



Tamil Nadu Forest Department
ADVANCED INSTITUTE FOR WILDLIFE CONSERVATION
(Research, Training & Education)
Vandalur



PROJECT COMPLETION REPORT
ON

**'HAEMATOLOGICAL AND BIOCHEMICAL
ASSESSMENT OF HEALTH IN CAMP ELEPHANTS AT
ANAMALAI AND MUDUMALAI CAMPS'**



**Annual Plan of Operations
(APO) Project
(2021-2022)**



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ADVANCED INSTITUTE FOR WILDLIFE CONSERVATION
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Vandalur, Chennai – 600 048.



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CENTRE FOR ANIMAL CARE SCIENCES

August 2023

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- **All Project Scientists, SRFs, JRFs, Project Assistants, Lab Assistants of AIWC**

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PROJECT COMPLETION REPORT

Title of the Project: 'HAEMATOLOGICAL AND BIOCHEMICAL ASSESSMENT OF HEALTH IN CAMP ELEPHANTS AT ANAMALAI AND MUDUMALAI ELEPHANT CAMPS'

Project Category: Annual Plan of Operations (APO) Project

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ABSTRACT

Haematological and serum biochemical analyses were carried out on blood samples collected from elephants at Anamalai Tiger Reserve (ATR) and Mudumalai Tiger Reserve (MTR) camps. Blood samples were collected from each individual elephant (10 ml/individual) in every two-month period starting from November 2022. Totally 25 elephants (16 males and 9 females) in ATR and 24 elephants (18 males and 6 females) in MTR were accessed for blood sample collection. Haematological parameters were analyzed by an automated analyzer 'Mindray' and serum biochemical parameters were analysed by 'IDEXX'. Results showed that the haematological and serum parameters were within the reference interval in all elephants except one or two in both camps, which were affected by wounds during the blood sample collection. There was

Key words:

- Blood parameters
- Serum Biochemistry
- RBC
- WBC
- Platelet
- Blood glucose
- Creatinine

an age-related difference in some parameters such as WBC, platelets, creatinine and calcium. Minimal differences were found between males and females, in some parameters like platelet, creatinine, and calcium values. Other parameters remained constant over age, seasons and sexes.

Based on the values obtained from healthy elephants, reference intervals of haematological and serum biochemical parameters for camp elephants were established. The outcome of the project will be helpful to forest veterinarians and camp managers in health assessment of camp elephants. The data will also be very useful to researchers who are involving in such studies on elephants.

Introduction

Elephants are the largest land-living animals and are the mega herbivores. There are three species of elephants in the world. They are African Savanna or bush elephant (*Loxodonta africana*), African forest elephant (*Loxodonta cyclotis*) and the Asian elephant (*Elephas maximus*) (Fig. 1). Taxonomic classification of elephant is given below:

Domain:	Eukaryota
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Proboscidea
Superfamily:	Elephantoidea
Family:	Elephantidae

African Elephants



African Bush Elephant

Asian Elephants



Indian Elephant



Borneo Pygmy Elephant



African Forest Elephant



Sri Lankan Elephant



Sumatran Elephant

Figure 1. Species and subspecies of Elephants in the world

(Image source: Animalspot.net)

Asian elephant or Asiatic elephant is distributed throughout the Indian subcontinent and Southeast Asian countries like India, Nepal, Sumatra and Borneo in the east (Shoshani, 2005). Three subspecies of Asian elephants viz., *E. m. maximus* (from Sri Lanka), *E. m. indicus* (from mainland Asia) and *E. m. sumatranus* (from the island of Sumatra) have been documented. Some taxonomists have reported one more subspecies known as *E. m. borneensis* (Borneo Pygmy Elephant) (Fig. 1). Elephants are inseparable from Indian history, culture and religion. They are umbrella species and they play major role in maintaining and creating habitats. Though it is a large animal, they can be easily tamed and trained to do many works.

In Tamil Nadu, many elephant camps have been established to maintain captive elephants. Mudumalai and Topslip elephant camps are internationally recognized elephant camps. The camp elephants were previously exploited mainly for timber-related operations. Now they are utilized for conservation-related activities, tourism purposes and in operations to drive or rescue or to capture wild elephants, which cause problems in human habitation. Unlike free ranging elephants, the camp elephants have restricted freedom for grazing and movements. Captive elephants face many health problems due to controlled living conditions, infection with parasites and being exploited for tourism purposes.



Major infectious diseases of captive elephants are anthrax, foot and mouth disease, tuberculosis, hemorrhagic septicaemia, rabies, tetanus, encephalomyocarditis, herpes virus infection and salmonellosis (Ghimire *et al.*, 2022). Some parasitic diseases such as trypanosomiasis, babesiosis, anaplasmosis and ehrlichiosis affect the blood cells of elephants (Miller *et al.*, 2015). It is reported that captive elephants are commonly affected by foot problems due to lack of exercise, long hours of standing on hard substrates and contamination resulting from standing on



their dung.

The health of camp elephants is regularly inspected by forest veterinarians and medical treatments are provided if found health issues. Diagnosis of blood and serum plays important role in the early detection of health problems. Studies on haematological parameters in captive elephants are scanty in Tamil Nadu. Though few studies have been carried out to investigate the haematological and serum biochemical profiles of captive elephants, they were based on one-time blood sampling and analysis. Repeated samplings and analyses may give a reliable data, which can be used to establish a reference interval of haematological and serum biochemical parameters in camp elephants.

With this background, the present study was undertaken to establish reference intervals of haematological and serum biochemical parameters for camp elephants using data obtained from repeated blood sample analyses.

Objectives



-
1. To estimate various haematological and serum biochemical values in camp elephants in Anamalai and Mudumalai forest camps
 2. To interpret the haematological and serum biochemical values to assess animal health status
 3. To establish haematological and serum biochemical reference values specific to camp elephants in Tamil Nadu
 4. To develop healthcare recommendations for camp elephants to improve veterinary care

REVIEW AND STATUS OF RESEARCH AND DEVELOPMENT IN THE SUBJECT

International Status

Elephants are the largest land living animals in the world. There are around 4,50,000 elephants exist throughout the world (Hannah Ritchie, 2022). Captive elephants are prone to tuberculosis, helminthiasis, Endotheliotropic Elephant Herpes Virus (EEHV), arthritis, ocular inflammation and opacity, foot lesions, abscesses, ulcerations, anaemia and dehydration (Clubb and Mason, 2002). Disease symptoms are not visible at earlier stages in elephants. But they may display slight signs in their behaviour which can be monitored by the animal keepers if they have close familiarity with the animals (Miller and Fowler, 2014). Dehydration causes low RBC counts whereas over hydration causes an increase in RBC count (Fischbach and Dunning, 2007; Pagana *et al.*, 2015).

Leukocytes, otherwise known as white blood cells (WBC), are blood cells that help the body fight against infections and react against antigens. Additionally, they also



produce, transport and distribute antibodies as part of the body's immune response. The whole count of WBCs serves as a guide to identify the condition and severity of various infections and diseases. Several works have been done on haematological analysis in elephants. Miller and Fowler

(2014) have recorded a WBC count of 12.29×10^3 cells / μL and Silva and Kuruwita (1993a & b) reported 11.50×10^3 cells/ μL). Weiss and Wardrop (2011) reported $13.6 \times 10^3/\mu\text{L}$ cells in Asian elephants and Salakij *et al.* (2005) and Niemuller *et al.* (1990) reported nearly similar values of $15.017 \times 10^3/\mu\text{L}$ and $15.96 \times 10^3/\mu\text{L}$, respectfully.

Elephants have one of the largest RBCs among mammals; the mean diameter of RBC measures nearly 9 μm ($\sim 1.4 \mu\text{m}$ larger than human RBC). They are biconcave discoid in shape, similar in shape to human RBCs, and enucleated. Due to the large size, the RBC count in elephants is lower than human and many other mammals (Benga *et al.*, 2000; Brown and White, 1980; Gromadzka-Ostrowska *et al.*, 1988; Lewis, 1974). Simon (1961) and Lewis (1974) reported RBC count of 2.81×10^6 cells/ μL and 2.88×10^6 cells/ μL , respectively. Weiss and Wardrop (2011) reported RBC count of 2.9×10^6 cells/ μL and Miller and Fowler (2014) reported RBC count of 2.91×10^6 cells/ μL . Salakij *et al.* (2005) reported 2.658×10^6 RBC cells/ μL . Niemuller *et al.* (1990) reported RBC count of 3.13×10^6 cells/ μL . All these previous studies clearly show that the average RBC count lies between 2×10^6 to 3×10^6 cells/ μL .

Haemoglobin is the main component of RBC that is responsible for the transport of oxygen and carbon dioxide. The levels of haemoglobin directly correlate with an organism's capacity to transport gases during respiration. The abnormalities reflected in the values of haemoglobin closely resemble those of RBC and haematocrit since they are all interrelated. Reports of haemoglobin values have been varied among African elephants. Steyrer *et al.*, (2021) reported a higher value of 14.1 g/dL (approx.), a value not reflected in other works. Bartels *et al.* (1962) reported a value of 12.4 g/dL, which was favourably comparable with Allen *et al.* (1985) who reported 11.8 g/dL and Woodford (1979) who reported 11.3 g/dL. Debbie and Clausen (1975) on the other hand reported a significantly low value of 7.08 g/dL. Thrombocytes, or platelets are non-nucleated, flattened and disc-shaped cells of the blood produced primarily in the bone marrow. Platelets are responsible for blood clotting, vasoconstriction, and formation of platelet plugs in the case of wounds and resulting blood loss. Platelet counts are very helpful in assessing bleeding disorders and bone marrow-related diseases. Reports of platelet count in African elephants were also minimal but the values were comparable to those of its Asian counterpart. Steyrer *et al.* (2021) reported a mean count of $284 \times 10^3/\mu\text{L}$ from a range of $182-386 \times 10^3/\mu\text{L}$. du Plessis and Stevens (2002) reported higher, describing values ranging from $229 \times 10^3/\mu\text{L}$ and $622 \times 10^3/\mu\text{L}$, with a mean count of $444.8 \times 10^3/\mu\text{L}$.

Serum biochemicals such as glucose, creatinine, bilirubin, cholesterol, total proteins, albumin/globulin ratio, calcium, phosphate, enzymes like Alanine

Aminotransferase (ALT), Alkaline Phosphatase (ALP), Gamma Glutamyl Transferase (GGT), Amylase and Lipase are important parameters used in the diagnosis of various health issues in elephants. Biochemical studies have been conducted in Asian elephants by many Indian investigators (Jani, 2008; Allwin *et al.*, 2015; Dhairykar *et al.*, 2020; Ranjini *et al.*, 2021)

National Status

Some haematological studies have been done on Asian captive elephants in India. Almost all these studies have reported data of only one time blood sample collection and analysis. Haematological parameters of camp elephants that were maintained by the Forest Department of the Government of Kerala were studied by Nirmalan *et al* (1967). Mean RBC count was recorded as 2.47×10^6 cells/ μL in adult males and 2.40×10^6 cells/ μL in adult non-pregnant females (Nirmalan *et al.*, 1967). They also reported that pregnant females had a significantly lower RBC count than normal females (1.84×10^6 cells/ μL). Gupta *et al.* (2020) studied the haematological parameters of 10 adult female elephants between the age group of 15-40 years in Jaipur. They reported a RBC count of 2.98×10^6 cells/ μL .

Recently Veeraselvam *et al.* (2021) have conducted a haematological study on 46 female captive elephants, which were housed around various parts of Tamil Nadu. These elephants were between 11-62 years old. Their results showed that the average RBC count was 2.92×10^6 cells/ μL . Ranjini *et al.* (2021) obtained a mean RBC count value of 2.62×10^6 cells/ μL for male and 2.37×10^6 cells/ μL for female Asian elephants and Jani (2008) reported 2.64×10^6 cells/ μL . Allwin *et al.* (2015) reported a higher RBC count of 3.47×10^6 cells/ μL in male and 3.16×10^6 cells/ μL in female elephants. All of these values recorded by various Indian researchers fell within the range of $2.17 - 3.47 \times 10^6$ cells/ μL (Boonprasert *et al.*, 2021).

