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Sex-Associated Effects on Hematologic and Serum Chemistry Analytes in Sand Rats (*Psammomys obesus*)

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We sought to determine whether sex had a significant effect on the hematologic and serum chemistry analytes in adult sand rats (*Psammomys obesus*) maintained under normal laboratory conditions. According to the few data available for this species, we hypothesized that levels of hematologic and serum chemistry analytes would not differ significantly between clinically normal male and female sand rats. Data analysis revealed several significant differences in hematologic parameters between male and female sand rats but none for serum biochemistry analytes. The following hematologic parameters were greater in male than in female sand rats: RBC count, hemoglobin, hematocrit, red cell hemoglobin content, and percentage monocytes. Red cell distribution width, hemoglobin distribution width, mean platelet volume, and percentage lymphocytes were greater in female than in male sand rats. The sex of adult sand rats is a source of variation that must be considered in terms of clinical and research data. The data presented here likely will prove useful in the veterinary medical management of sand rat colonies and provide baseline hematologic and serum chemistry analyte information for researchers wishing to use this species.

Psammomys obesus, commonly called the sand rat or fat sand rat, is a diurnal desert animal belonging to the family Muridae and subfamily Gerbillinae. These terrestrial mammals naturally inhabit the salty desert areas of North Africa and regions to the east across the Arabian Peninsula.[5,28,29,37]

Sand rats have been useful animal models for numerous human diseases, but because of the special nutritional requirements and low reproductive performance of this species, they are difficult to breed and maintain in captivity, averaging 2.5 pups per litter.[30,37] Sand rats are prone to develop hyperinsulinemia, hyperglycemia, and obesity when fed a high-energy diet.[1,22] The diabetic state that develops under high-energy conditions can be prevented by feeding the rats a high-fiber, low-carbohydrate diet.[21,22] Researchers at the Hebrew University (Jerusalem, Israel) generated an animal model for type 2 diabetes mellitus by isolating 2 separate lines of sand rats: a diabetes-prone line and a diabetes-resistant line.[2,21,22] Sands rats have also been used as models for the study of otic cholesteatoma, spondylosis, renal function, and numerous diabetes-related disorders.[3,12,27] Sand rats are naturally susceptible to infection with *Leishmania major* and have been identified as the main reservoir host that maintains and transmits leishmaniasis to sand flies in southern and central Israel and southern Iraq.[26,34,35] In addition, sand rats are the most important reservoir host of zoonotic cutaneous leishmaniasis[26] in the Middle East and North Africa.[28,34,35] Most recently, sand rats have been used in behavioral studies and are considered an appropriate model to study circadian mechanisms that are involved in mood and anxiety disorders in humans.[4,10]

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Sand rats currently are not raised at any commercial rodent breeding farms in the United States. Instead, they typically must be bred inhouse or shipped from the Hebrew University–Hadassah Medical Center. Our institution, the Walter Reed Army Institute of Research (Silver Spring, MD), maintains one of the 2 sand rat breeding colonies in the United States. This breeding colony originated from the colony at Wake Forest University (Winston Salem, NC), which itself was established from the well-characterized colony at Hebrew University–Hadassah Medical Center. The colony at the Walter Reed Army Institute of Research is maintained for educational and research purposes.

We performed the present study to determine whether hematologic and serum chemistry analytes differed between male and female adult sand rats. Only limited hematologic, glucose, and insulin values for the diabetic-prone sand rat have been available previously.[1,2,14,21,22,39] Given the admittedly limited data available for diabetes-prone sand rats and the inconsistent published data regarding sex-associated hematologic differences for most of the common laboratory animals,[11] we hypothesized that hematologic and serum chemistry analytes would not differ significantly between clinically normal adult male and female sand rats.[1,22]

Materials and Methods

Animals. All sand rats used in this study were maintained according to accepted animal care and use standards.[19] The protocol was approved by the IACUC and carried out in AAALAC-accredited facilities.

