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Technical Report

Comparison of longevity and common tumor profiles between Sprague-Dawley and Han Wistar rats

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Abstract: The Sprague Dawley (SD) and Han Wistar (HW) are the two most commonly used rat strains in Europe and the US, with the Han Wistar increasing in popularity because of its greater longevity and lower tumor burden. This survey was undertaken at Covance CRS (Huntingdon and Eye) to compare in-house longevity and common spontaneous tumor profiles of the two strains with published data. Data were compiled from 104-week studies started between 2010 and 2017. Mean survival was greater for both sexes of HWs when compared with SDs. Pituitary tumors were the commonest in both strains, with slightly higher incidences and more malignant tumors in SDs of both sexes. Mammary tumors were the second most common tumor in both strains; the incidence being greater in SDs compared to HWs. Benign pheochromocytomas of the adrenal and fibromas of the skin/subcutis were commoner in male SDs than in HWs. Granular cell tumors of the uterine tract were recorded only in SDs, but uterine stromal and glandular tumors were more common in HWs, which also displayed a higher incidence of granulosa cell tumors of the ovaries. Vascular tumors of the mesenteric lymph nodes, thymomas and follicular cell tumors of the thyroids were recorded at a higher incidence in HWs than in SDs. Tumor profiles of other common tumors were broadly similar between the two strains. The results of this survey correlate closely with similar comparisons made at other laboratories, and with data compiled at our laboratories 10 years ago and published as a poster. (DOI: 10.1293/tox.2020-0005; J Toxicol Pathol 2020; 33: 189–196)

Key words: rat, Sprague-Dawley, Han Wistar, longevity, spontaneous tumors

The data used for collation comprised: 13 Han Wistar (HW) rat studies (16 control groups of 879 males and 879 females in total) obtained from Harlan (UK) Limited, Envigo RMS (UK) or Charles River (UK) Limited; 13 Sprague-Dawley (SD) rat studies (13 control groups of 876 males in total, and 15 control groups of 1,016 females in total) obtained from Charles River (UK) Limited. Animals were obtained between ages 7 to 9 weeks and acclimatized for at least 7 days before being placed on a study. They were cage-housed in environmentally controlled (temperature: 20–24°C and humidity: 40–70%) full barrier buildings and fed a commercially available standard diet (pelleted Rat and Mouse No. 1 Maintenance Diet) *ad libitum*, with access to water at all times. All studies were conducted in AAALAC-accredited facilities, and in accordance with the UK Animals (Scientific Procedures) Act 1986, which conforms to the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, Council of Europe). Tumors were diagnosed and classified according to the guidelines for proliferative lesions of each organ system published by the Society of Toxicological Pathology/INHAND.

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Survival

The overall survival rates for control animals in the studies selected are presented in Table 1. Where necessary, animals were euthanased before scheduled sacrifice in accordance with set humane endpoints for the study type and the company's guidelines.

The mean percentage survival in HW rats was greater than that in SD rats in both sexes, and females showed lower survival than males in both strains.

Common neoplastic findings

Tumor incidences in carcinogenicity studies run over the last 7 years at two of our laboratories were collated and profiles compared between HWs and SDs. The results closely reflected a similar survey carried out at different laboratories and published in 2017, despite geographical and husbandry differences[1].

The classification of tumors as common or rare is based on the criteria set out in FDA draft document. Statistical Aspects of the Design, Analysis, and Interpretation of Chronic Rodent Carcinogenicity Studies of Pharmaceuticals. Tumors occurring at an overall incidence of 1% or less are classified

Table 1. Mean Percentage Survival (%)

	Animals surviving to scheduled euthanasia[a]					
	Male			Female		
	mean	min	max	mean	min	max
HW rats	69.6	56.4	85.0	65.5	49.1	80.0
SD rats	41.9	27.7	52.9	37.0	23.1	51.4

[a]Mean percentage survival represents the average survival calculated from the total number of control groups for each sex/strain combination. The range presented is based on the control groups within each sex/strain combination with the lowest and highest percentage survival.

as rare; tumors occurring at an overall incidence greater than 1% are classified as common. The findings listed in the tables are those which have reached an overall incidence of greater than 1% in one or more of the strain/sex combinations in the selected studies. For completeness, both the benign and malignant forms of the neoplastic findings are presented, where appropriate, even if both have not reached the 1% threshold.