Leucocyte counts are good indicator of acute and chronic diseases in elephants. Dhairykar *et al.* (2020) have analysed haematobiochemical levels in 30 captive elephants at Kanha tiger reserve, Panna tiger reserve and Bandhavgarh tiger reserve in Madhya Pradesh. They reported that total leucocyte count, total erythrocyte count, Hb, HCT, MCH, MCHC, and DLC were higher in sub-adults and these parameters significantly

differs between the tiger reserves. Ranjini *et al.* (2021) reported statistically similar counts of WBC in males ($17.61 \times 10^3 / \mu\text{L}$) and females ($17.20 \times 10^3 / \mu\text{L}$) of Asian elephants.

Serum biochemical analysis of elephants has been reported by many investigators (Gromadzka-Ostrowska *et al.*, 1988; Silva and Kuruwita, 1993; Janyamethakul *et al.*, 2017).

The review of literature on haematological and biochemical studies on elephants in India clearly showed that all of these studies were not repeated and most studies were done on female captive elephants only. The conclusions derived from the above studies on haematological evaluation were supporting the fact that the captive elephants in Tamil Nadu were normal and healthy. However, repeated studies on individuals at different camps and at different seasons are necessary to know the exact health status of camp elephants in Tamil Nadu. Hence the present study was undertaken.

MATERIALS AND METHODS

Place of the study

The haematological analysis was done for camp elephants, which are maintained at Mudumalai Tiger Reserve (MTR) and Anamalai Tiger Reserve (ATR) in Tamil Nadu (Fig.2). In MTR, elephants are kept in two camps namely Theppakadu ($11^{\circ}57'91.2''\text{N}$; $76^{\circ}58'40.3''\text{E}$) and Abhayaranyam ($11^{\circ}55'71.1''\text{N}$; $76^{\circ}56'19.5''\text{E}$). In ATR there are two elephant camps namely Kozhikamuthi ($10^{\circ}44'53.8''\text{N}$; $76^{\circ}84'88.5''\text{E}$) and Varakalayar ($10^{\circ}41'92.9''\text{N}$; $76^{\circ}86'66.1''\text{E}$).

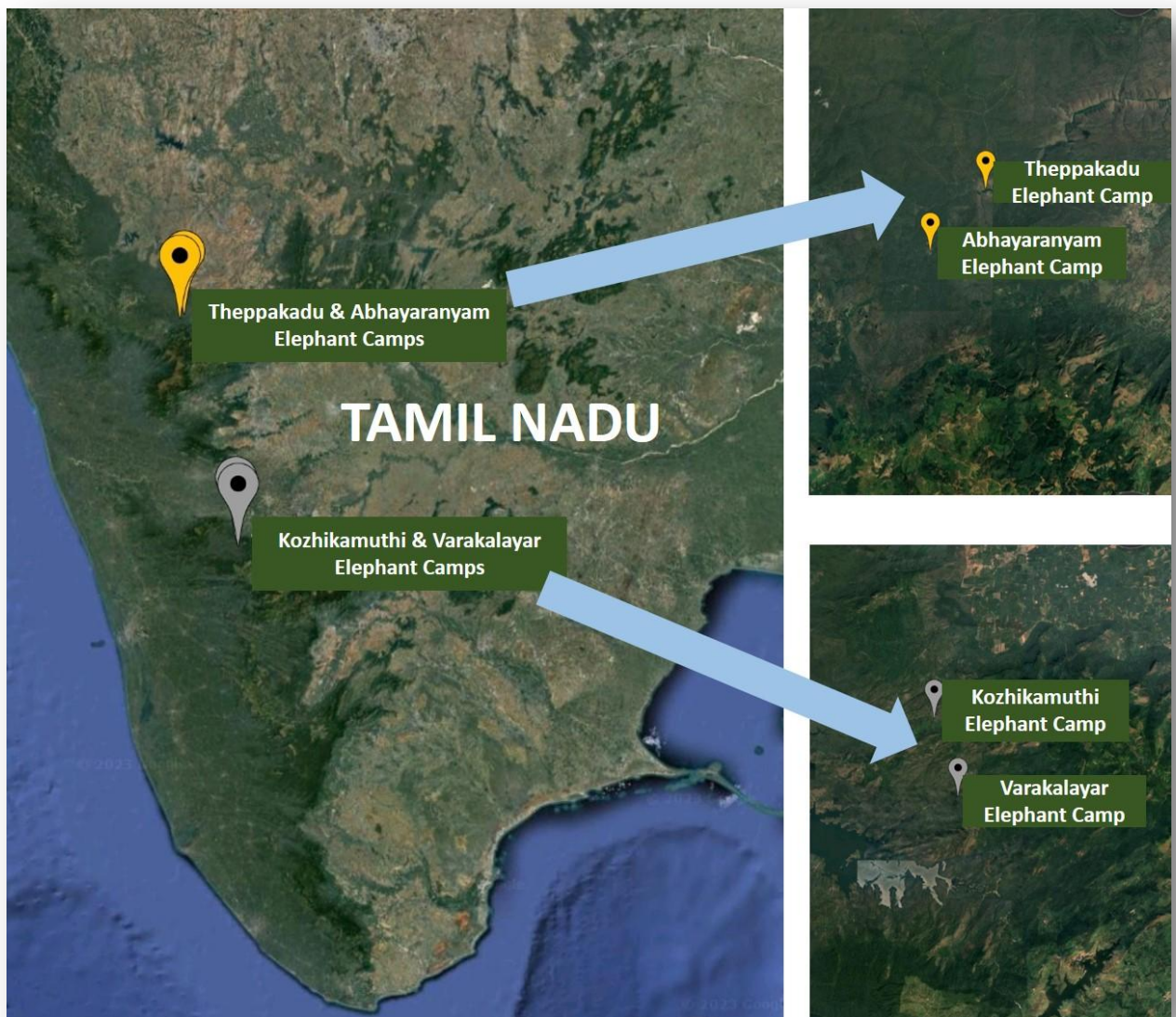


Figure 2. Location Map of Theppakadu and Abhayaranyam Elephant Camps in Mudumalai Tiger Reserve and Kozhikamuthi and Varakalayar Elephant Camps in Anamalai Tiger Reserve

In Tiruchirappalli, Tamil Nadu, 10 elephants are maintained in Elephant Rehabilitation and Rescue Centre (ERRC) in Marama Reddy Palayam (MR Palayam). These elephants have been rescued from private owners and temples. These elephants were also accessed for blood sample collection and analysis. The haematological and serum biochemical values of both camp elephants and ERC elephants were compared

Blood collection

Permission was obtained from Principal Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu for blood sample collection from camp elephants (Ref. No. WL5(A)/28609/2022; dated 22-11-2022 and Permission No. 85/2022). From each elephant, 10 ml of blood was permitted to collect for the studies. The blood was collected by the Forest Veterinary Assistant Surgeon (FVAS) from the auricular vein in the posterior part of the ear of the elephants (Fig. 3-5). The area surrounding the vein was sterilized with 70% alcohol and blood was drawn in butterfly needle. Collected blood was divided into two parts of 5 ml each. One part of blood was directly collected in a EDTA tube and gently mixed. Remaining blood was collected in a clot activator tube and allowed to clot for the separation of serum.

Serum was separated by centrifugation at 3000rpm at 10 minutes and immediately stored under cold environment in ice box. Blood smear was also made immediately on clean, dry glass slides with a single drop of blood of each elephant.



Figure 3. Blood sample collection from a camp elephant at Theppakadu, Mudumalai Tiger Reserve



Figure 4. Blood sample collection from Elephants at Kozhikamuthi and Varakalayar Elephant Camps, Anamalai Tiger



Figure 5. Blood sample collection from Elephants at Theppakadu and Abhavaravam camps. Mudumalai Tiger Reserve



Haematological studies

Haematological analysis was done using 'Mindray' (Model: BC-2800 vet.) (Fig. 6).

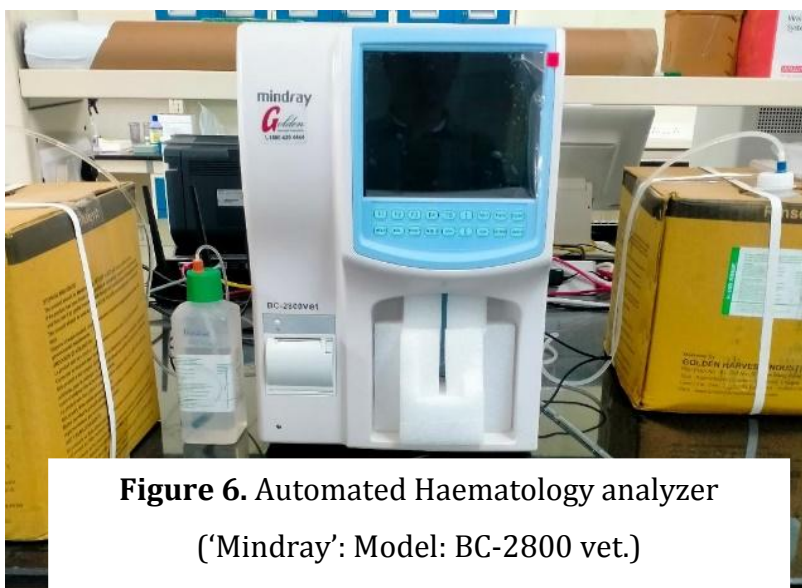


Figure 6. Automated Haematology analyzer ('Mindray': Model: BC-2800 vet.)

Blood parameters such as white blood cell count (WBC), lymphocytes, monocytes, granulocytes, lymphocytes (%), monocytes (%), granulocytes (%), red blood cell count (RBC), haemoglobin, HCT, MCV, MCH, MCHC, RDW, platelets, MPV, PDW and PCT were quantified and recorded. The

analysis of each individual blood sample was replicated twice. Blood smears were examined under microscope to record the total number of different types of white blood cells.

Serum parameters

The cold-stored serum samples were transported to the Centre for Animal Care Sciences, AIWC, Vandalur and serum parameters were quantified by the IDEXX Catalyst One (Fig. 7).



Figure 7. Automated Serum Biochemistry analyzer (IDEXX Catalyst One)

The serum biochemical parameters quantified were: glucose, creatinine, blood urea nitrogen, blood urea nitrogen/creatinine, phosphate, calcium, total protein, albumin, globulin, albumin/globulin, alanine amino transferase, alkaline phosphatase, gamma glutamyl transferase, total bilirubin, cholesterol, amylase, lipase, sodium,

potassium, sodium/potassium, chloride and osmolality. All serum biochemical data were recorded and tabulated.