A total of 30 adult sand rats (15 male and 15 female; weight, 130 to 300 g; age, 2.1 to 3.1 y) that had been bred inhouse were used for this study. The sand rats were determined to be healthy based on history, general health, and appearance. Health surveillance reports indicated that these rats were free from common murine pathogens. As part of our institutional

health-surveillance program, serum and fecal samples were submitted quarterly for screening of the following: cilia-associated respiratory bacillus, mouse adenovirus, pneumonia virus of mice, rat coronavirus–sialodacroadenitis virus, reovirus, Sendai virus, Toolan H1 virus, Kilham rat virus, Theiler mouse encephalomyelitis virus, and *Helicobacter* species. Screening was outsourced (BioReliance, Rockville, MD). All sentinels to date have been negative for all tested agents, but the colony is positive for *Helicobacter rodentium*. Additional sentinel rats were submitted to the Diagnostic Pathology Branch (Walter Reed Army Institute of Research, Silver Spring, MD) for a complete necropsy.

Sand rats were either singly or pair-housed in standard polycarbonate rodent cages that contained aspen shavings (Northeastern Products, Warrensburg, NY) and were fitted with stainless-steel wire lids. Cages were changed weekly. Rats were provided extra bedding material and PVC tubes for environmental enrichment. Room conditions included a 12:12-h light:dark cycle, 68 to 79 °F (20.0 to 26.1 °C), relative humidity of 30% to 70%, and a minimum of 10 to 15 changes of HEPA-filtered air hourly. All animal handling and husbandry were performed by trained personnel. Because the colony was *Helicobacter*-positive, all personnel wore Biosafety Level 2 personal protective equipment while interacting with the colony.

Diet. The sand rats had ad libitum access to a custom-formulated nondiabetogenic diet (5L09, Land O' Lakes Purina Feed, Richmond, IN) and water. This hard-pellet diet is high-fiber, low-protein, and low-carbohydrate and contains ground corn, dehulled soybean meal, ground oat hulls, ground aspen, dried beet pulp, fish meal, ground oats, dried brewer's yeast, cane molasses, dehydrated alfalfa meal, dried whey, wheat germ, meat meal, wheat middlings, animal fat preserved with butylated hydroxyanisole, casein, salt, calcium carbonate, choline chloride, calcium pantothenate, folic acid, DL-methionine, ferrous sulfate, manganous oxide, zinc oxide, ferrous carbonate, copper sulfate, zinc sulfate, calcium iodate, cobalt carbonate, and vitamins D_3, A, E, and B complex supplements. The guaranteed analysis is: crude protein (minimum), 20.0%; crude fat (minimum), 3.0%; crude fiber (maximum), 18.0%; ash (maximum), 8.0%; and added minerals (maximum), 2.5%.

Experimental procedures. We considered several issues when determining the number of sand rats to be used in this study: 1) the need to generate statistically significant information; 2) the importance of minimizing the number of animals that had to be euthanized to generate this information; and 3) the availability of this uncommon animal species. Animal numbers were determined by using a 2-sample test to calculate power for comparing hematologic values between female and male sand rats. Because established blood values for sand rats are scant, we used reference values from a related species, the Mongolian gerbil (*Meriones unguiculatus*). We determined that 15 animals per sex would give 80% power to detect a difference of 1 SD between male and female sand rats. A total of 30 clinically normal sand rats older than 6 mo were selected randomly from the colony and divided into 2 groups based on sex (male, $n = 15$; and female, $n = 15$) for hematology and serum chemistry analysis. Because previous work indicated that fasting did not cause a significant change in the blood glucose levels of sand rats,[14] feed was not withheld before blood collection. All sampling was performed between 0700 and 1000. At the time of blood collection, sand rats were euthanized by CO_2 narcosis, and whole blood (11/2 to 3 mL) was obtained by cardiocentesis via a 22-gauge needle (Monoject, Tyco HealthCare Group, Mansfield, MA) and 3-mL syringe (Monoject). A 0.5-mL volume of blood was placed in a microtainer tube containing EDTA (Becton Dickinson, Franklin Lakes, NJ), and the remainder was placed in a serum separator tube (Kendall, Corvac, Tyco HealthCare Group).