The overall incidence (with percentage), and range of incidences in individual studies for common tumors in Han Wistar and SD rats are presented in Tables 2 (Males) and 3 (Females).

Table 2. Incidence and Range of Common Neoplastic Findings in Male Han Wistar and Sprague-Dawley Rats

Males		Han Wistar rats			SD rats		
		Totals	Range of percentages		Totals	Range of percentages	
			min	max		min	max
	Number of animals	879			876		
ENDOCRINE SYSTEM							
Pituitary	No examined	870			865		
Adenoma, Pars Distalis	Incidence	354			366		
	Percentage	40.69%	15.0%	66.7%	42.31%	29.7%	60.0%
	Incidence	0			2		
Carcinoma, Pars Distalis	Percentage	0.00%	0.0%	0.0%	0.23%	0.0%	2.8%
Thyroids	No examined	877			871		
Adenoma, Follicular Cell	Incidence	71			26		
	Percentage	8.10%	0.0%	15.3%	2.99%	0.0%	11.4%
Carcinoma, Follicular Cell	Incidence	9			5		
	Percentage	1.03%	0.0%	9.1%	0.57%	0.0%	3.2%
Adenoma, C-Cell	Incidence	104			72		
	Percentage	11.86%	3.6%	21.8%	8.27%	0.0%	20.6%
Carcinoma, C-Cell	Incidence	5			15		
	Percentage	0.57%	0.0%	2.0%	1.72%	0.0%	5.7%
Adrenals	No examined	879			876		
Adenoma, Cortical	Incidence	11			12		
	Percentage	1.25%	0.0%	4.0%	1.37%	0.0%	8.3%
Carcinoma, Cortical	Incidence	0			0		
	Percentage	0.00%	0.0%	0.0%	0.00%	0.0%	0.0%
Pheochromocytoma, Benign	Incidence	39			96		
	Percentage	4.44%	0.0%	12.0%	10.96%	0.0%	21.7%
Pheochromocytoma, Malignant	Incidence	7			16		
	Percentage	0.80%	0.0%	5.5%	1.83%	0.0%	4.3%
Endocrine Pancreas	No examined	875			872		
Adenoma, Islet Cell	Incidence	58			82		
	Percentage	6.63%	1.7%	12.0%	9.40%	3.1%	14.3%
Carcinoma, Islet Cell	Incidence	12			16		
	Percentage	1.37%	0.0%	9.1%	1.83%	0.0%	4.7%
Parathyroids	No examined	827			828		
Adenoma, Chief Cell	Incidence	14			11		
	Percentage	1.69%	0.0%	5.4%	1.33%	0.0%	7.5%
INTEGUMENT AND MAMMARY							
Mammary Glands	No examined	850			869		
Mammary Adenoma	Incidence	1			3		
	Percentage	0.12%	0.0%	1.8%	0.35%	0.0%	1.6%
Mammary Fibroadenoma	Incidence	2			11		
	Percentage	0.24%	0.0%	2.0%	1.27%	0.0%	3.3%
Mammary Adenocarcinoma	Incidence	0			6		
	Percentage	0.00%	0.0%	0.0%	0.69%	0.0%	1.6%

