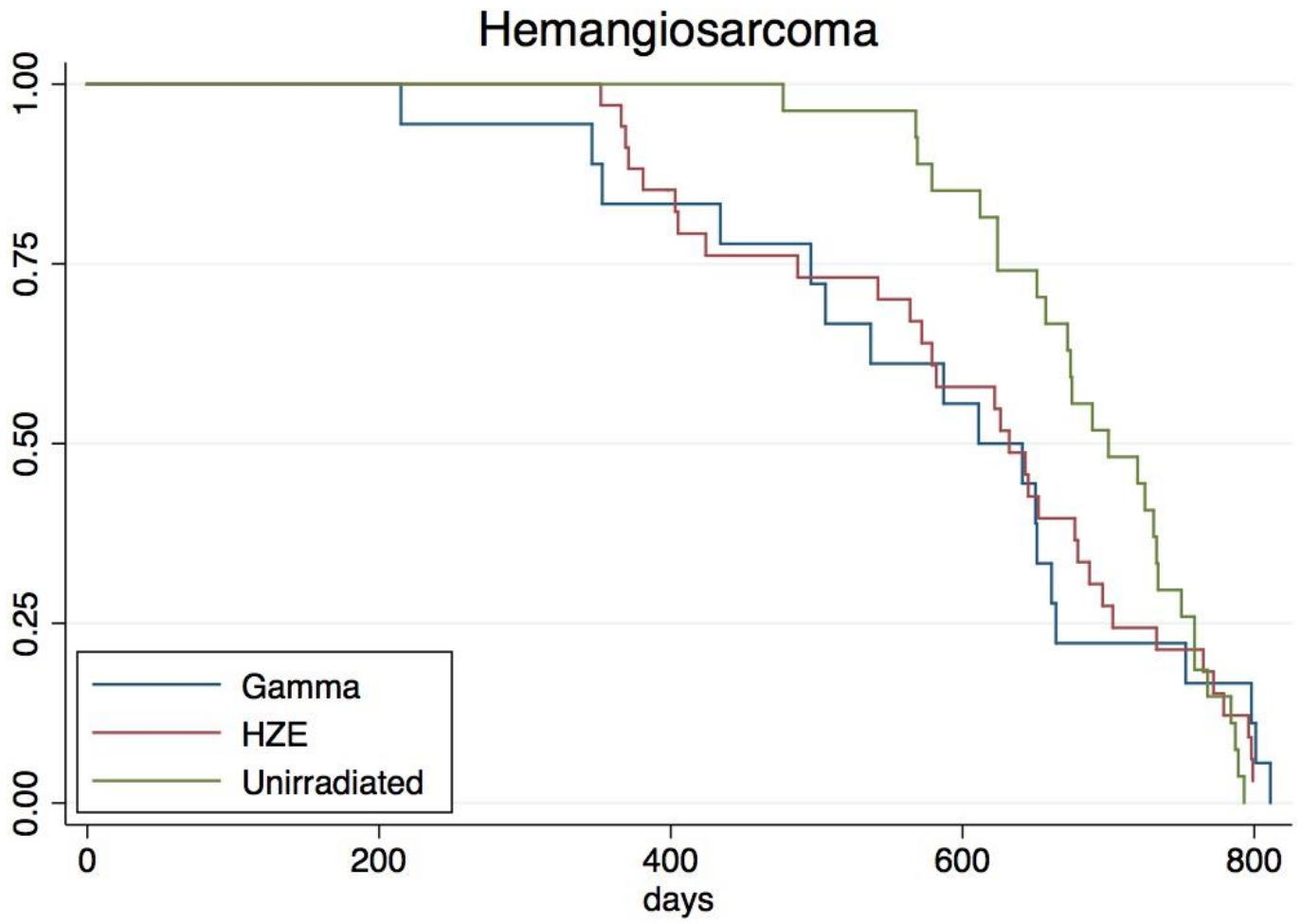

Fig. S14: Kaplan-Meier survival estimates for hemangiosarcoma by exposure group.