Hematologic analysis. Blood collected in EDTA microtainer tubes was refrigerated at 2 to 8 °C, and samples were analyzed within 2 to 3 h of collection. Hematologic parameters were analyzed at the Diagnostic Pathology Branch, Clinical Pathology Laboratory, which is a member of the Veterinary Laboratory Association Quality Assurance Program. Parameters were measured automatically by using a hematology analyzer (Advia 120 Hematology System, Siemens Healthcare Diagnostics, Deerfield, IL). Hematologic parameters studied included the following: WBC count, RBC count, hemoglobin concentration, hematocrit, MCV, MCH, MCHC, cellular hemoglobin mean concentration value, red cell hemoglobin content, RBC distribution width, hemoglobin distribution width, platelet count, mean platelet volume, neutrophils, lymphocytes, monocytes, eosinophils, and basophils.

Biochemical analysis. Blood collected in serum separator tubes was allowed to clot at room temperature for approximately 1 h and centrifuged at $1500 \times g$ for 5 min (blood mode) by using a Clay Adams Triac Centrifuge (Becton Dickinson). Serum then was transferred into a fresh 1.5-mL microfuge tube (Fisherbrand Microcentrifuge Tubes, Fisher Scientific, Pittsburgh, PA) and stored at 2 to 8 °C until samples were analyzed. Serum samples were analyzed within 8 h of collection. Biochemical parameters were analyzed at the Diagnostic Pathology Branch, Clinical Pathology Laboratory. Samples were measured by an automatic chemistry analyzer (Vitros 350; Ortho Clinical Diagnostics, Rochester, NY). Biochemical parameters studied included the following: glucose, BUN, creatinine, sodium, potassium, chloride, carbon dioxide, calcium, phosphorus, cholesterol, triglycerides, total protein, albumin, AST, ALT, LDH, creatine kinase, ALP, and total bilirubin.

Statistical analysis. Statistical analysis was performed by using both SAS (SAS Institute, Cary, NC) and R (R Foundation for Statistical Computing, Vienna, Austria) software.[32,36] Significance was set to a P level of less than 0.05. The sample data for each parameter were examined to determine appropriate statistical methods for the analysis. We were concerned with the underlying distributional assumption (normal distribution) and in identifying possible outliers that would affect the results. Four statistical tests (Shapiro–Wilk, Kolmogorov–Smirnov, Cramer–von Mises, and Anderson–Darling) and 2 graphical methods (normal probability plots and box plots) were used to identify any parameters for which assumption of normality might be problematic.

As for normality, we used several statistical tests and graphical methods (the Dixon, Grubbs, Z-score, and Tukey tests) to identify potential outliers in the data.[8,9,17,18,33,38] The Dixon and Grubbs tests both produce P values that test the null hypothesis of no outliers; P values greater than 0.05 suggest that outliers may be present in the data. Points with Z-scores of more than 3 standard deviations from the mean (Z-score > 3.0) are considered possible outliers. For the Tukey test, values more than 1.5 times away from the limits of the interquartile range are considered possible outliers.

Results for parameters based on normality and outlier tests. We defined several categories to describe the results of statistical analysis based on the results of tests of normal distribution and outliers of the various parameters. Normal-based analysis was appropriate for category 1 parameters; for most parameters in this category, no statistical or graphical test rejected the assumption of normality or identified a potential outlier.