Table 2. Continued

Males		Han Wistar rats			SD rats		
		Totals	Range of percentages		Totals	Range of percentages	
			min	max		min	max
Skin and Subcutis	No examined	879			874		
Tumor, Basal Cell, Benign	Incidence	3			11		
	Percentage	0.34%	0.0%	2.0%	1.26%	0.0%	4.2%
Tumor, Basal Cell, Malignant	Incidence	1			1		
	Percentage	0.11%	0.0%	1.8%	0.11%	0.0%	1.5%
Fibroma	Incidence	25			107		
	Percentage	2.84%	0.0%	10.9%	12.24%	2.9%	21.5%
Fibrosarcoma	Incidence	11			15		
	Percentage	1.25%	0.0%	4.0%	1.72%	0.0%	4.2%
Keratoacanthoma	Incidence	60			50		
	Percentage	6.83%	0.0%	13.3%	5.72%	0.0%	11.7%
Lipoma	Incidence	17			20		
	Percentage	1.93%	0.0%	6.0%	2.29%	0.0%	5.6%
Liposarcoma	Incidence	1			1		
	Percentage	0.11%	0.0%	2.0%	0.11%	0.0%	1.5%
Adenoma, Sebaceous Cell	Incidence	1			9		
	Percentage	0.11%	0.0%	2.0%	1.03%	0.0%	3.1%
Carcinoma, Sebaceous Cell	Incidence	2			2		
	Percentage	0.23%	0.0%	1.9%	0.23%	0.0%	1.7%
Papilloma, Squamous Cell	Incidence	5			13		
	Percentage	0.57%	0.0%	2.0%	1.49%	0.0%	4.2%
Carcinoma, Squamous Cell	Incidence	4			6		
	Percentage	0.46%	0.0%	3.8%	0.69%	0.0%	6.9%
REPRODUCTIVE SYSTEM							
Testes	No examined	878			875		
Adenoma, Leydig Cell	Incidence	18			26		
	Percentage	2.05%	0.0%	6.0%	2.97%	0.0%	8.6%
CENTRAL NERVOUS SYSTEM							
Brain	No examined	879			876		
Tumor, Granular Cell, Benign	Incidence	27			8		
	Percentage	3.07%	0.0%	9.1%	0.91%	0.0%	3.1%
Tumor, Granular Cell, Malignant	Incidence	3			1		
	Percentage	0.34%	0.0%	2.0%	0.11%	0.0%	1.4%
Astrocytoma	Incidence	7			12		
	Percentage	0.80%	0.0%	5.0%	1.37%	0.0%	3.1%
HEMATOPOIETIC SYSTEM							
Thymus	No examined	860			831		
Thymoma, Benign	Incidence	27			2		
	Percentage	3.14%	0.0%	6.3%	0.24%	0.0%	1.7%
Thymoma, Malignant	Incidence	2			2		
	Percentage	0.23%	0.0%	3.4%	0.24%	0.0%	1.6%
Hematolymphoreticular System	No examined	879			876		
Malignant Lymphoma	Incidence	15			12		
	Percentage	1.71%	0.0%	5.5%	1.37%	0.0%	4.6%
LN Mesenteric	No examined	875			871		
Hemangioma	Incidence	43			10		
	Percentage	4.91%	0.0%	23.3%	1.15%	0.0%	4.7%
Hemangiosarcoma	Incidence	7			2		
	Percentage	0.80%	0.0%	6.0%	0.23%	0.0%	1.5%
DIGESTIVE SYSTEM							
Liver	No examined	878			876		
Adenoma, Hepatocellular	Incidence	8			16		
	Percentage	0.91%	0.0%	5.8%	1.83%	0.0%	6.2%
Carcinoma, Hepatocellular	Incidence	1			5		
	Percentage	0.11%	0.0%	2.0%	0.57%	0.0%	2.8%
Exocrine Pancreas	No examined	875			872		

Table 2. Continued

Males		Han Wistar rats			SD rats		
		Totals	Range of percentages		Totals	Range of percentages	
			min	max		min	max
Adenoma, Acinar Cell	Incidence	1			15		
	Percentage	0.11%	0.0%	1.7%	1.72%	0.0%	4.6%
Adenocarcinoma, Acinar Cell	Incidence	1			1		
	Percentage	0.11%	0.0%	1.9%	0.11%	0.0%	1.6%
RESPIRATORY SYSTEM							
Lungs	No examined	879			876		
Adenoma, Bronchioloalveolar	Incidence	9			2		
	Percentage	1.02%	0.0%	3.6%	0.23%	0.0%	1.5%
Carcinoma, Bronchioloalveolar	Incidence	2			1		
	Percentage	0.23%	0.0%	3.6%	0.11%	0.0%	1.5%

Table 3. Incidence and Range of Common Neoplastic Findings in Female Han Wistar and Sprague-Dawley Rats