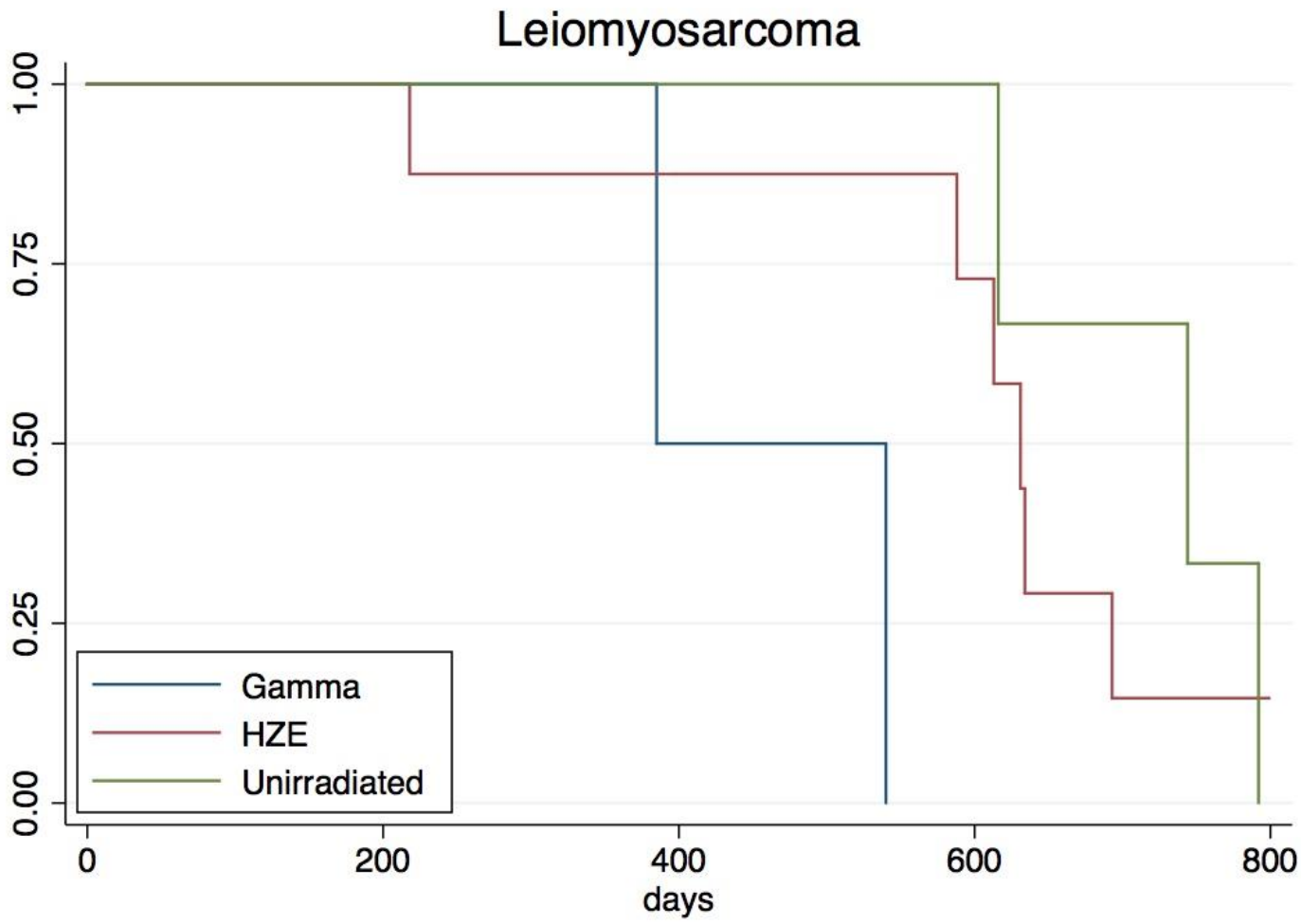

Fig. S15: Kaplan-Meier survival estimates for leiomyosarcoma by exposure group.