Parameters in category 1 included chloride, potassium, glucose, phosphorus, total protein, RBC count, hematocrit, RBC distribution width, CH concentration value, absolute number of eosinophils, platelet count, cholesterol, cell hemoglobin mean concentration value, percentage of neutrophils, absolute number of neutrophils, percentage of lymphocytes, absolute number of lymphocytes, percentage of monocytes, absolute number of monocytes, carbon dioxide, BUN, albumin, and calcium. Data for category 2 showed clear outliers, but assumption of normality was reasonable, given that tests without the outliers failed to reject assumptions of normality. For category 2 parameters, analysis was conducted with and without the outliers or by using robust methods to assess effect. Parameters in category 2 included WBC count, MCV, MCH, MCHC, hemoglobin, hemoglobin distribution width, and sodium. Regarding data for category 3 parameters, removing outliers did not change the results of tests of normality, but appropriate transformations of the data led to data that could be analyzed by using traditional analysis under the assumption of normality. Parameters in Category 3 included MPV, percentage of eosinophils, percentage of basophils, absolute number of basophils, triglycerides, AST, ALT, LDH, creatine kinase, and ALP. Data for category 4 parameters demonstrated various other issues such that normal-based analysis was not appropriate. These parameters were discrete or categorical in nature. Nonparametric or robust methods were used to analyze these parameters. Parameters in category 4 included total bilirubin and creatinine.

Results

Values for hematologic parameters demonstrated several significant differences between female and male sand rats, but none of the serum biochemistry analytes showed sex-associated differences (that is, $P > 0.10$). The following hematologic parameters (mean ± 1 SD) were greater in male than in female sand rats: RBC count, hemoglobin concentration, hematocrit, RBC hemoglobin content, and percentage of monocytes. RBC distribution width, hemoglobin distribution width, MPV, and percentage of lymphocytes were greater in female than in male sand rats (Table 1). Serum chemistry analytes appear in Table 2.

For parameters in categories 1 and 3, we conducted a traditional normal analysis. All category 2 parameters were tested both with and without potential outliers. All category 4 parameters were tested by using nonparametric procedures. The category 2 parameters of WBC, MCV, MCH, sodium, and MCHC did not show significant differences between male and female sand rats regardless of whether potential outliers were included in the data analyzed. However, the parameters of hemoglobin and hemoglobin distribution width showed significant ($P < 0.05$) differences between sexes when potential outliers removed from the data. Sex had a marginally significant effect or a near-significant effect on albumin ($P \leq 0.0728$) and percentage of neutrophils ($P \leq 0.0710$). Because marginally significant data are subject to interpretation by the individual researcher, we decided to classify these parameters as having no significant difference due to sex.

Discussion

Of the hematologic values that were significantly greater in male than in female sand rats, 4 (RBC count, hemoglobin, HCT, and RBC hemoglobin content) are related to hemoglobin capacity. Of these, RBC count, hemoglobin, and HCT appear the most important. The difference in RBC hemoglobin content, although statistically significant, is small (1 pg), and the reference ranges for male and female sand rats overlap considerably (Table 1). The measured difference of RBC hemoglobin content, therefore, is unlikely to have a biologic significance.

Because hematologic and biochemical values for common laboratory animals can vary widely depending on strain, age, and even fasting state,[20] direct comparison with data from sand rats is likely of limited value. However, because of the large amount of data from laboratory animals, especially rats (*Rattus norvegicus*) and mice (*Mus musculus*), comparison of general trends might be useful. Like sand rats, other rodent species including rats, mice, and Mongolian gerbils exhibit increased erythrocyte indices in males (although statistical analysis for significance is not reported in all references).[6,7,15,24,31] One hypothesis for the difference between male and female erythrocyte indices is that the male has a greater muscle mass and therefore requires greater hemoglobin-carrying capacity. However, other factors affecting erythrocyte indices cannot be excluded. For example, in rats, the difference between male and female RBC count and hemoglobin varies with age and, in some cases, reverses; for example, female rats have greater RBC values at 3 to 7 wk than do males, and at 88 to 150 wk old, hemoglobin in female rats is greater than that of males of similar age.[24]