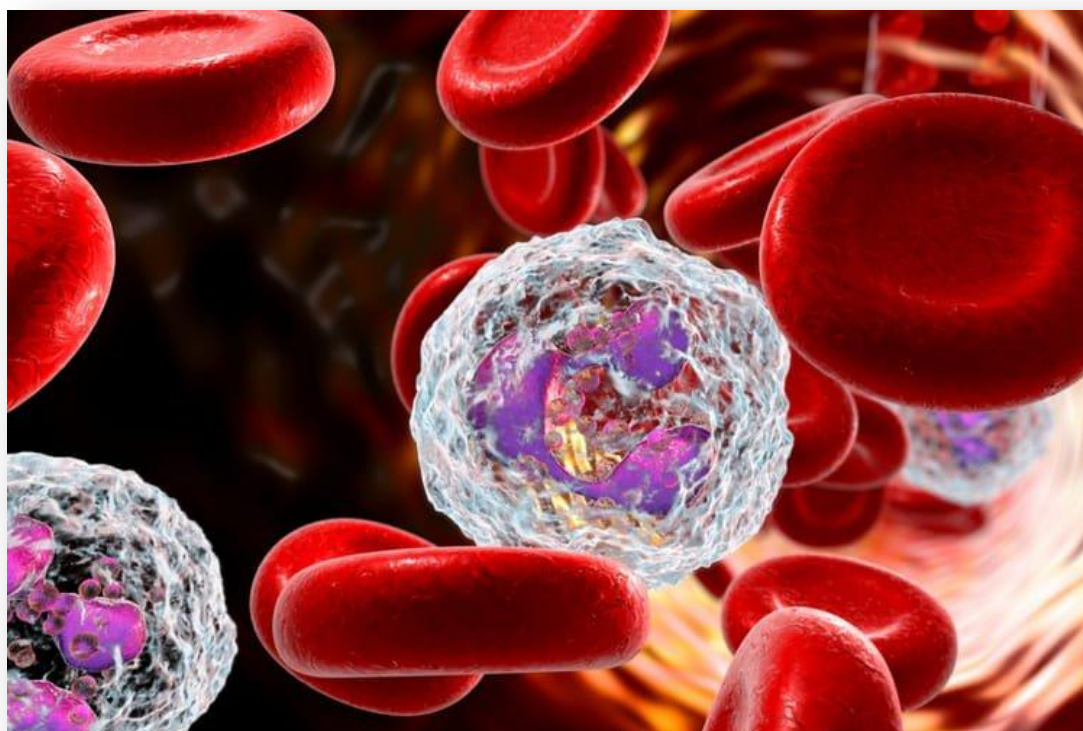
Statistical Analysis



Mean and Standard deviations were calculated from replication values of haematological and serum biochemical data. Statistical comparisons of haematological and serum biochemical analyses between male and female, between different age groups and between different seasons were performed using Student's t-test, one-way analysis of variance (ANOVA) and post hoc 'Tukey's range test' with the help of GraphPad Prism software. Simple linear regression analysis was done to show the association between age and different parameters in male and female elephants.



RESULTS



RESULTS

Blood samples were collected from 49 elephants in both MTR and ATR forest camps. In ATR, blood sample was collected from 25 elephants (16 males and 9 females) and in MTR, from 24 elephants (18 males and 6 females) ((Tables 1 & 2). At ERRC (Trichy) and SMTR, 10 and 6 elephants were accessed, respectively for blood sample collection (Table 3). The haematological parameters and serum biochemical parameters were studied and results are presented below.

Blood cell types

Elephant blood contains Red Blood Cells (RBC), and five types of white blood cells viz., monocytes, lymphocytes, neutrophils, basophils and eosinophils (Fig. 8). The peculiar character in elephant blood is the presence of three types of monocytes, which are differentiated by the presence of unilobed, bilobed or trilobed nucleus..

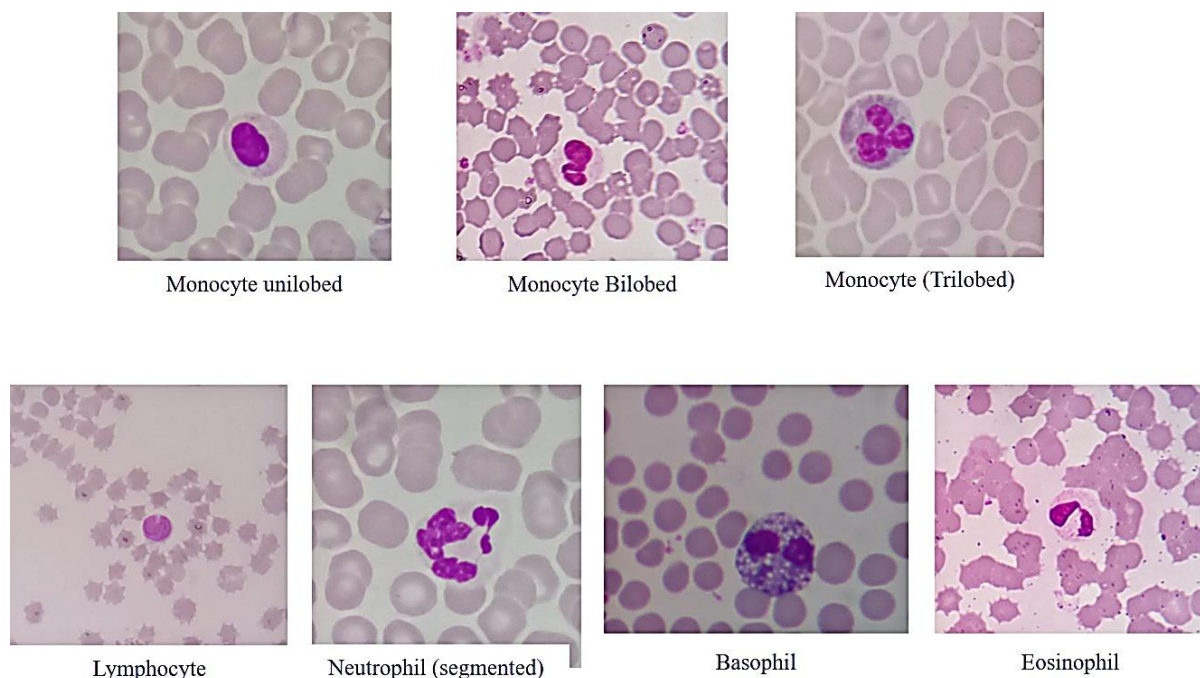


Figure 8. Different White Blood Cell types photographed under light microscope (magnification: 400X)

Haematological parameters in ATR camp elephants

The haematological parameters of ATR camp elephants were analysed and their values are presented in Tables 4 and 5. The average WBC count was 15.51×10^3 cells/ μ L in females and 16.36×10^3 cells/ μ L in males. Lymphocytes were higher in male elephants. Highest lymphocyte count was recorded in Urgan (14.28×10^3 cells/ μ L) while the lowest number of lymphocytes was recorded in Rajavarthan (4.35×10^3 cells/ μ L). RBC count was slightly higher in female (3.02×10^6 cells/ μ L) than male (2.97×10^6 cells/ μ L) elephants (Fig. 9). Haemoglobin content was nearly same for both female and male elephants whereas male elephants had a higher platelet count (613.78×10^6 cells/ μ L) than female elephants (558.86×10^6 cells/ μ L). The highest haemoglobin content (15.51 g/dL) was recorded in Selvi while the highest platelet content (952.75×10^6 cells/ μ L) was recorded in Suyampu.

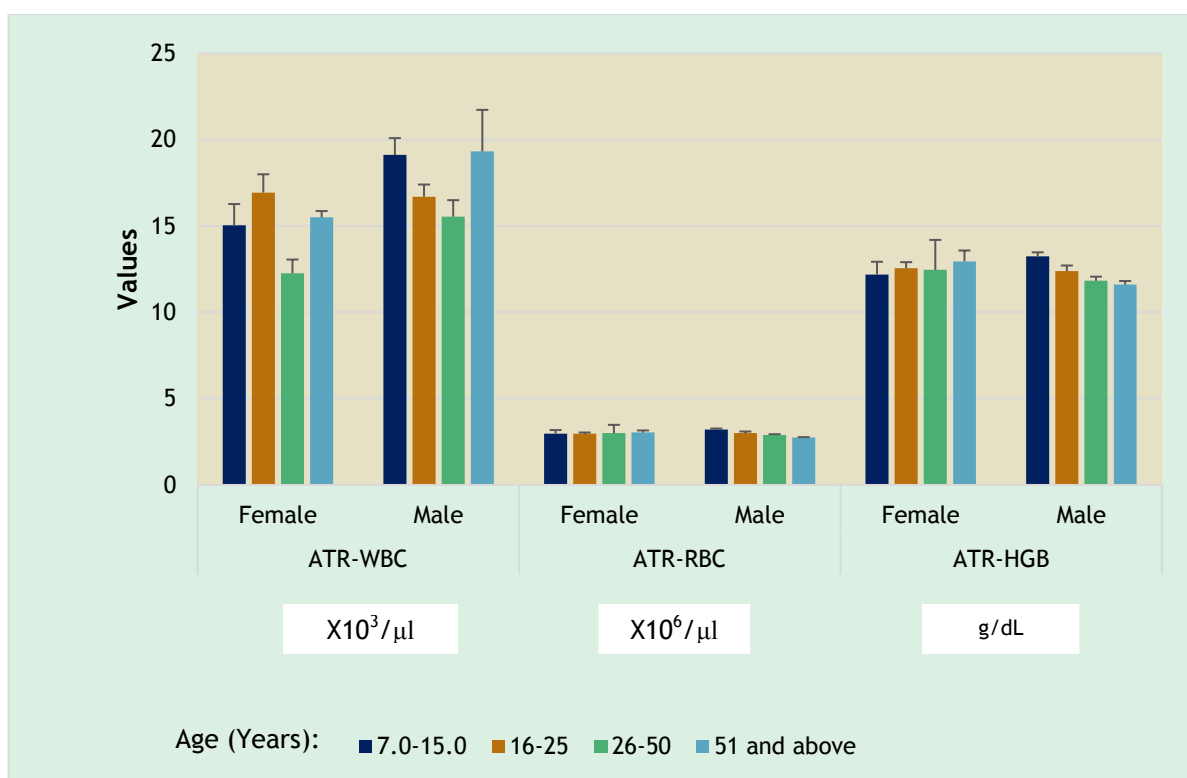


Figure 9. Haematological Parameters of different age groups of male and female in ATR camps. Each bar represents mean \pm SE

Haematological parameters in MTR camp elephants

The haematological parameters of MTR camp elephants were analysed and their values are reported in Tables 6 & 7 and Figure 10. The average WBC count was higher in male (22.51 $\times 10^3$ cells/ μ l) than female elephants (18.59 $\times 10^3$ cells/ μ l). The highest number of WBC cell count was recorded in Raghu (22.58 $\times 10^3$ cells/ μ l) and lowest WBC count was recorded in Wilson (10.4 $\times 10^3$ cells/ μ l). Raghu also had the highest lymphocytes levels (15.62 $\times 10^3$ cells/ μ l). RBC count was slightly higher in females with an average RBC count of 3.17 $\times 10^6$ cells/ μ l. The highest and lowest RBC counts were recorded in Raghu (4.04 $\times 10^6$ cells/ μ l) and Jambu (2.75 $\times 10^6$ cells/ μ l), respectively and these two elephants had the highest and lowest haemoglobin content, respectively. Average platelet count was slightly higher in males (661.1 $\times 10^3$ / μ l) than females (635.41 $\times 10^3$ / μ l). The highest platelet count was recorded in Vijay (795.5 $\times 10^3$ / μ l) and lowest in Sujay (442.5 $\times 10^3$ / μ l).

Table 8 shows the average haematological values of all age-group male and female elephants at ATR and MTR camps.