Females		Han Wistar rats			SD rats		
		Totals	Range of percentages		Totals	Range of percentages	
			min	max		min	max
	Number of animals	879			1,016		
ENDOCRINE SYSTEM							
Pituitary	No examined	874			1,011		
Adenoma, Pars Distalis	Incidence	512			715		
	Percentage	58.58%	40.7%	74.6%	70.72%	58.6%	84.3%
Carcinoma, Pars Distalis	Incidence	8			21		
	Percentage	0.92%	0.0%	5.8%	2.08%	0.0%	8.3%
Thyroids	No examined	873			1,013		
Adenoma, Follicular Cell	Incidence	26			17		
	Percentage	2.98%	0.0%	10.0%	1.68%	0.0%	6.9%
Carcinoma, Follicular Cell	Incidence	4			2		
	Percentage	0.46%	0.0%	2.0%	0.20%	0.0%	1.5%
Adenoma, C-Cell	Incidence	78			77		
	Percentage	8.93%	4.0%	16.9%	7.60%	2.9%	15.7%
Carcinoma, C-Cell	Incidence	2			12		
	Percentage	0.23%	0.0%	1.9%	1.18%	0.0%	4.3%
Adrenals	No examined	879			1,014		
Adenoma, Cortical	Incidence	11			14		
	Percentage	1.25%	0.0%	5.0%	1.38%	0.0%	3.1%
Carcinoma, Cortical	Incidence	2			4		
	Percentage	0.23%	0.0%	2.0%	0.39%	0.0%	1.5%
Pheochromocytoma, Benign	Incidence	12			26		
	Percentage	1.37%	0.0%	3.3%	2.56%	0.0%	7.1%
Pheochromocytoma, Malignant	Incidence	3			6		
	Percentage	0.34%	0.0%	3.6%	0.59%	0.0%	4.3%
Endocrine Pancreas	No examined	877			1,014		
Adenoma, Islet Cell	Incidence	13			28		
	Percentage	1.48%	0.0%	6.1%	2.76%	0.0%	6.2%
Carcinoma, Islet Cell	Incidence	5			6		
	Percentage	0.57%	0.0%	3.6%	0.59%	0.0%	4.3%
Parathyroids	No examined	824			962		
Adenoma, Chief Cell	Incidence	1			2		
	Percentage	0.12%	0.0%	2.0%	0.21%	0.0%	1.6%

Table 3. Continued

Females		Han Wistar rats			SD rats		
		Totals	Range of percentages		Totals	Range of percentages	
			min	max		min	max
INTEGUMENT AND MAMMARY							
Mammary Glands	No examined	878			1,014		
Mammary Adenoma	Incidence	34			51		
	Percentage	3.87%	0.0%	13.3%	5.03%	0.0%	11.3%
Mammary Fibroadenoma	Incidence	219			539		
	Percentage	24.94%	8.3%	42.0%	53.16%	43.1%	69.2%
Mammary Adenocarcinoma	Incidence	75			297		
	Percentage	8.54%	0.0%	17.3%	29.29%	18.5%	41.5%
Skin and Subcutis	No examined	879			1,014		
Tumor, Basal Cell, Benign	Incidence	2			0		
	Percentage	0.23%	0.0%	2.0%	0.00%	0.0%	0.0%
Tumor, Basal Cell, Malignant	Incidence	0			1		
	Percentage	0.00%	0.0%	0.0%	0.10%	0.0%	1.5%
Fibroma	Incidence	10			14		
	Percentage	1.14%	0.0%	5.5%	1.38%	0.0%	6.3%
Fibrosarcoma	Incidence	8			6		
	Percentage	0.91%	0.0%	4.0%	0.59%	0.0%	3.1%
Keratoacanthoma	Incidence	8			2		
	Percentage	0.91%	0.0%	7.3%	0.20%	0.0%	1.4%
Lipoma	Incidence	4			8		
	Percentage	0.46%	0.0%	1.8%	0.79%	0.0%	5.7%
Liposarcoma	Incidence	0			0		
	Percentage	0.00%	0.0%	0.0%	0.00%	0.0%	0.0%
Adenoma, Sebaceous Cell	Incidence	0			0		
	Percentage	0.00%	0.0%	0.0%	0.00%	0.0%	0.0%
Carcinoma, Sebaceous Cell	Incidence	1			0		
	Percentage	0.11%	0.0%	1.9%	0.00%	0.0%	0.0%
Papilloma, Squamous Cell	Incidence	2			2		
	Percentage	0.23%	0.0%	2.0%	0.20%	0.0%	1.5%
Carcinoma, Squamous Cell	Incidence	2			2		
	Percentage	0.23%	0.0%	2.0%	0.20%	0.0%	1.7%
REPRODUCTIVE SYSTEM							
Ovaries	No examined	879			1,013		
Tumor, Granulosa Cell, Benign	Incidence	18			2		
	Percentage	2.05%	0.0%	5.0%	0.20%	0.0%	1.5%
Tumor, Granulosa Cell, Malignant	Incidence	4			2		
	Percentage	0.46%	0.0%	3.3%	0.20%	0.0%	1.4%
Uterine Cervix	No examined	878			1,014		
Tumor, Granular Cell, Benign	Incidence	0			15		
	Percentage	0.00%	0.0%	0.0%	1.48%	0.0%	7.1%
Tumor, Granular Cell, Malignant	Incidence	0			0		
	Percentage	0.00%	0.0%	0.0%	0.00%	0.0%	0.0%
Uterus	No examined	879			1,014		
Polyp, Endometrial Stromal	Incidence	101			62		
	Percentage	11.49%	5.5%	18.3%	6.11%	1.5%	11.1%
Sarcoma, Endometrial Stromal	Incidence	3			1		
	Percentage	0.34%	0.0%	3.6%	0.10%	0.0%	1.4%
Adenoma, Endometrium	Incidence	9			5		
	Percentage	1.02%	0.0%	6.7%	0.49%	0.0%	3.1%
Adenocarcinoma, Endometrium	Incidence	15			8		
	Percentage	1.71%	0.0%	10.0%	0.79%	0.0%	4.6%
Vagina	No examined	878			1,014		
Tumor, Granular Cell, Benign	Incidence	0			13		
	Percentage	0.00%	0.0%	0.0%	1.28%	0.0%	8.7%
Tumor, Granular Cell, Malignant	Incidence	0			2		
	Percentage	0.00%	0.0%	0.0%	0.20%	0.0%	2.8%
CENTRAL NERVOUS SYSTEM							