In addition, percentage of monocytes is significantly greater for male than female sand rats. Rats[15] and Mongolian gerbils[7] show similar sex-associated differences, but the magnitude of the difference was much less, but female mice had higher percentages of monocytes.[6] In addition, as seen with some erythrocyte indices, sex-associated difference regarding percentage of monocytes in rats can vary with time and even reverse: at 23 to 47 wk old, female rats have a greater percentage of monocytes than do male rats.[15]

The following measures were greater in female than male sand rats: percentage of lymphocytes, mean platelet volume, hemoglobin distribution width, and RBC distribution width. Both distribution width indices tend to reflect variability within the RBC population, whereas mean platelet volume addresses variability in platelet size. Among Wistar rats older than 17 wk, males have a greater HDW than do females.[16] In sand rats the sex-associated difference in hemoglobin distribution width is small, and the sex-specific reference ranges overlap considerably. This difference is unlikely to be biologically significant. Comparing sex-associated differences in RBC distribution width and mean platelet volume in sand rats with those of other species produces mixed results. For example, RBC distribution width is greater in male than female rats but greater in female than male mice. Both male rats and mice have slightly higher values for mean platelet volume.[6,15] Probably the most conspicuous sex-associated difference in hematologic parameters for which the measure is greater in female than male sand rats is in percentage of lymphocytes. The magnitude of this difference between female and male sand rats is relatively large (13.5%), and the data follow the same pattern in rats, mice, and Mongolian gerbils as in sand rats.[6,15,24] However, neither total number of lymphocytes nor measures for any other leukocyte parameter (differential count) differed between male and female sand rats. Therefore, the importance of this difference in percentage of lymphocytes is difficult to interpret. It is most likely reflects increased percentages in male sand rats in both percentages monocytes (significant at $P \leq 0.0342$) and neutrophils (marginally significant at $P \leq 0.0710$). If the percentages of monocytes and neutrophils increase, then the percentage of lymphocytes must decrease. Regardless, given the lack of sex-associated significant differences in the absolute differential count, the increased percentage of lymphocytes in female sand rats is unlikely to be clinically important.

Table 1. Hematologic values in adult sand rats

	Unit	Female sand rats	Male sand rats
RBC count[a]	$\times 10^6/\mu L$	6.22 ± 0.56 (n = 12)	7.20 ± 0.73 (n = 14)
Hemoglobin[a]	g/dL	10.88 ± 1.04 (n = 12)	12.84 ± 1.21 (n = 14)
Hematocrit[a]	%	37.80 ± 4.36 (n = 12)	44.51 ± 4.26 (n = 14)
MCV	fL	61.63 ± 1.75 (n = 11)	61.91 ± 2.53 (n = 14)
MCH	pg	17.50 ± 0.83 (n = 12)	17.85 ± 0.66 (n = 14)
MCHC	g/dL	28.83 ± 1.21 (n = 12)	28.85 ± 0.64 (n = 14)
RBC hemoglobin mean concentration value	g/dL	27.64 ± 0.84 (n = 12)	28.05 ± 0.70 (n = 14)
RBC hemoglobin content[a]	pg	16.74 ± 0.65 (n = 12)	17.33 ± 0.72 (n = 14)
RBC distribution width[a]	%	13.43 ± 0.96 (n = 12)	12.57 ± 0.84 (n = 14)
Hemoglobin distribution width[a]	g/dL	1.89 ± 0.13 (n = 11)	1.81 ± 0.08 (n = 13)
Platelet count	$\times 10^3/\mu L$	536.18 ± 179.46 (n = 12)	502.29 ± 127.57 (n = 14)
Mean platelet volume[a]	fL	13.23 ± 1.94 (n = 12)	11.97 ± 1.15 (n = 14)
WBC count	$\times 10^3/\mu L$	5.22 ± 2.19 (n = 11)	5.47 ± 1.78 (n = 14)
% Neutrophils	%	17.48 ± 4.75 (n = 12)	21.52 ± 7.21 (n = 14)
% Lymphocytes[a]	%	67.32 ± 7.84 (n = 12)	58.99 ± 11.51 (n = 14)
% Monocytes[a]	%	11.98 ± 3.54 (n = 12)	15.61 ± 5.32 (n = 14)
% Eosiniophils	%	1.39 ± 0.70 (n = 12)	1.98 ± 1.10 (n = 14)
% Basophils	%	1.62 ± 1.63 (n = 12)	1.84 ± 1.97 (n = 14)
Absolute no. of neutrophils	$\times 10^3/\mu L$	1.02 ± 0.58 (n = 12)	1.12 ± 0.46 (n = 14)
Absolute no. of lymphocytes	$\times 10^3/\mu L$	3.99 ± 2.16 (n = 12)	3.33 ± 1.50 (n = 14)
Absolute no. of monocytes	$\times 10^3/\mu L$	0.69 ± 0.36 (n = 12)	0.83 ± 0.29 (n = 14)
Absolute no. of eosinophils	$\times 10^3/\mu L$	0.08 ± 0.05 (n = 12)	0.10 ± 0.04 (n = 14)
Absolute no. of basophils	$\times 10^3/\mu L$	0.09 ± 0.12 (n = 12)	0.09 ± 0.07 (n = 14)