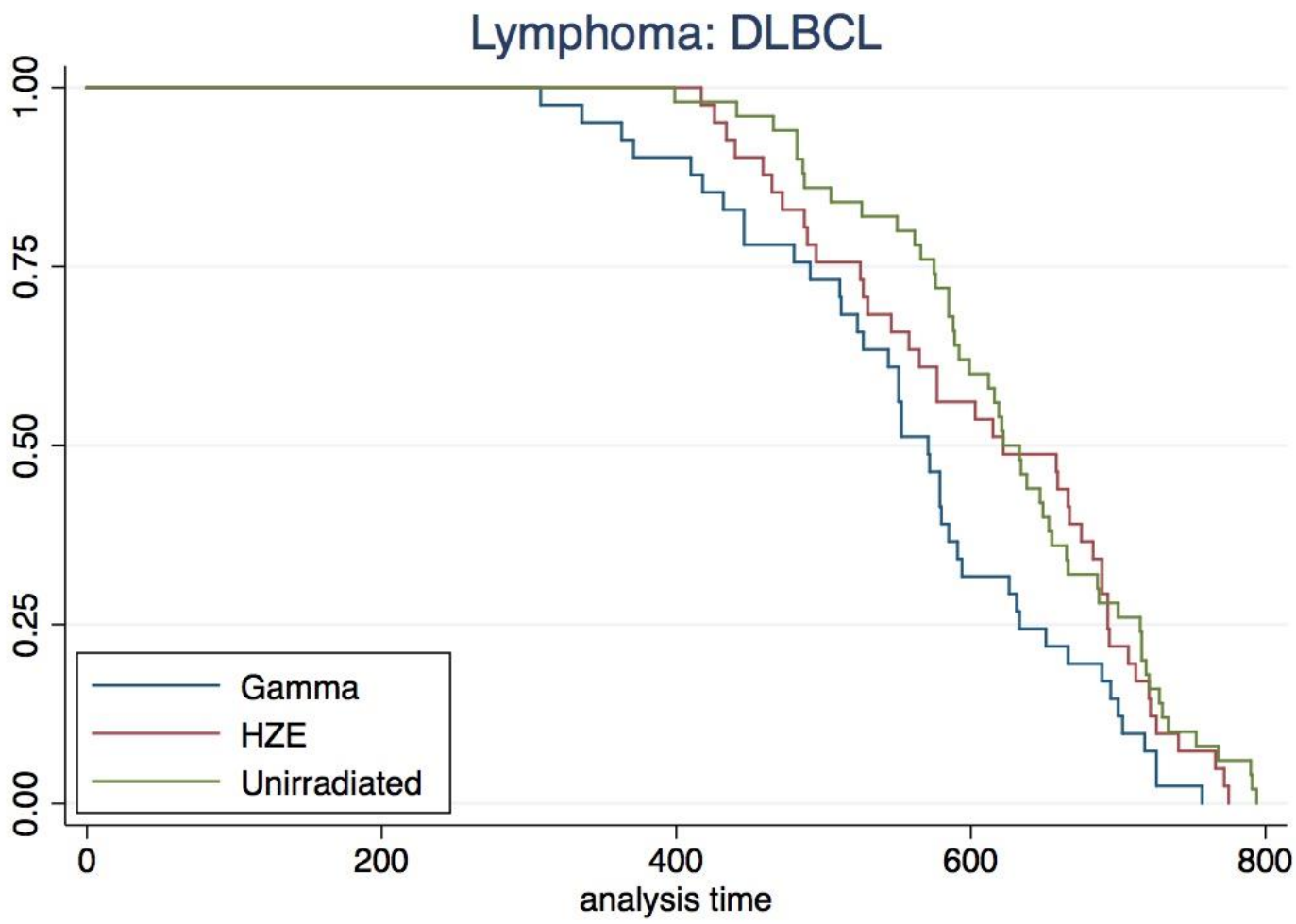

Fig. S16: Kaplan-Meier survival estimates for diffuse large B-cell lymphoma by exposure group.