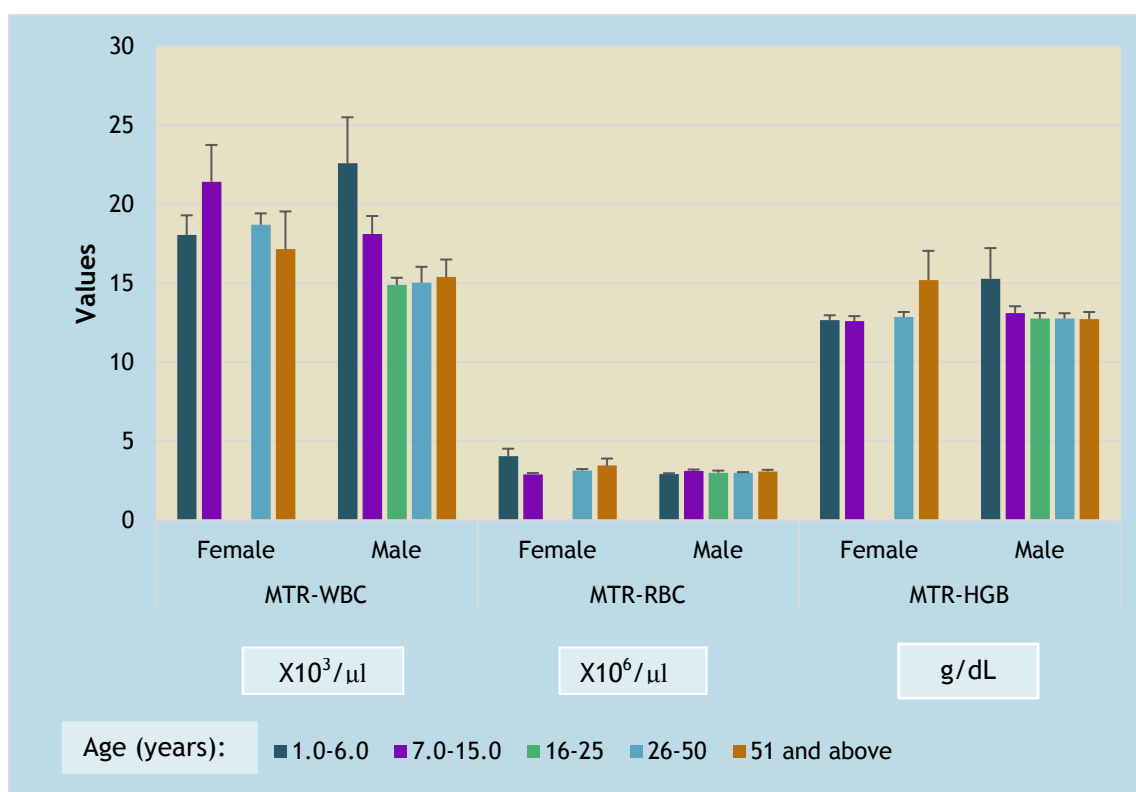


Figure 10. Haematological Parameters of different age group male and female elephants at MTR camps. Each bar represents mean \pm SE

Serum parameters in ATR camp elephants

The serum biochemical parameters of ATR elephants are given in Tables 9 & 10 and figure 11. The average glucose level for male and female elephants was 83.56 mg/dL and 67.87 mg/dL, respectively. Blood glucose level was the highest in Sivagami (105 mg/dL) and lowest in Suyampu (36 mg/dL). Creatinine, blood urea nitrogen, albumin and globulin levels were nearly same for both male and female elephants. Average lipase level for female elephants was 36.31 U/L and for male elephants, it was recorded as 23.86 U/L.

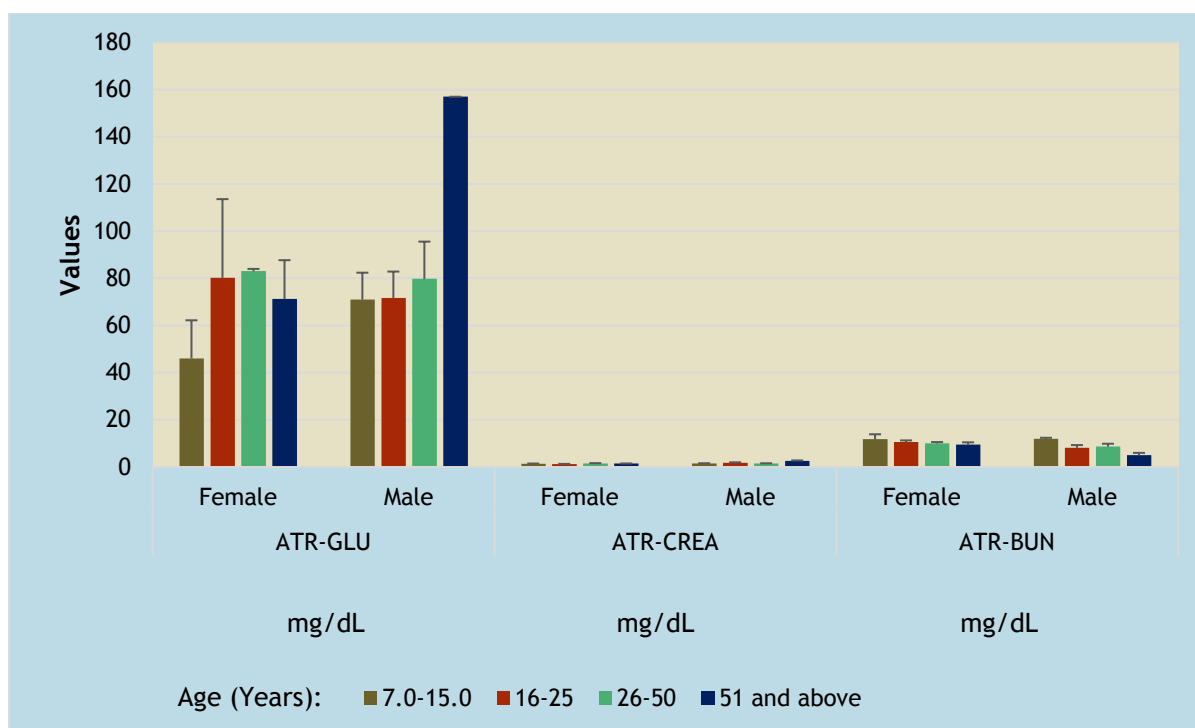


Figure 11. Serum Biochemical Parameters of different age group male and females at ATR camps. Each bar represents mean \pm SE

Serum parameters in MTR camp elephants

The serum biochemical parameters of MTR elephants are given in Tables 11 & 12 and figure 12.. Blood glucose level was lower in male elephants (79.34 mg/dL) than females (89.7 mg/dL). The highest blood glucose level (133.75 mg/dL) was recorded in Bommi and the lowest (50.5 mg/dL) in Jambu. Average creatinine level was same in both male (1.31 mg/dL) and female (1.36 mg/dL) elephants and the highest creatinine

level was recorded in Indhar (1.95 mg/dL). Average cholesterol level was higher in male elephants (59.28 mg/dL) than females (43.34 mg/dL).

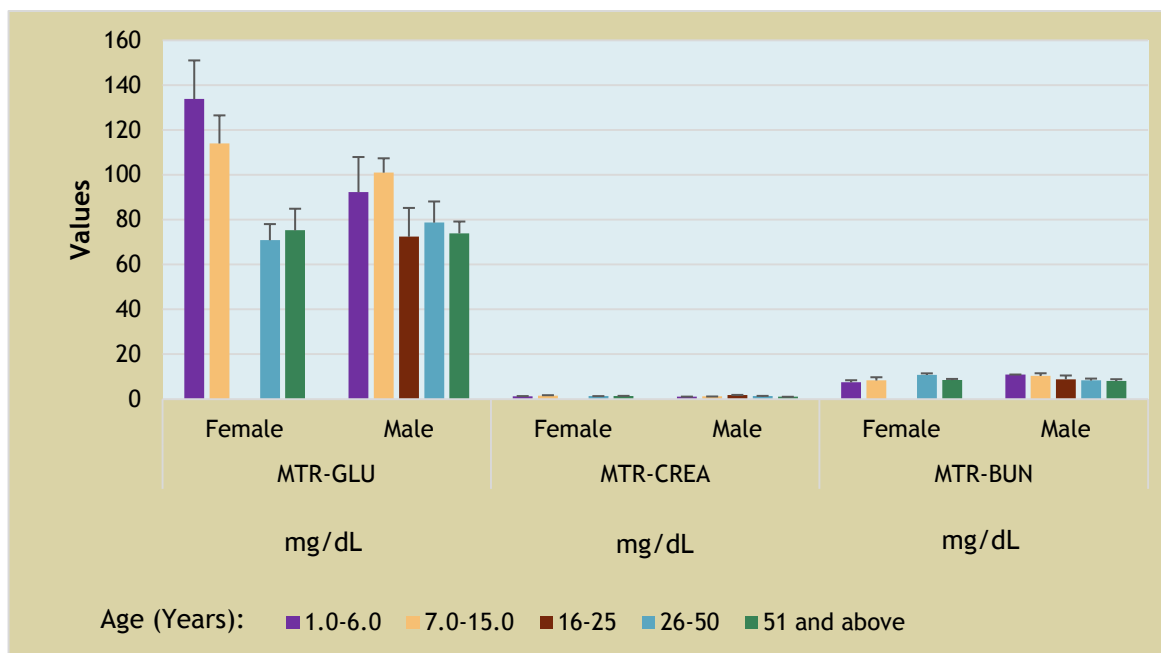


Figure 12. Serum Biochemical Parameters of different age groups of male and female elephants at MTR camps

Table 13 shows the average serum biochemical values of all age-group male and female elephants at ATR and MTR camps.

Comparison between camp elephants and temple elephants

Tables 14 and 15 show haematological and serum biochemical values of rescued private elephants at ERC and SMTR camps. It was seen that there were no significant differences between the haematological parameters. But it was seen that while analysing serum biochemical parameters glucose levels of the temple elephants significantly differed from those camp elephants of ATR ($P=0.0002$) and MTR ($P=0.001$).

Variations between male and female elephants

Student's t-test was performed between the analyses conducted between the male and female populations to see which group exhibited significant difference. Significant difference was observed when P value was lesser than 0.05. Haematological parameters showed very minimal variations between the sexes. In ATR platelet vales

($P=0.0391$) analysed during the month of May exhibited significant differences between the two sexes.

Average glucose, ALT and ALP values of all age group male and female elephants at ATR and MTR camps are presented in figure 13. In serum biochemical parameters there existed some variation. In MTR calcium levels ($P=0.0068$) analysed during the month of February exhibited significant differences whereas creatinine ($P=0.0065$) and calcium ($P=0.0027$) levels exhibited significant differences in the month of May.

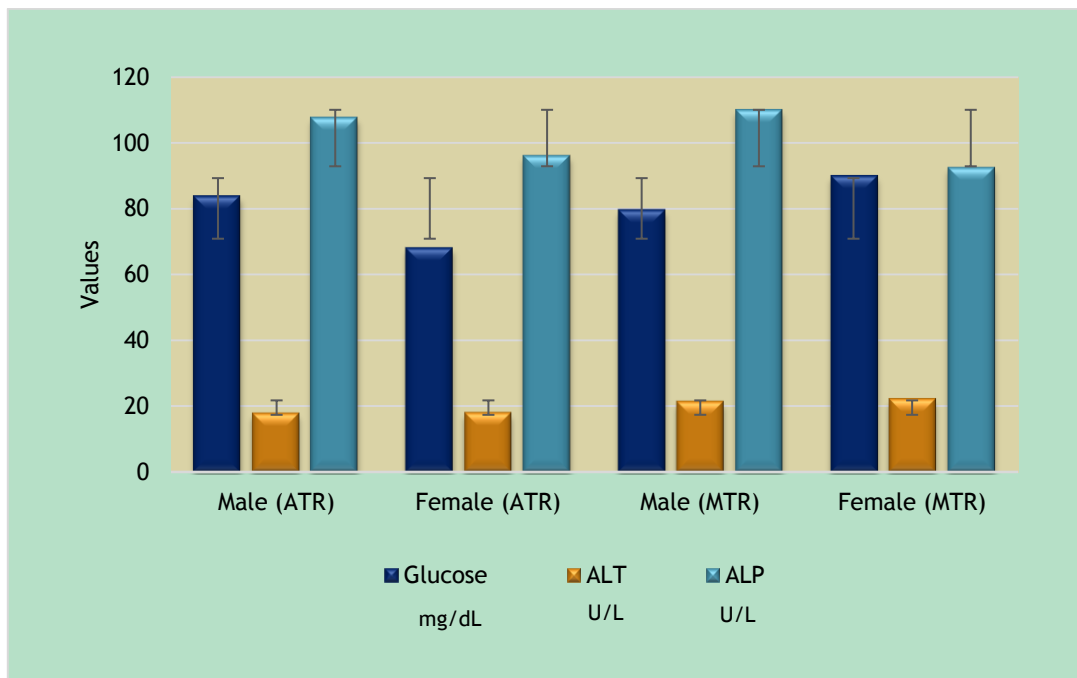


Figure 13. Average glucose, ALT and ALP values of all age group male and female elephants at ATR and MTR camps

Linear model for relating age with haematological and serum biochemical values

Simple Linear Regression model was established to know the relationship of age with haematology and age with serum biochemistry. Important parameters alone were considered to draw linear model. The figures 14 to 17 show the linear regression analysis.