Table 3. Continued

Females		Han Wistar rats			SD rats		
		Totals	Range of percentages		Totals	Range of percentages	
			min	max		min	max
Brain	No examined	879			1,016		
Tumor, Granular Cell, Benign	Incidence	12			9		
	Percentage	1.37%	0.0%	5.5%	0.89%	0.0%	5.7%
Tumor, Granular Cell, Malignant	Incidence	1			0		
	Percentage	0.11%	0.0%	1.8%	0.00%	0.0%	0.0%
Astrocytoma	Incidence	1			9		
	Percentage	0.11%	0.0%	1.7%	0.89%	0.0%	2.9%
HEMATOPOIETIC SYSTEM							
Thymus	No examined	871			989		
Thymoma, Benign	Incidence	68			2		
	Percentage	7.81%	0.0%	18.0%	0.20%	0.0%	2.9%
Thymoma, Malignant	Incidence	5			1		
	Percentage	0.57%	0.0%	6.8%	0.10%	0.0%	1.4%
Hematolymphoreticular System	No examined	879			1,016		
Malignant Lymphoma	Incidence	5			4		
	Percentage	0.57%	0.0%	4.0%	0.39%	0.0%	3.1%
LN Mesenteric	No examined	879			1,012		
Hemangioma	Incidence	7			0		
	Percentage	0.80%	0.0%	3.6%	0.00%	0.0%	0.0%
Hemangiosarcoma	Incidence	0			0		
	Percentage	0.00%	0.0%	0.0%	0.00%	0.0%	0.0%
DIGESTIVE SYSTEM							
Liver	No examined	879			1,016		
Adenoma, Hepatocellular	Incidence	10			10		
	Percentage	1.14%	0.0%	3.8%	0.98%	0.0%	3.1%
Carcinoma, Hepatocellular	Incidence	1			0		
	Percentage	0.11%	0.0%	1.7%	0.00%	0.0%	0.0%
Exocrine Pancreas	No examined	877			1,014		
Adenoma, Acinar Cell	Incidence	1			2		
	Percentage	0.11%	0.0%	1.8%	0.20%	0.0%	1.4%
Adenocarcinoma, Acinar Cell	Incidence	0			0		
	Percentage	0.00%	0.0%	0.0%	0.00%	0.0%	0.0%
RESPIRATORY SYSTEM							
Lungs	No examined	879			1,016		
Adenoma, Bronchioloalveolar	Incidence	0			1		
	Percentage	0.00%	0.0%	0.0%	0.10%	0.0%	1.5%
Carcinoma, Bronchioloalveolar	Incidence	0			1		
	Percentage	0.00%	0.0%	0.0%	0.10%	0.0%	1.4%

Endocrine System

Tumors of the endocrine system accounted for the largest proportion of spontaneous tumors in rats of both sexes and both strains. Whereas pituitary tumors occurred at a higher incidence in SDs of both sexes, follicular cell tumors of thyroids were more frequent in HWs, with males in particular being more affected. A similar incidence pattern for these tumors has been recorded at other laboratories[1].