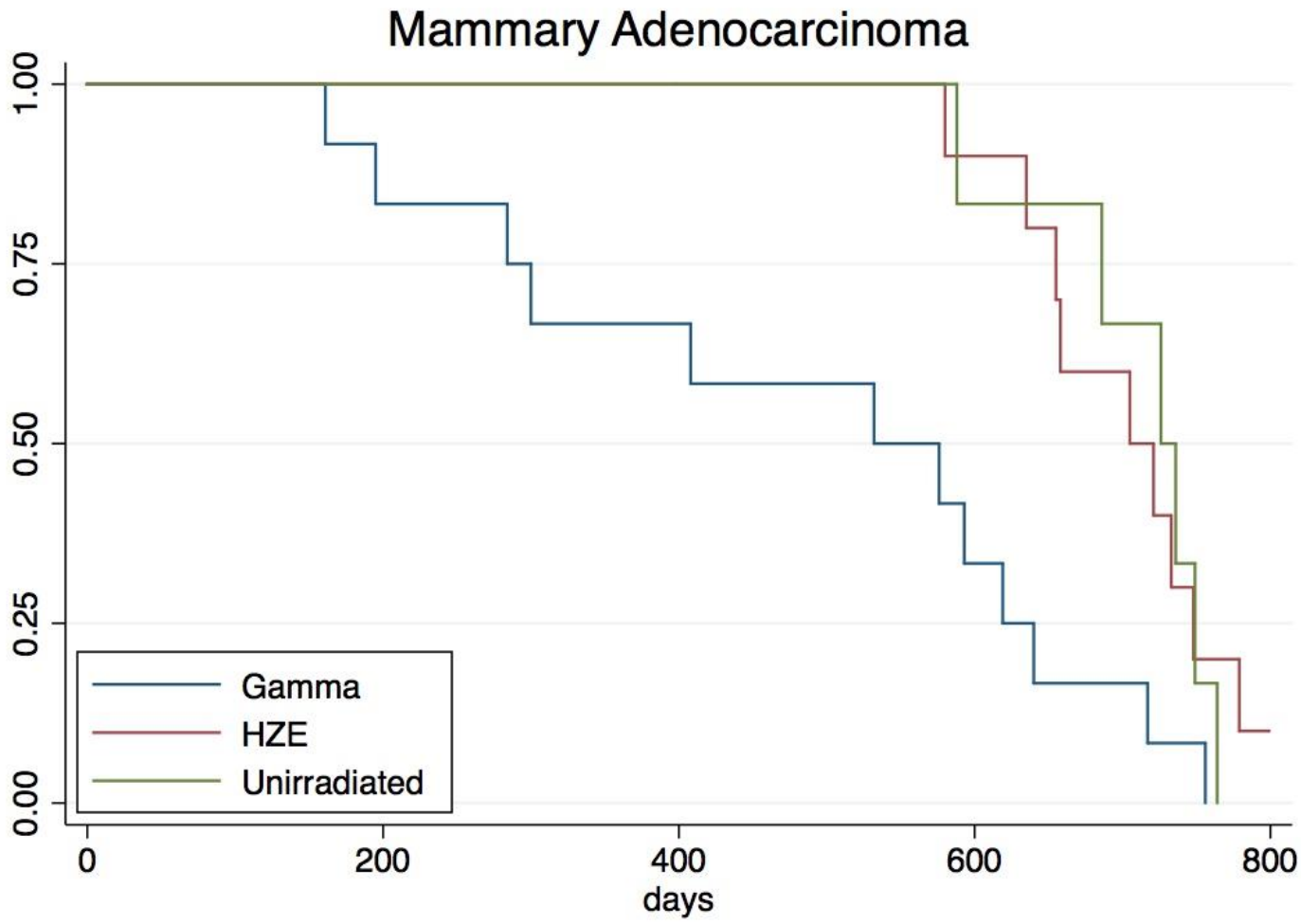

Fig. S17: Kaplan-Meier survival estimates for mammary adenocarcinoma by exposure group.