Data are expressed as mean ± 1 SD.
[a]Significant ($P < 0.05$) difference between male and female sand rats.

Table 2. Serum chemistry values in adult sand rats

	Unit	Female sand rats	Male sand rats
Albumin	g/dL	2.16 ± 0.19 (n = 14)	2.01 ± 0.29 (n = 15)
Albumin:globulin ratio	—	0.84 ± 0.082 (n = 14)	0.79 ± 0.074 (n = 15)
ALP	U/L	35.55 ± 20.10 (n = 11)	43.93 ± 24.69 (n = 15)
ALT	U/L	192.92 ± 175.58 (n = 12)	162.79 ± 68.35 (n = 14)
Anion gap	mmol/L	17.03 ± 2.47 (n = 10)	17.58 ± 2.99 (n = 12)
AST	U/L	240.90 ± 225.96 (n = 10)	219.71 ± 162.34 (n = 14)
BUN	mg/dL	32.21 ± 5.45 (n = 14)	32.80 ± 4.43 (n = 15)
Calcium	mg/dL	9.89 ± 0.76 (n = 14)	9.59 ± 0.85 (n = 15)
Chloride	mmol/L	128.14 ± 5.76 (n = 14)	127.13 ± 4.19 (n = 15)
Cholesterol	mg/dL	83.93 ± 12.01 (n = 14)	77.4 ± 17.01 (n = 15)
Creatine kinase	U/L	262.44 ± 122.88 (n = 10)	431.55 ± 215.06 (n = 11)
CO_2	mmol/L	20.50 ± 4.81 (n = 14)	23.00 ± 3.22 (n = 15)
Creatinine	mg/dL	0.41 ± 0.08 (n = 14)	0.46 ± 0.11 (n = 15)
Globulin	g/dL	2.59 ± 0.22 (n = 14)	2.54 ± 0.23 (n = 15)
Glucose	mg/dL	83.36 ± 15.56 (n = 14)	72.27 ± 21.61 (n = 15)
LDH	U/L	706.45 ± 524.71 (n = 11)	565.08 ± 519.53 (n = 13)
Phosphorus	mg/dL	5.16 ± 1.65 (n = 14)	4.77 ± 1.37 (n = 15)
Potassium	mmol/L	7.04 ± 1.18 (n = 11)	6.75 ± 1.48 (n = 14)
Sodium	mmol/L	161.50 ± 2.90 (n = 10)	160.21 ± 5.28 (n = 14)
Total bilirubin	mg/dL	0.51 ± 0.27 (n = 14)	0.39 ± 0.26 (n = 15)
Total protein	g/dL	4.76 ± 0.31 (n = 14)	4.55 ± 0.48 (n = 15)
Triglycerides	mg/dL	113.86 ± 57.09 (n = 14)	113.80 ± 82.54 (n = 15)

Data are expressed as mean ± 1 SD. None of these analytes differed significantly between male and female sand rats.