Pituitary

The most common tumor in both strains of animal, and both sexes, was benign pituitary adenoma of the pars distalis, with SD rats showing a higher incidence than HW rats in both sexes, and females showing a higher incidence than males in both strains (Male HW 40.69%; Male SD 42.31%; Female HW 58.58%; Female SD 70.72%). Malignant carcinoma of the pars distalis was rare in male rats of both strains, seen occasionally in female HW rats (0.92%), but occurred commonly in female SD rats (2.08%).

Thyroids

Benign and malignant follicular cell tumors were seen at a greater incidence in males of both strains compared to females, while occurring at a higher incidence in HW rats compared to SD rats in both sexes. Benign follicular cell

adenoma exceeded the Common threshold in both sexes and both strains (Male HW 8.10%; Male SD 2.99%; Female HW 2.98%; Female SD 1.68%). Malignant follicular cell carcinoma reached the common threshold in male HW rats only (1.03%). In both strains and both sexes, benign C-Cell adenoma was more common than follicular cell tumors (Male HW 11.86%; Male SD 8.27%; Female HW 8.93%; Female SD 7.60%). In male HW rats, benign C-Cell adenoma and benign follicular cell adenoma were the second and third most common tumors respectively. Malignant C-Cell carcinoma occurred rarely in HW rats, but reached the common threshold in SD rats of both sexes (Male SD 1.72%; Female SD 1.18%).

Adrenals

Benign pheochromocytoma was seen at a greater incidence in SD rats of both sexes compared to HW rats, while occurring more commonly in males than females in both strains (Male HW 4.44%; Male SD 10.96%; Female HW 1.37%; Female SD 2.56%). Malignant pheochromocytoma reached the common threshold in male SD rats only (1.83%). Benign adrenal cortical adenoma was seen at a lower incidence in comparison to adrenal pheochromocytoma, and at a similar incidence in both sexes and both strains (Male HW 1.25%; Male SD 1.37%; Female HW 1.25%; Female SD 1.38%). Malignant adrenal cortical carcinoma was not reported in HW rats and were only seen rarely in SD rats.

Endocrine pancreas

Benign islet cell adenoma occurred commonly in both strains, with a higher incidence in SD rats compared to HW rats in both sexes, and at a greater incidence in males compared to females in both strains (Male HW 6.63%; Male SD 9.40%; Female HW 1.48%; Female SD 2.76%). Malignant islet cell carcinoma exceeded the common threshold in males of both strains but occurred rarely in females. The incidences were comparable in both strains (Male HW 1.37%; Male SD 1.83%; Female HW 0.57%; Female SD 0.59%).

Parathyroids

Benign chief cell adenoma occurred at a greater incidence in males of both strains compared to females, and at a similar incidence in both strains. These tumors were rare in females but exceeded the common threshold in males (Male HW 1.69%; Male SD 1.33%; Female HW 0.12%; Female SD 0.21%).

Integument and Mammary

In general, all types of mammary gland and skin tumors were reported more often in SDs than in HWs. Mammary fibroadenoma and adenocarcinoma were recorded at a higher incidence in SDs of both sexes than in HWs, although mammary adenoma showed no significant differences between the strains in either sex.

Mammary glands

The second most common tumor type seen in control females were mammary tumors, with SD rats showing a higher incidence of all tumor types compared to HW rats. Benign fibroadenoma was the most commonly occurring tumor (24.94% in HW females and 53.16% in SD females) with a much higher incidence of malignant adenocarcinoma in female SD rats (29.29%) compared to female HW rats (8.54%). Mammary benign fibroadenoma occurred at a common incidence (1.27%) in male SD rats, but benign adenoma and malignant adenocarcinoma were rare. All mammary tumor types were rare in male HW rats.

Skin and subcutis

In males of both strains, tumors of the skin and subcutis were the second most common neoplastic findings seen in control animals. Benign fibroma was the single most common finding of the integument in male SD rats (12.24%), and apart from benign keratoacanthoma which occurred at a slightly higher incidence in male HW rats (6.83% compared to 5.72% in SD rats), all skin/subcutis tumors occurred at a higher incidence in male SD rats compared to male HW rats. In females of both strains, all skin/subcutis tumors with the exception of benign fibroma (1.14% in HW and 1.38% in SD) fell into the rare classification.