Impact of age on haematological values

Samples were collected and haematological parameters were analysed among different age groups using one-way ANOVA. Figures 14 and 15 show the linear model of association between age and haematological parameters of both sexes in ATR camps. A 'P' value less than 0.05 indicates significant difference.

In ATR there existed some significant differences. In WBC differences were observed between the "16-25 years vs. 26-50 years" (P=0.0096) age groups in females and between the "7-15 years vs. 26-50 years" (P=0.0396) age groups in male. When examining RBC (P=0.0008), haemoglobin (P=0.0008) and haematocrit (P=0.0005) values in males the age groups "7-15 years vs. 26-50 years" and "7-15 years vs. 51 and above years" exhibited significant differences. With these analyses it can be summarised that the age group "7-15 years" shows significant difference when compared to the other populations.

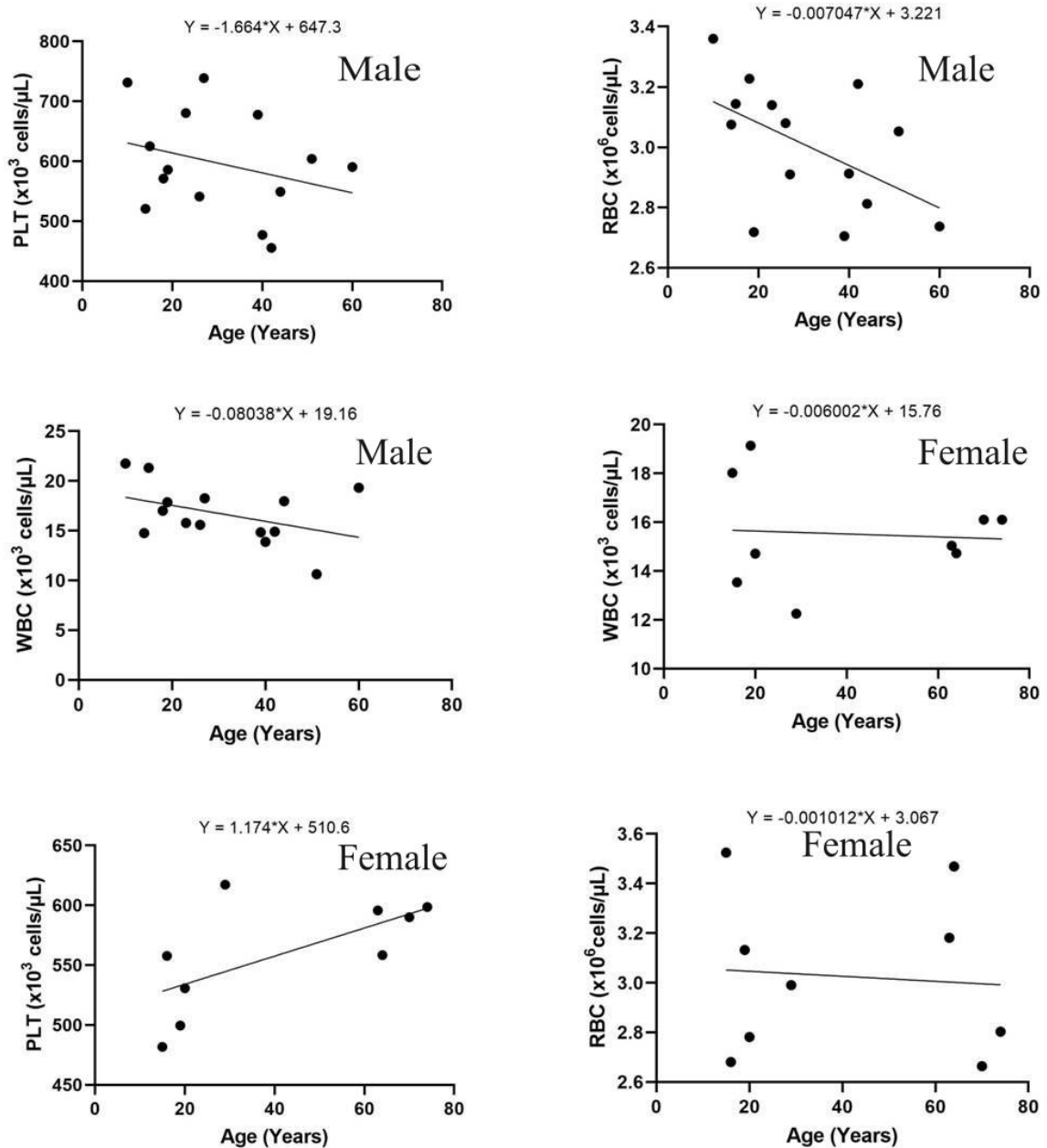


Figure 14. Simple Linear Regression model to show the association between age and haematological parameters in male and female elephants at ATR camps

In MTR it was found that WBC exhibited significant difference among the different age groups, namely between “1-6 years vs. 26-50 years” ($P=0.0189$) and “1-6 vs. 51 and above” ($P=0.0227$) age groups in males. This suggests that age group “1-6 years” shows significant difference when compared to the adult population.

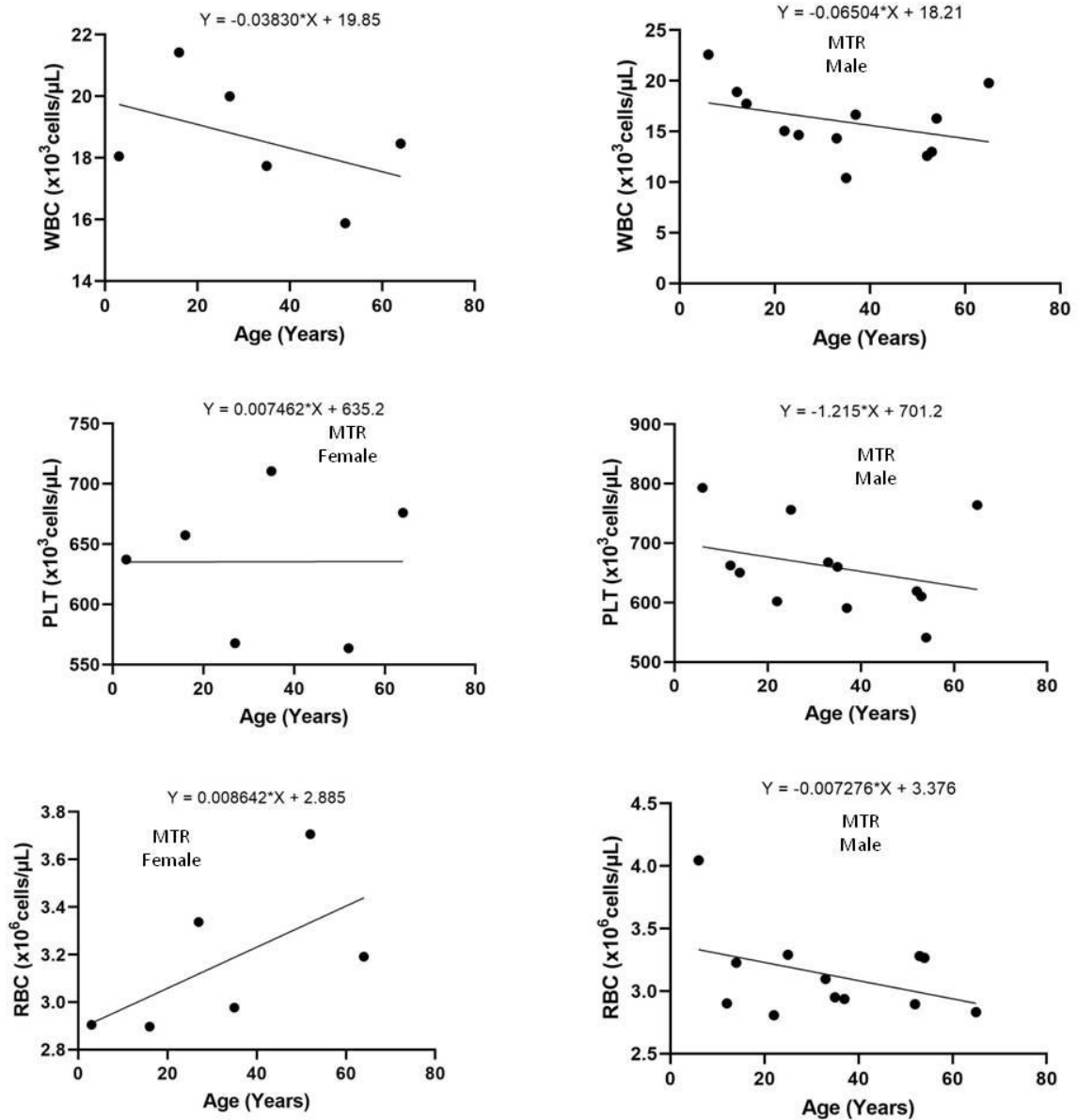


Figure 15. Simple Linear Regression model to show the association between age and haematological parameters in male and female elephants at MTR camps

Impact of age on serum biochemical values

Samples were collected and serum biochemical parameters were analysed among different age groups using one-way ANOVA. Figures 16 and 17 show a graphical summary of association between age and serum biochemical values. Significant difference was observed when P value was lesser than 0.05.

In ATR there existed some significant differences. When analysing creatinine (P=0.0459) and blood urea nitrogen (P=0.0095) in male elephants, the age groups "7-15 years vs. 51 and above years" showed significant differences. When analysing calcium levels, in females it was seen that the age groups "16-25 years vs. 51 and above years" (P=0.0278) showed significant difference whereas in males it was seen that the age groups "7-15 years vs. 51 and above years" (P=0.0004), "16-25 years vs. 51 and above years" (P=0.0061) and "26-50 years vs. 51 and above years" (P=0.0111) showed significant difference. From these it can be inferred that the age group "51 and above years" shows the most significant deviation from the population.

In MTR also significant differences were observed. Glucose levels in females showed significant difference between the age groups "1-6 years vs. 16-25 years" (P=0.0053) and "1-6 vs. 51 and above" (P=0.0079). In creatinine analysis of males there existed significant difference between "1-6 years vs. 16-25 years" (P=0.0026), "7-15 years vs. 16-25 years" (P=0.0016), "16-25 years vs. 26-50 years" (P=0.0195), "16-25 years vs. 51 and above years" (P<0.0001) and "26-50 years vs. 51 and above years" (P=0.006). Blood urea nitrogen analysis in females showed a significant difference between the age groups "1-6 years vs. 26-50 years" (P=0.0374). While examining total protein, in males there existed a significant difference between the "26-50 years vs. 51 and above years" (P=0.0022) age groups whereas in females there existed a significant difference between the "1-6 years vs. 26-50 years" (P<0.0001), "1-6 vs. 51 and above" (P=0.0064) and "7-15 years vs. 51 and above years" (P=0.0046) age groups. In serum biochemical parameters all age groups show significant difference between age groups with the "1-6 years" and "51 and above" age groups being most deviated from other age groups.