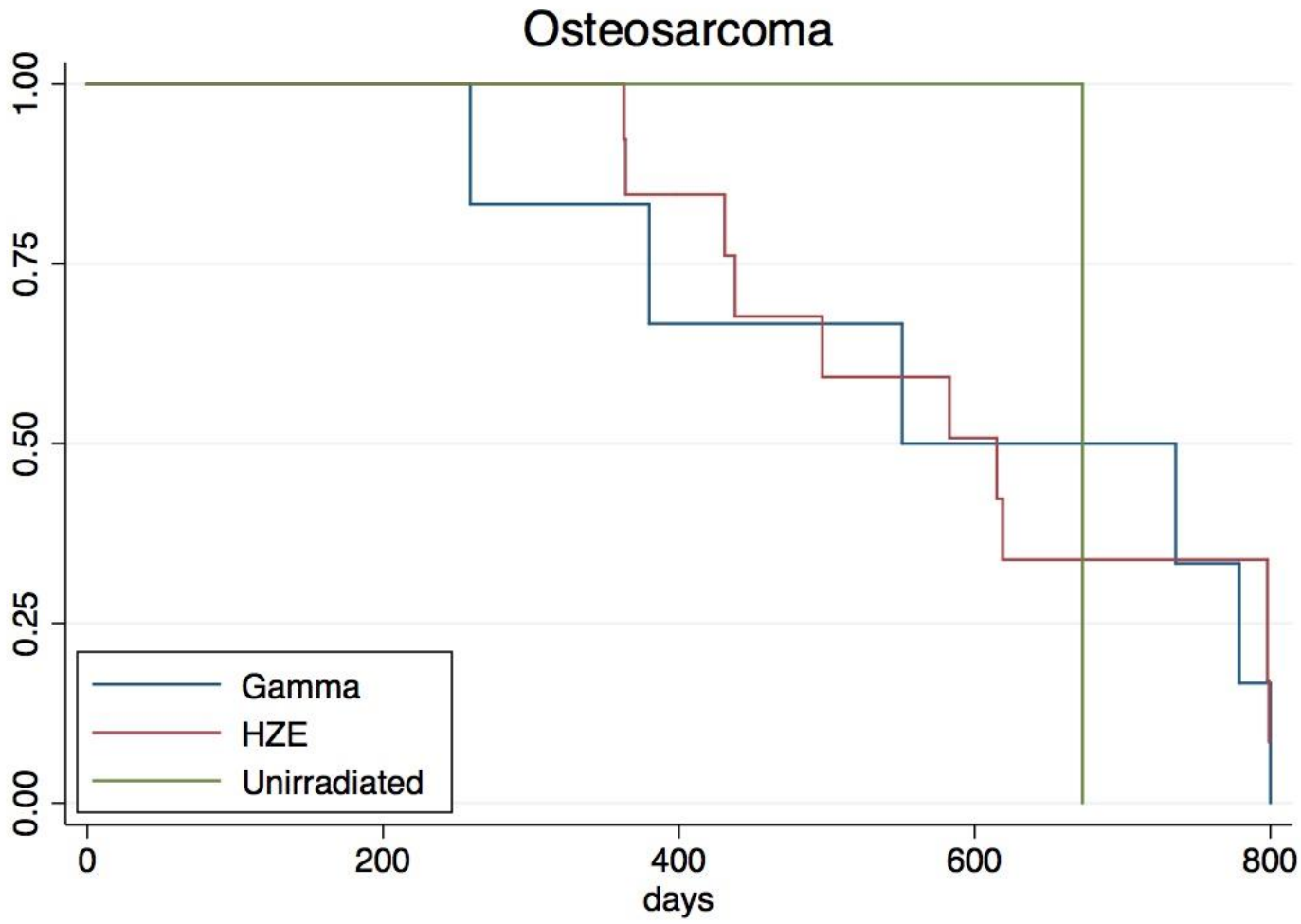

Fig. S18: Kaplan-Meier survival estimates for osteosarcoma by exposure group.