Male and Female Reproductive System

In the female reproductive tract, most tumors occurred more frequently in HWs than in SDs (stromal polyp, adenoma and adenocarcinoma of the uterus and granulosa cell tumors of the ovary), with the exception of benign and malignant granular cell tumors which were recorded only in SDs.

The most common neoplastic finding in the female reproductive tract was benign endometrial stromal polyp of the uterus, with a higher incidence in HW rats compared to SD rats (HW 11.49%; SD 6.11%). Benign endometrial adenoma and malignant endometrial adenocarcinoma of the uterus reached the common threshold in HW rats (1.02% and 1.71% respectively) but were rare in SD rats. Benign granulosa cell tumor was the only neoplastic finding in the ovaries to reach the common threshold but did so only in HW rats (2.05%). Benign granular cell tumors of the uterine cervix and vagina were seen only in the SD rat, occurring at an incidence of 1.48% and 1.28% respectively. A low incidence of malignant granular cell tumor was reported in the vagina of the SD rat (0.20%).

The interstrain differences in pituitary, mammary and uterine (in females) tumor incidences are thought to relate to differences in hormonal patterns during senescence[2].

Testes

Benign adenoma of the Leydig cells was common, occurring at a similar incidence in both strains (HW 2.05%; SD 2.97%).

Central Nervous System

Benign granular cell tumor of the brain was common in HW rats of both sexes, but rare in SD rats (Male HW 3.07%; Male SD 0.91%; Female HW 1.37%; Female SD 0.89%). Malignant granular cell tumor was rare in both strains and both sexes. The incidence of malignant astrocytoma exceeded the common threshold in male SD rats only (1.37%).

Hematopoietic System

The most marked differences between the strains were in the lymphoreticular system. Benign thymoma and haemangioma of the mesenteric lymph nodes occurred more frequently in HW rats of both sexes than in SD rats; the higher incidence of these tumors is characteristic of HW rats[1].

Thymus

Benign thymoma occurred commonly in HW rats of both sexes, with a higher incidence in females than males (Male HW 3.14%; Male SD 0.24%; Female HW 7.81%; Female SD 0.20%). Malignant thymoma was rare in both sexes and strains.

Hematolymphoreticular system

The only systemic neoplastic finding to reach the common threshold was malignant lymphoma in males of both strains (Male HW 1.71%; Male SD 1.37%; Female HW 0.57%; Female SD 0.39%).

LN Mesenteric

Benign hemangioma of the mesenteric lymph nodes occurred at a higher incidence in males compared to females and in HW rats of both sexes compared to SD rats (Male HW 4.91%; Male SD 1.15%; Female HW 0.80%; Female SD 0.00%). Malignant hemangiosarcoma was rare in males of both strains and were not reported in females.

Digestive System

Liver

Benign hepatocellular adenoma had a relatively low incidence in both strains and reached the common threshold in male SD rats and female HW rats only (Male HW 0.91%; Male SD 1.83%; Female HW 1.14%; Female SD 0.98%). Malignant hepatocellular carcinoma was rare.

Exocrine pancreas

Benign acinar cell adenoma had a relatively low incidence in both strains and sexes and reached the common threshold in male SD rats only (Male HW 0.11%; Male SD 1.72%; Female HW 0.11%; Female SD 0.20%). Malignant acinar cell adenocarcinoma was rare in males of both strains, and not reported in females.

Respiratory System

Lungs

Benign bronchioloalveolar adenoma had a relatively low incidence in both strains and sexes and reached the common threshold in male HW rats only (Male HW 1.02%; Male SD 0.23%; Female HW 0.00%; Female SD 0.10%). Malignant bronchioloalveolar carcinoma was rare.

Disclosure of Potential Conflicts of Interest: The authors declare that there is no conflict of interest.

References

1. Weber K. Differences in types and incidence of neoplasms in Wistar Han and Sprague-Dawley rats. Toxicol Pathol. **45**: 64–75. 2017. [Medline] [CrossRef]
2. Vidal JD. The impact of age on the female reproductive system: a pathologist's perspective. Toxicol Pathol. **45**: 206–215. 2017. [Medline] [CrossRef]