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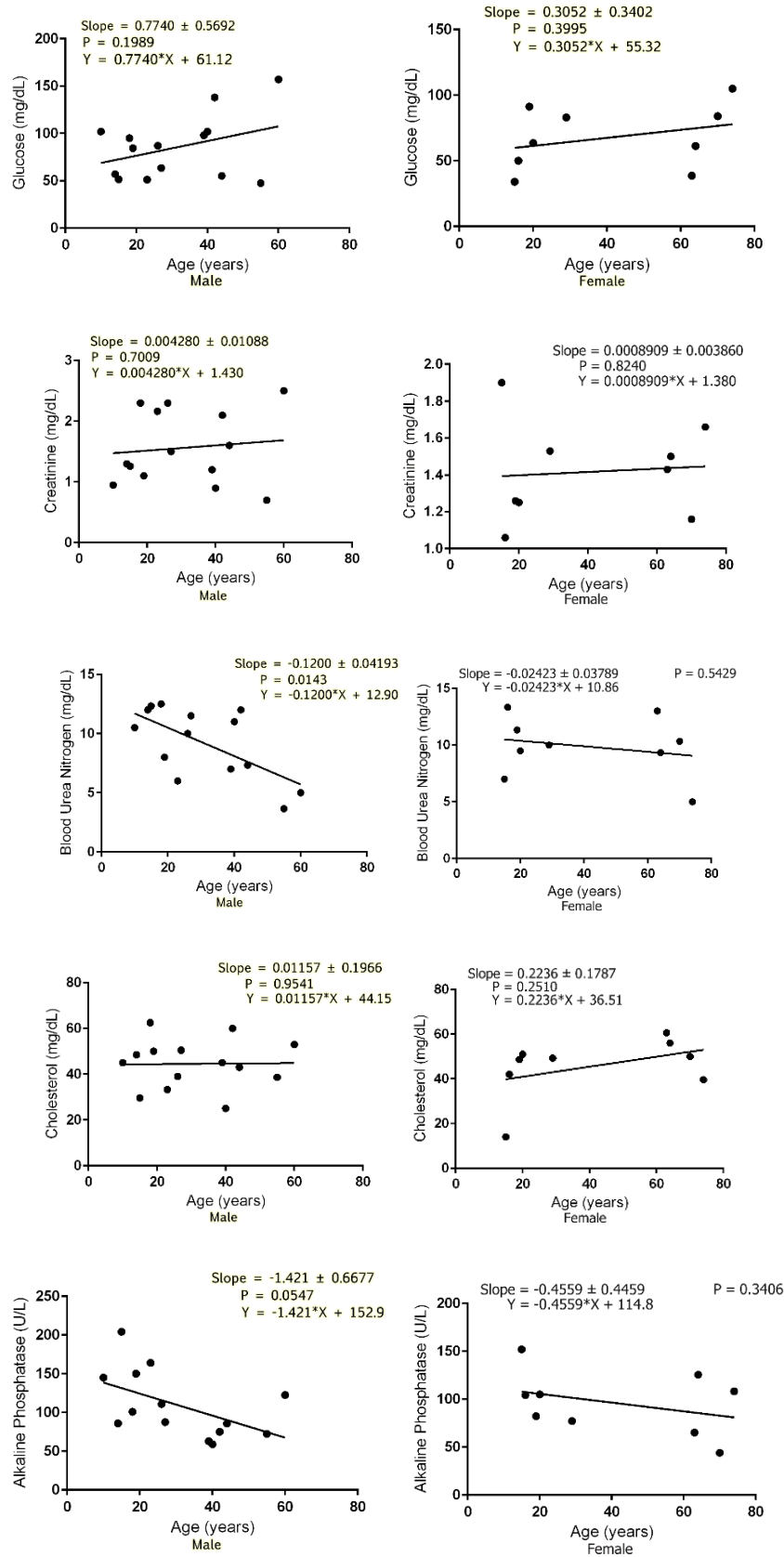


Figure 16. Simple Linear Regression model to show the association between age and serum biochemicals in male and female elephants at ATR camps

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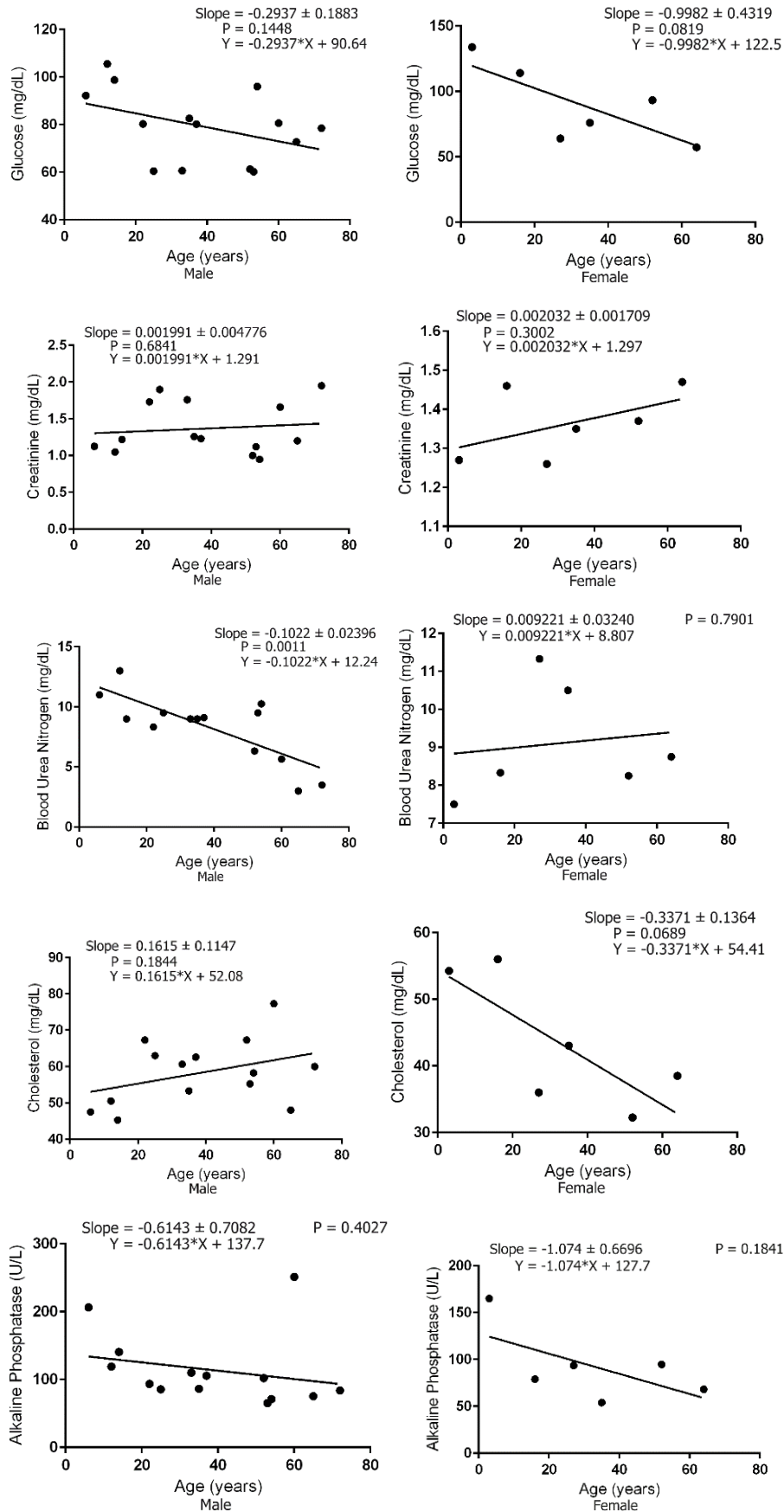


Figure 17. Simple Linear Regression model to show the association between age and serum biochemicals in male and female elephants at MTR camps

Seasonal impact on haematological parameters

Samples were collected during different months – namely November 2022, February 2023, May 2023 and July 2023 – which correspond with different seasonal changes. These changes in haematological parameters were analysed using one-way ANOVA. Figures 18 and 19 show a graphical summary. Significant difference was observed when P value was lesser than 0.05.

In ATR, on examining platelet values significant difference was observed between the months of “November vs. February” ($P=0.0018$) and “November vs. July” ($P=0.0004$) in females whereas in males the months “November vs. February” ($P=0.0034$), “November vs. May” ($P=0.0034$) and “November vs. July” ($P<0.0001$) showed significant difference. In MTR platelets showed significant difference between the months “November vs. February” ($P=0.0262$) in males. From these observations it was observed that samples collected during the month of November (“winter”) showed significant deviation from the other months.

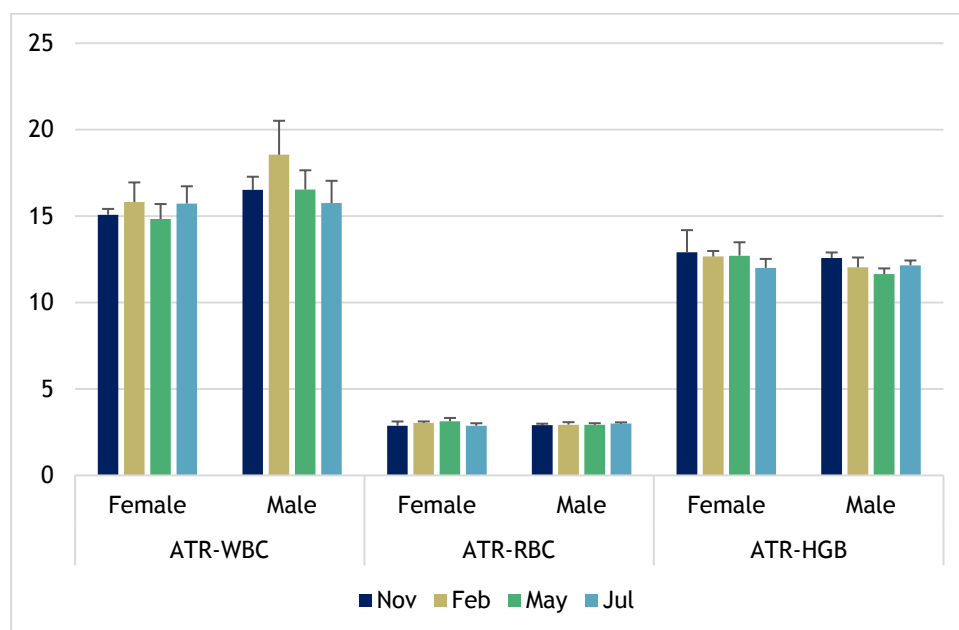


Figure 18. Haematological Parameters of ATR camp elephants at different seasons. Each bar represents mean \pm SE.