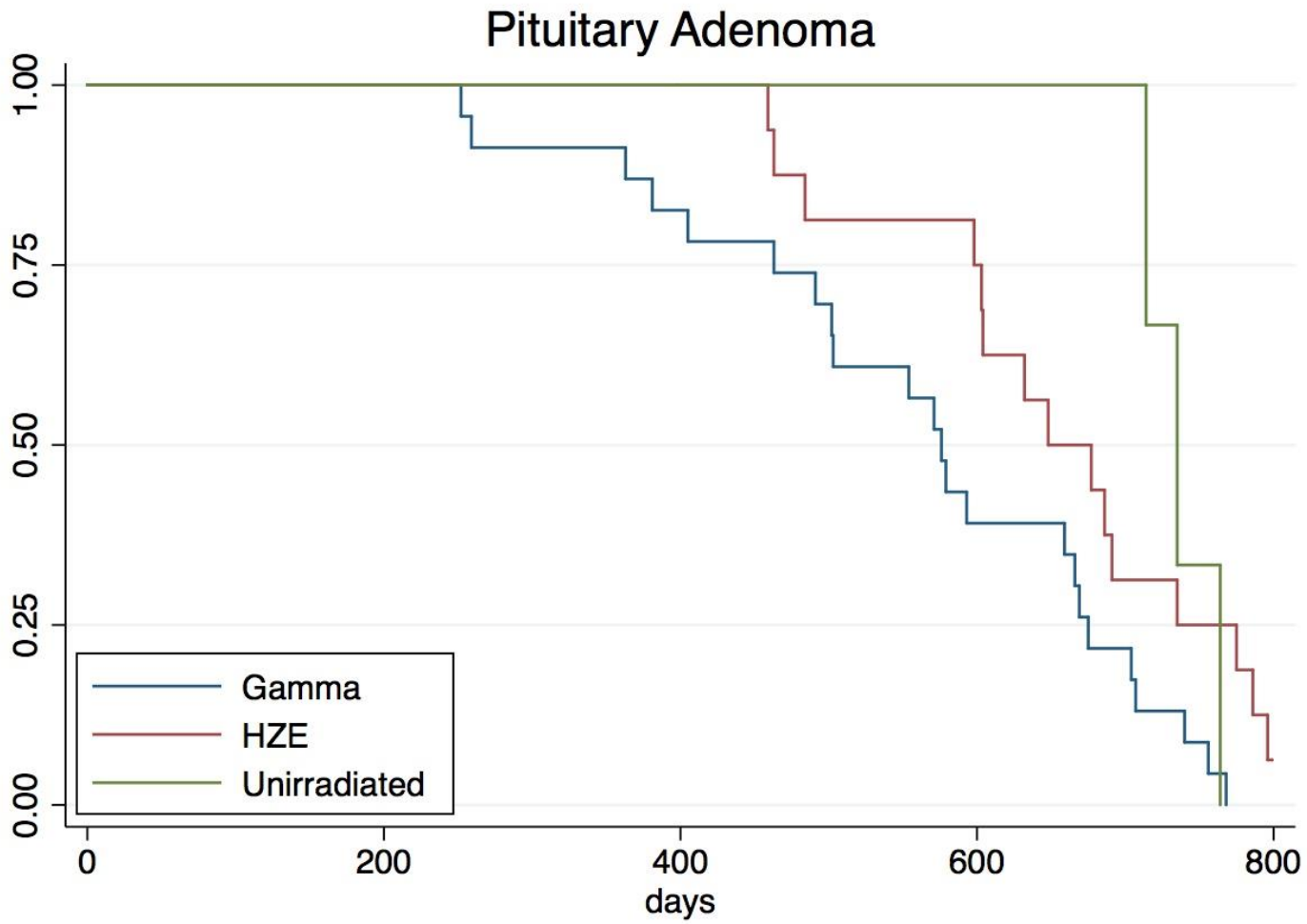

Fig. S19: Kaplan-Meier survival estimates for pituitary adenoma by exposure group.