Even though the remaining hematology and clinical chemistry values in sand rats lacked significant sex-associated differences, it is useful to compare these values with those of other rodents, again being careful not to draw too great of an inference for the reasons previously stated. The comparison for clinical chemistry values is enhanced due to published biochemistry values for fat-tailed jirds (*Pachyuromys duprasi*),[13] which are closer phylogenetically to sand rats than are either rats or mice. The mean glucose level of 78 mg/dL in sand rats is much lower than that in rats, mice, and Mongolian gerbil and is considerably lower than that in fat-tailed jirds.[6,13,15] The reason for this relatively low glucose level is unknown, but it is consistent with previously published glucose values in nondiabetic sand rats.[14,23,30]

Compared with that in rats and mice, BUN in sand rats (33 mg/dL) is markedly elevated. However, when compared with those of fat-tailed jirds (25.7 mg/dL)[13] and Mongolian gerbils (20.9 mg/dL)[24] the difference is less striking. This similarity may be due to the environmental adaptations of sand rats, fat-tailed jirds, and Mongolian gerbils, all of which must survive in semiarid environments and therefore must have increased renal concentration ability. Other serum chemistry analytes in sand rats that are more comparable to those of fat-tailed jirds than rats or mice include phosphorus, total protein, and ALT.[6,13,15] Why these serum chemistry analytes are similar between sand rats and fat-tailed jirds is unclear. In addition, sand rats had a markedly low ALP (40 U/L)—those of rats, mice, and fat-tailed jirds are 2 to 3 times higher.[6,13,15] The reason underlying this difference is unknown, and because no published values for sand rats are available for comparison with our data, ALP levels in sand rats should be interpreted cautiously. Finally, the platelet count in sand rats is roughly half that of rats or mice, but it is equivalent to that in Mongolian gerbils (means of $536 \times 10^3/mm^3$ in female sand rats, and $502 \times 10^3/mm^3$ in male sand rats, and $600 \times 10^3/mm^3$ in Mongolian gerbils).[25]

In conclusion, the analysis of the results from our sand rat colony produced statistically significant sex-associated differences in a number of hematologic parameters of male and female sand rats, with no such differences in measured serum chemistry analytes. Of the hematologic parameters showing sex-associated differences, the increased erythrocyte indices in male sand rats (RBC count, hematocrit, hemoglobin) are probably the most meaningful clinically or biologically. These differences are consistent with those in other rodent species. Where sex-associated differences did not exist, hematologic and serum chemistry analytes in sand rats are often similar to those of other rodents, such as rats and mice, or those of closer relatives, such as fat-tailed jirds and Mongolian gerbils. For a few parameters, such as ALP, the magnitude of the serum chemistry analyte values in the sand rat appear to be unique to the species. Because our collection was confined to adult sand rats, further enhancement of the hematologic and biochemical profile of sand rats could be undertaken by investigating age or environmental factors that could produce statistically significant differences.

The sex of adult sand rats is a definite source of potential variation that should be considered in experimental design. Given the difficulty in breeding and maintaining sand rats in captivity and the dearth of published information available, we hope that the information presented here will provide useful baseline hematologic and serum chemistry analyte information for researchers wishing to establish a sand rat breeding colony. Reference ranges were not provided because of the considerable variability that can occur between laboratories and the dependence of these values on the methodology, reagents, and instrumentation used.

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