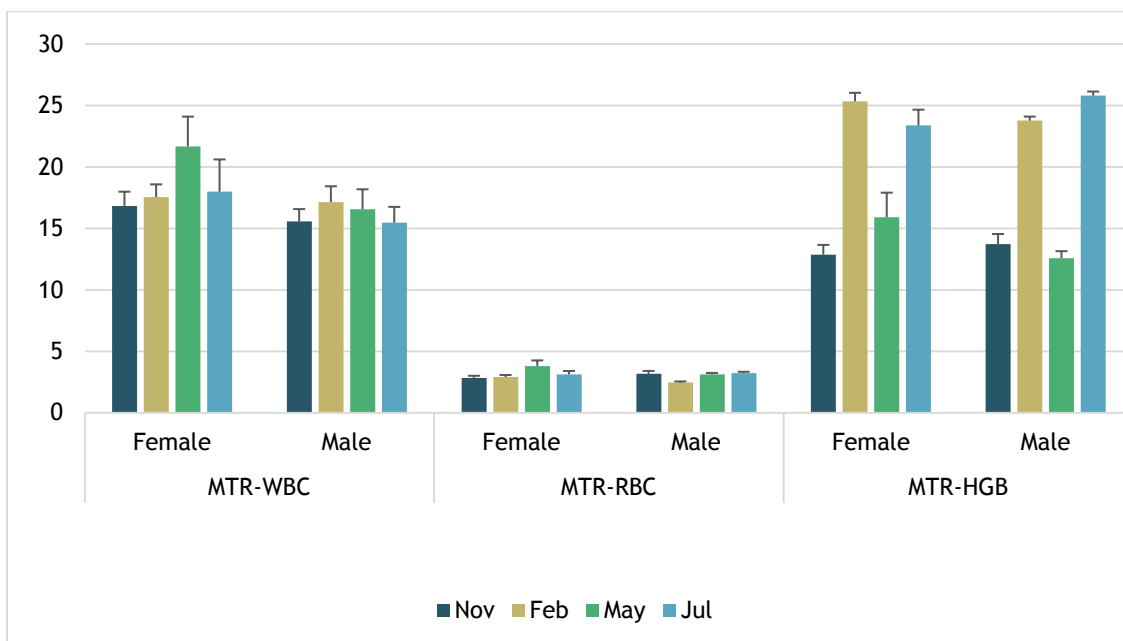


Figure 19. Comparison of Haematological Parameters of MTR camp elephants at different seasons. Each bar represents mean \pm SE.

Seasonal impact on serum biochemical parameters

Serum biochemical parameters analysed during the different months were also examined using one-way ANOVA. Figures 20 and 21 show a graphical summary. Significant difference was observed when P value was lesser than 0.05.

In ATR, while examining glucose levels it was seen that in males there existed a significant difference between the months "November vs. May" ($P < 0.0001$) and "February vs. May" ($P = 0.0104$) whereas in females, significant difference was observed between the months "November vs. February" ($P = 0.0217$) and "November vs. May" ($P = 0.0004$). Total protein levels in males exhibited a significant difference between the months "November vs. May" ($P = 0.014$).

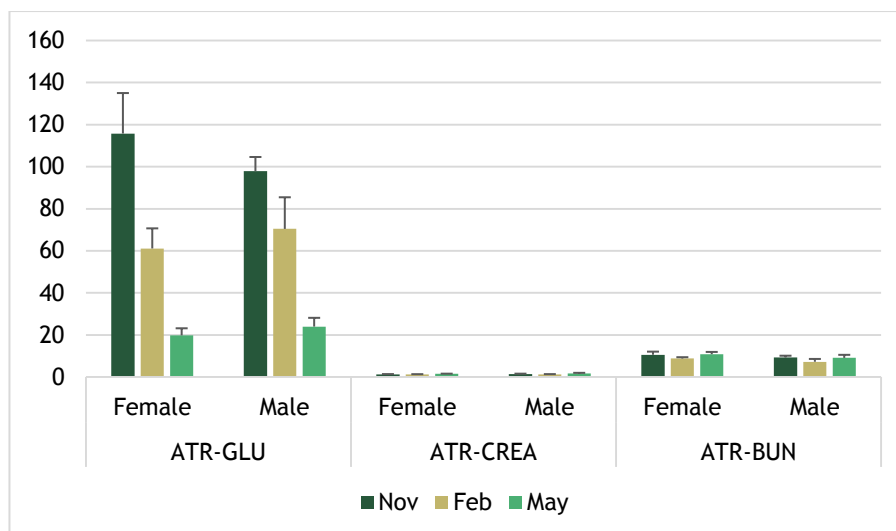


Figure 20. Serum Biochemical Parameters of ATR camp elephants at different seasons. Each bar represents mean \pm SE

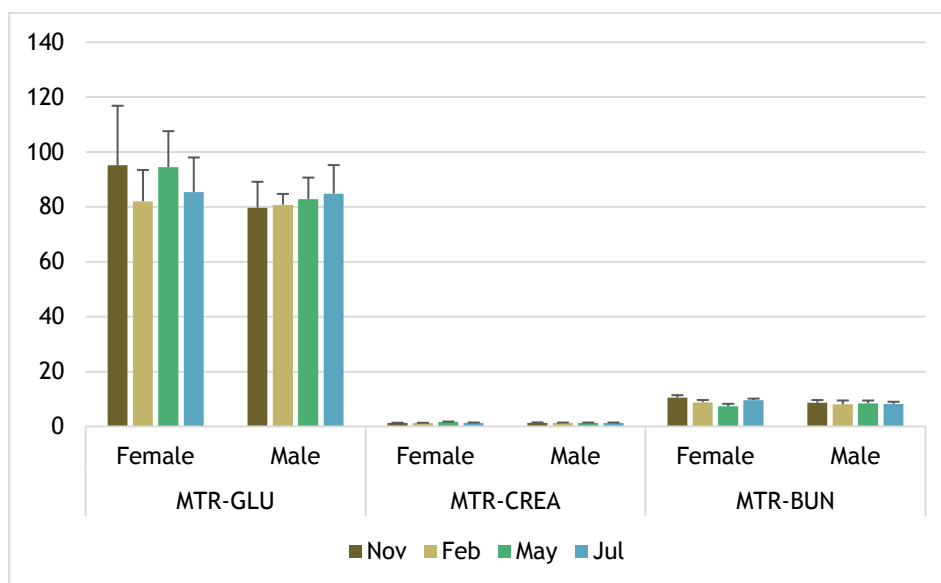


Figure 21. Serum Biochemical Parameters of MTR camp elephants at different seasons. Each bar represents mean \pm SE.

In MTR it was seen that creatinine levels significantly differed between the months of “November vs. May” ($P=0.0111$) and “February vs. May” ($P=0.0131$) in females. Calcium levels showed significant difference in males between the months of “November vs. May” ($P=0.0189$) and “February vs. May” ($P=0.0465$) while total protein levels in males showed significant difference between the months “May vs. July” ($P=0.0022$).

As seen from these analyses it can be seen that the samples collected during the month of November ("winter") showed significant deviation from the other months.

Establishment of reference intervals for haematological and serum biochemical parameters

The consolidated reference intervals for haematological and serum biochemical values are listed in Table 16 and 17. These values are helpful in the diagnosis and health monitoring of camp elephants in Tamil Nadu.

Discussion

Forest camp elephants have the risk of acquiring pathogenic diseases due to diverse management practices, feeding practices and habitat-related conditions (Allwin *et al.*, 2015). Blood test is a basic and essential requirement for the diagnosis of many diseases. Haematological studies in Asian elephants are ample, but most of the previous studies have some limitations. Very few studies have been undertaken to understand the haematology of Asian elephants in Tamil Nadu (Allwin *et al.*, 2015; Veeraselvam *et al.*, 2021). Earlier studies were carried out without any repeated samplings in different seasons. Likewise, some studies were done only on female captive elephants. So a reliable reference interval of haematological parameters for forest camp elephants has not been established so far.

In the present study, blood and serum samples of 49 elephants at Anamalai and Mudumalai Camps were subjected to haematological and serum biochemical analysis. Total number of blood samples collected from the ATR and MTR elephants were 154. In addition, 16 more elephants from ERRC and SMTR were also accessed for haematology and serum biochemical studies. Earlier reports on elephant haematology in Tamil Nadu camps and temple elephants were based mainly on one time sample analysis and also female-biased (Veeraselvam *et al.*, 2021; Allwin *et al.*, 2015). So the reference intervals computed from the data of earlier studies are prone to more deviation. In the present study, four repetitions were conducted in camp elephants, which helped us to arrive at more concurrent and precise results.

Five types of leucocytes such as lymphocytes, monocytes, heterophils, eosinophils and basophils perform different functions in the immune system of elephants. So the counting of these different white blood cells helps us to understand the immune response to different pathogenic conditions. Monocytes and neutrophils are phagocytic cells and are taking part in the innate immune response (Cheyne *et al.*, 2017). Lymphocytes are involved in adaptive immunity and Eosinophils fight against internal parasites. Eosinophils also take part in the inflammatory responses (Cheyne *et al.*, 2017). Basophils are responsible for the immunity against macroparasites (Karasuyama *et al.*, 2011). In this study, the monocyte and Lymphocyte populations showed interchangeable deviations, which is attributed to the workings of the

automated analyser, which struggled to differentiate between the unilobed and multilobed cells. Platelet count is another parameter that varied due to the minute size of the cells and the detection capacity of the machine.

Seasonal impact on haematological parameters of elephants has been reported by many investigators. Franco dos Santos (2020) studied the seasonal variation in 23 health parameters including haematological parameters in different age groups of male and female Asian elephants. Blood haemoglobin concentration and circulating RBC cell mass concentration could be affected by seasonal variations (DelGiudice *et al.* 1992; Hellgren *et al.* 1993).

Biochemical parameters were prone to more variations across the age groups but remained constant on the different trips. Glucose, in spite of varying across the spectrum, remains concurrent across both the camps.

Creatinine and blood urea nitrogen also stayed within the limits, indicating good renal health. Camp elephants have the benefit of getting immediate diagnosis for any ailments they suffer and these findings can help the forest veterinarians to give the proper treatment as soon as possible. Thus, from these findings it can be concluded that a repeatable set of haematological and serum biochemical values have been established for the camp elephants of Anamalai and Mudumalai Tiger Reserves.

Reference intervals for haematological and serum biochemical values have been established in this study. In spite of minute variations under different seasons, age groups and genders, the results remained replicable and reliable. Certain elephants like Indhar (at MTR) and Ramu (at ATR) had injuries while collecting blood samples at any one sampling periods. Moorthy in MTR was affected by long-sustaining injuries during all sample collections. Moorthy in MTR is a victim of chronic ulceration in the legs. It showed a very high number of leucocytes, approximately 5 times higher than that of other elephants. This was due to the immune response to the wound. Similarly, Indhar in MTR and Ramu in ATR showed higher WBC counts during our first and second sample analysis, because of wounds in their body. Later, their wounds healed and showed normal haematological values. Janyamethakul *et al.* (2017) have reported reference intervals for Asian elephants in Thailand. Their reported values for some

parameters were in broad range. For example, the reference interval for platelets was $101.6 - 577.7 \times 10^3$ cells/ μL in males and $105.3-598.7 \times 10^3$ cells/ μL in females. In the present study, we removed the abnormal haematological values obtained from diseased elephants while establishing the reference interval. Therefore, the values in the present study may be considered normal haematological values for Camp elephants in Tamil Nadu, India.

The individuals, which showed high deviations in the parameters were not included while calculating the reference interval values. Apart from such outliers the other parameters mostly show concurrent results. Haematological parameters showed lesser variations than serum biochemical parameters.

Forest camp elephants receive a good medical care for any illnesses and the present findings can help the forest veterinarians to give a proper treatment as soon as possible. Despite minute variations under different seasons, age groups and genders, the results of the present study remained replicable and reliable. Thus, from these findings, it can be concluded that a repeatable set of haematological values have been established for the camp elephants of Anamalai and Mudumalai Tiger Reserves.