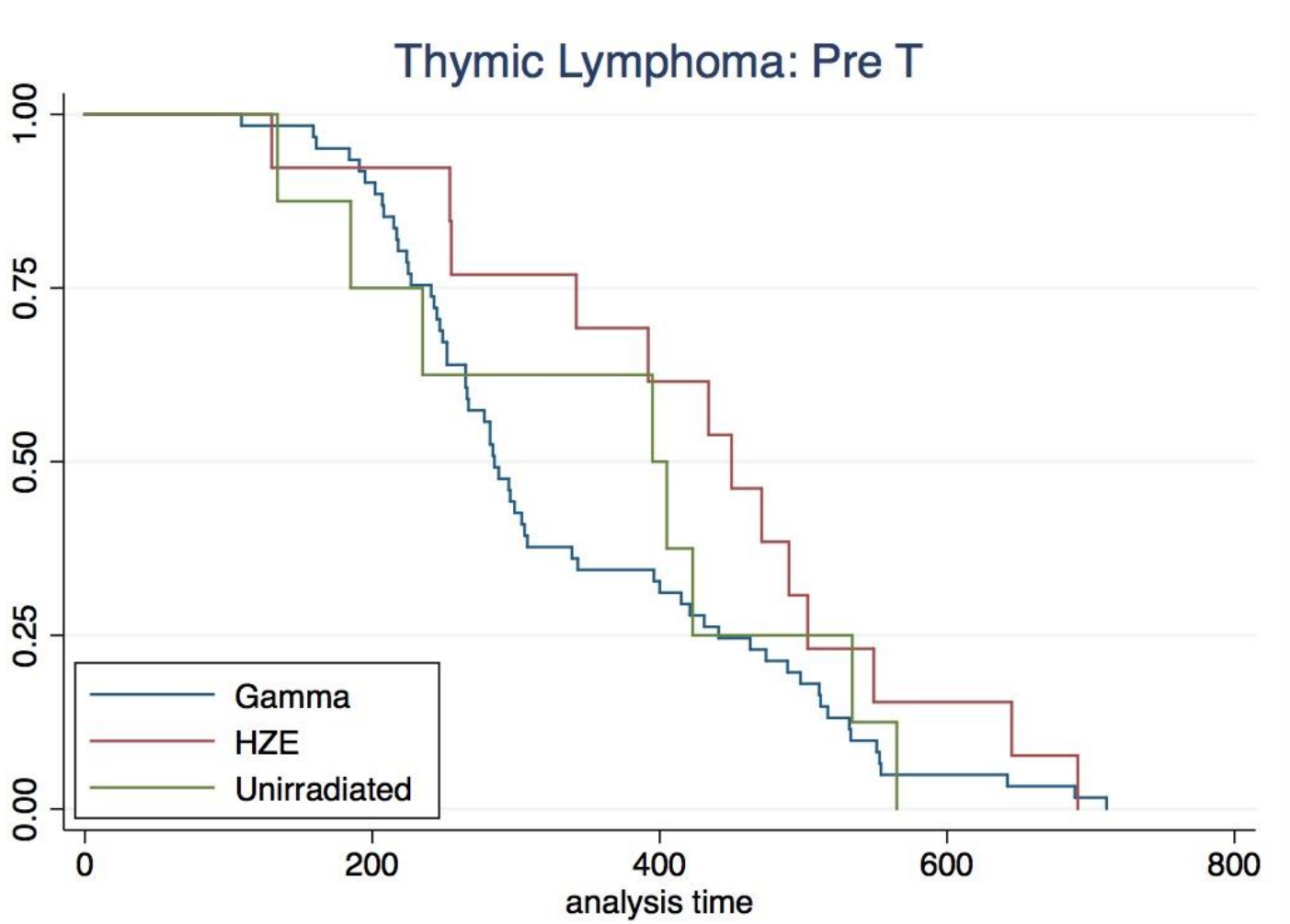

Fig. S20: Kaplan-Meier survival estimates for thymic lymphoma (Pre-T lymphoblastic lymphoma) by exposure group.

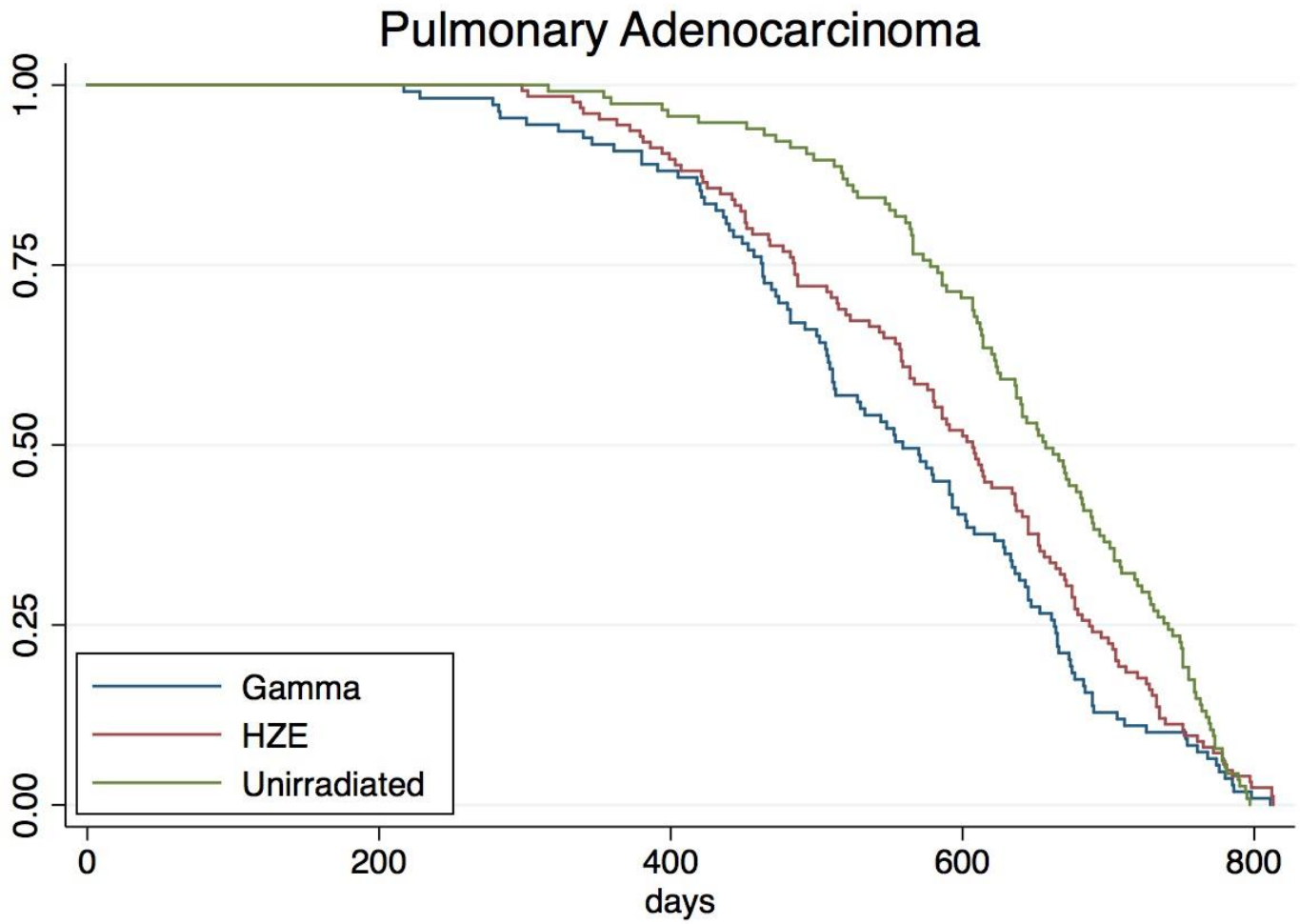

Fig. S21: Kaplan-Meier survival estimates for pulmonary adenocarcinoma by exposure group.

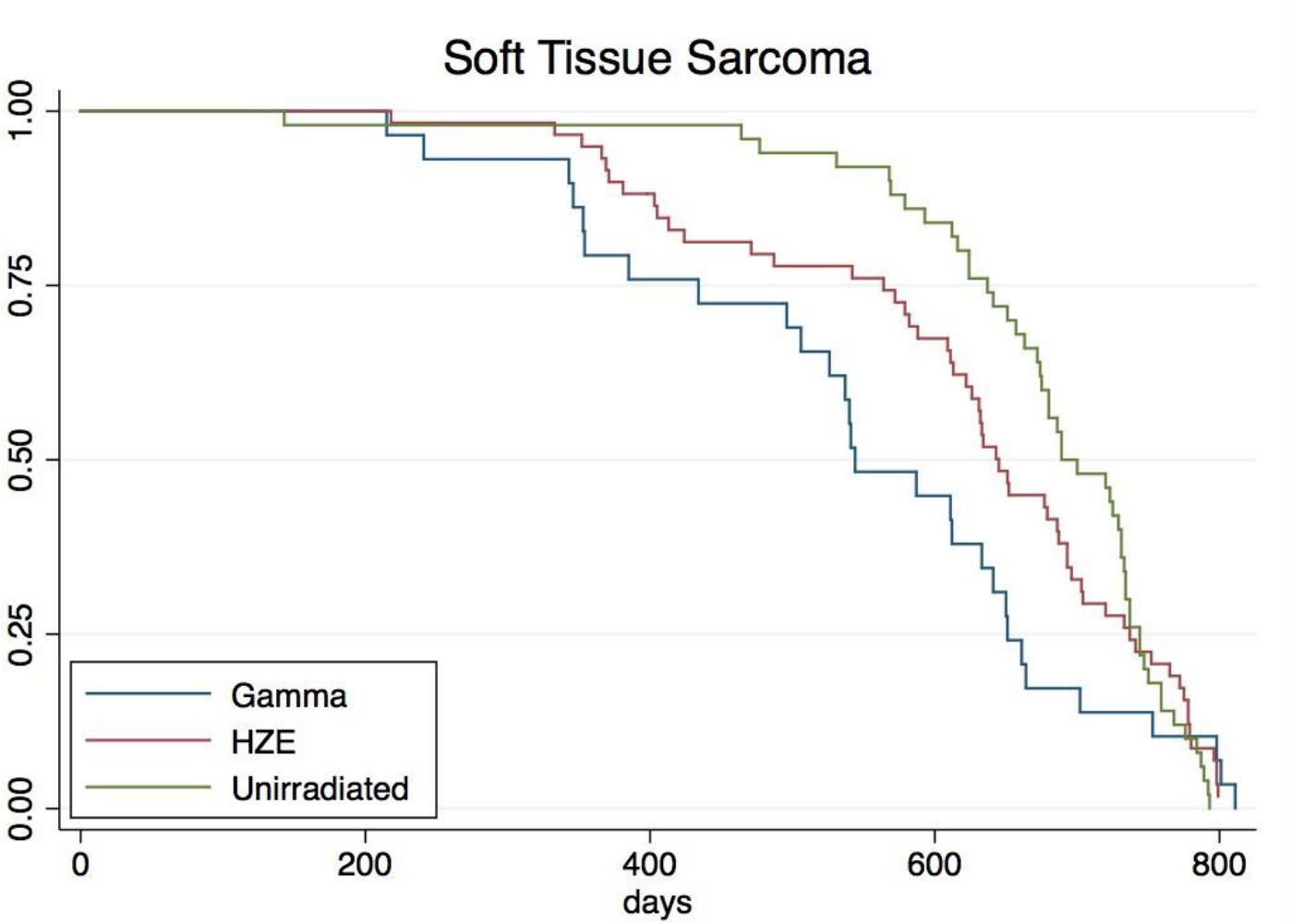

Fig. S22: Kaplan-Meier survival estimates for soft tissue sarcoma by exposure group.