CONCLUSION

In conclusion, the study helped in establishing a reliable and repeatable set of reference intervals for haematological and serum biochemical parameters in captive Asian elephants. Through repeated sampling across different seasons in all age groups, the values consolidated showed good statistical significance without much difference. The study will help serve as an important reference to Forest Veterinarians of Tamil Nadu (and other states) which house Asian elephants who can immediately and accurately diagnose and correlate the symptoms of the animal with a simple and preliminary blood and serum test. The study also tested significantly large number of parameters than other previous studies, which will also serve to be advantageous. Camp elephants, although in a safe and protected environment, face a myriad of health issues. Results of this study will serve beneficial in protecting these keystone species of India



References

- Allen, J. L., Jacobson, E. R., Harvey, J. W., and Boyce, W. (1985). Hematologic and serum chemical values for young African elephants (*Loxodonta africana*) with variations for sex and age. *The Journal of Zoo Animal Medicine*, **16**(3): 98-101.
- Allwin, B., Kalaigan, P. A., Kumar, G. S., Senthil, N. R., Vairamuthu, S. and Kalyaan, U. S. (2015). Haematology of the Asian elephants. *International Journal of Advanced Multidisciplinary Research*, **2**(3): 82-86.
- Allwin, B., Senthil Kumar, G., Kalaigan, Pa, Senthil, N.R., Vairamuthu, S., Vedamanickam, S., Kalyaan, U.S. and Ingole, D.K. (2015). Serum biochemistry of the Asian elephant. *International Journal of Advanced Multidisciplinary Research*, **2**(4): 62-66
- Dhairykar, M., Singh, K.P., Jadav, K.K. and Dubey, A. (2020). Estimation of haematobiochemical and cortisol level in captive elephants. *International Journal of Creative Research Thoughts*, **8**(8): 2062-2066
- Ghimire, R., Regmi, S., Shrestha, R., Sadaula, A. and Joshi, J.D. (2022). Hematological value of captive Asian elephants *Elephas maximus* around Chitwan National Park, Sauraha, Nepal. *Journal of Threatened Taxa*, **14**(9): 21811-21817.
- Gromadzka-Ostrowska, J., Jakubów, K., Zalewska, B., & Krzywicki, Z. (1988). Haematological and blood biochemical studies in female domesticated Indian elephants (*Elephas maximus* L.). *Comparative Biochemistry and Physiology. A, Comparative Physiology*, **89**(3), 313-315
- Gupta, B., Gottam, G. S., Bhatt, L., Mittal, P. K., Pandey, A. K., Jindal, S. K., ... & Mathur, A. (2020). Hematological studies in Indian elephants (*Elephas maximus*).
- Hannah Ritchie, 2022. The state of the world's elephant populations. Our World in Data, <https://ourworldindata.org/elephant-populations>
- Harvey, J. W. (2011). *Veterinary hematology: a diagnostic guide and color atlas*. Elsevier Health Sciences.
- Jani, R. G. (2008). Prevalence and haemato-biochemical studies of gastro-intestinal parasites of Indian Elephants (*Elephas maximus*). *Veterinary World*, **1**(10), 296.
- Janyamethakul, T., Sripiboon, S., Somgird, C., Pongsopawijit, P., Panyapornwithaya, V., Klinhom, S., Loythong, J. and Thitaram, C. 2017. Hematologic and biochemical reference intervals for captive Asian elephants (*Elephas maximus*) in Thailand. *Kafkas Univ Vet Fak Derg*, **23**(4): 665-669
- Lewis, J. H. (1974). Comparative hematology: studies on elephants, *Elephas maximus*. *Comparative Biochemistry and Physiology Part A: Physiology*, **49**(1), 175-181
- Mel, R. K. D., Weerakoon, D. K., Ratnasooriya, W. D., & Dangolla, A. (2014). A comparative haematological analysis of Asian Elephants *Elephas maximus* Linnaeus, 1758 (Mammalia: Proboscidea: Elephantidae) managed under different captive conditions in Sri Lanka. *Journal of Threatened Taxa*, **6**(8), 6148-6150.
- Miller, D., Jackson, B., Riddle, H.S., Stremme, C., Schmitt, D. and Miller, T. (2015). Elephant (*Elephas maximus*) Health and management in Asia: Variations in veterinary perspectives. *Veterinary Medicine International*, vol. 2015, Article ID 614690, 19 pages, 2015. <https://doi.org/10.1155/2015/614690>
- Nirmalan, G., Nair, S. G., and Simon, K. J. (1967). Hematology of the Indian elephant (*Elephas maximus*). *Canadian Journal of Physiology and Pharmacology*, **45**(6), 985-991.

- Ranjini, M., P. M. Deepa and Ashok, R. U. (2021). Clinico-physiological, haemato-biochemical and urinalysis of 20 adult captive Indian Elephants (*Elephas maximus*). *International Journal of Current Microbiology and Applied Sciences*. **10**(2): 2091-2099.
- Salakij, J., Salakij, C., Narkkong, N. A., Apibal, S., Suthunmapinuntra, P., Rattanakukuprakarn, J. and Yindee, M. (2005). Hematology, cytochemistry and ultrastructure of blood cells from Asian elephant (*Elephas maximus*). *Agriculture and Natural Resources*, **39**(3), 482-493.
- Shoshani, J. (2005). "Species *Elephas maximus*". In: Wilson, D.E.; Reeder, D.M (eds.). *Mammal Species of the World: A Taxonomic and Geographic Reference* (3rd ed.). Johns Hopkins University Press. p. 90.
- Silva, I. D. and Kuruwita, V. Y. (1993). Hematology, plasma, and serum biochemistry values in domesticated elephants (*Elephas maximus ceylonicus*) in Sri Lanka. *Journal of Zoo and Wildlife Medicine*, 440-444.
- Veeraselvam, M., Selvaraj, P., Kumar, S. S., Senthilkumar, A., Senthilkumar, T. M. A., Sreekumar, C., and Priya, R. J. (2021). Haematology profile of the captive Asian elephants (*Elephas maximus*) in the Tamil Nadu state of India.

TABLES

Table 1. Name, sex and age of Elephants at Kozhikamuthi and Varakalayar camps in Anamalai Tiger Reserve (ATR) from which blood samples were collected (Total number of samples collected: 78)

Sl. No.	Name of the Elephant	Age (years) & Sex	Place of birth/Capture	Date of birth/capture	Height (cm)	Father & Mother	1 st blood sample collection	2 nd blood sample collection	3 rd blood sample collection	4 th blood sample collection
1	Abinaya	19, F	From AAZP	3-12-2011	228.6	Wild	1-12-22	4-02-23	9-05-23	20-07-23
2	Andal	63, F	KZP, Salem	6-12-2019	236.22	Wild	30-11-22	3-02-23	9-05-23	20-07-23
3	Ashok	14, M	From AAZP	8-9-2018	236.22	Wild	30-11-22	NC	10-05-23	20-07-23
4	Barani	40, M	Varakalayar camp	20-1-1986	---	Valli&Srithar	1-12-22	NC	9-05-23	NC
5	Chinnathambi	27, M	Kannadiputhur, Amaravathi range	16-2-2019		Wild	30-11-22	NC	NC	NC
6	Devi	20, F	Thandarampattu, Vellore	30-08-2013	243.84	Wild	30-11-22	3-02-23	9-05-23	20-07-23
7	Durga	29, F	From Swamimalai temple	21-7-2009	264.16	Wild	30-11-22	4-02-23	9-05-23	20-07-23
8	Kaleem	60, M	Sathyamangalam Forest	4-12-1972		Wild	1-12-22	NC	10-05-23	20-07-23
9	Kapildev	42, M	Varakalayar Forest	5-5-1983	289.5	Wild	1-12-22	NC	NC	NC
10	Kaveri	16, F	Thandarampattu, Vellore	30-8-2013	236.22	Wild	30-11-22	4-02-23	9-05-23	20-07-23
11	Muthu	23, M	Arthanaripalayam, Pollachi range	14-11-2019	---	Wild	30-11-22	3-02-23	10-05-23	20-07-23
12	Narasimman	19, M	Thandarampattu, Vellore	29-8-2013	----	Wild	30-11-22	4-02-23	NC	20-07-23
13	Paari	44, M	Alankayam range	13-8-1988	----	Wild	1-12-2022	4-02-23	9-05-23	20-07-23
14	Rajavarthan	26, M	Near Kozhikamuthi camp	3-10-2007	----	Wild	30-11-2022	NC	NC	NC
15	Ramu	55, M	Kalikesam forest, Kanyakumari	20-11-1978	264.16	Wild	30-11-22	3-02-23	10-05-23	20-07-23
16	Sanjeev	10, M	Karamadai range, Coimbatore circle	16-4-2017	210.82	Wild	30-11-22	4-02-23	9-05-23	20-07-23
14	Saratha	70, F	Ulanthy valley	25-8-2004	243.84	Wild	30-11-22	4-02-23	10-05-23	20-07-23
18	Saravanan	18, M	AAZP, Vandalur	5-2-2014	238.76	Wild	30-11-22	NC	9-05-23	20-07-23
19	Selvi	64, F			---	Wild	30-11-22	4-02-23	9-05-23	20-07-23
20	Sivakami	74, F	Sathyamangalam forest	16-11-1972	240.0	Wild	1-12-22	4-02-23	10-05-23	20-07-23
21	Surya	51, M	Nayakaneri village, Ambur	10-12-1999	----	Wild	NC	NC	10-05-23	20-07-23
22	Suyampu	27, M	Coimbatore ThadakamMaangari forest	3-10-2007	266.7	Wild	NC	NC	9-05-23	20-07-23
23	Theivanai (@ 'Prerona')	15, F	From Assam to Trichy camp to ATR	Not known	---	Wild	NC	NC	10-05-23	20-07-23
24	Urigan	15, M	From AAZP	6-4-2018	---	Wild	30-11-22	4-02-23	10-05-23	20-07-23
25	Venkatesh	39, M	Karuneerpallam, Ulanthi range	6-4-1987	---	Devaki & Pallavan	1-12-22	4-02-23	NC	20-07-23

AAZP - Arignar Anna Zoological Park; KZP - Kurumpapatti Zoological Park; NC - Not Collected

Table 2. Name, sex and age of Elephants at Theppakadu and Abhayaranyam camps in Mudumalai Tiger Reserve (MTR) from which blood samples were collected (Total number of samples collected: 76)

Sl. No.	Name of the Elephant	Age (years) & Sex	Place of birth/Capture	Date of birth/capture	Height (cm) & weight (kg)	Father & Mother	1 st blood sample collection	2 nd blood sample collection	3 rd blood sample collection	4 th blood sample collection
1	Anna	65, M		30-5-71	283; 4860	Wild	28-11-22	02-02-23	12-05-23	18-07-23
2	Bommi	3, F	Sathyamangalam		156; 790	Wild	28-11-22	02-02-23	12-05-2023	18-07-23
3	S. Sankar	37, M	Cherampadi, Cudalur	12-2-21	254; 4200	Wild	NC	02-02-23	12-05-23	18-07-23
4	Cheran	37, M	Theppakadu camp	10-7-86	268; 3500	Bommi & wild	29-11-22	02-02-23	NC	18-07-23
5	Ganesh	54, M	Thunakadavu (ATR)	28-8-81	257; 3390	Wild	28-11-22	02-02-23	12-05-23	18-07-23
6	Giri	14, M	Thiruvannamalai	20-3-10	253; 2795	Wild	29-11-22	02-02-23	12-05-23	18-07-23
7	Indhar	72, M	Thunakadavu	13-10-60	259; 3660	Wild	29-11-22	02-02-23	12-05-23	18-07-23
8	Indra	27, F	Theppakadu camp	----	253; 3680	Kamatchi & wild	29-11-22	02-02-23	12-05-23	NC
9	Jambu	37, M	Ponnakiri, Mudumalai	26-8-86	272; 3945	Wild	NC	02-02-23	12-05-23	NC
10	John	33, M	Sathyamangalam		262; 3500	Wild	28-11-22	02-02-23	12-05-23	NC
11	Kamatchi	64, F	Anamalai	20-10-60	240; 2870	Wild	28-11-22	02-02-23	12-05-23	18-07-23
12	Krishna	12, M	Thiruvannamalai	27-8-13	260; 3115	Wild	28-11-22	02-02-23	NC	NC
13	Masini	16, F	Karkudi	5-8-06	243;	Wild	28-11-22	02-02-	12-05-	18-07-

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					2805			23	23	23
14	Moorthy	60, M	Vachikolli (Cudalur)	12-7-98		Wild	NC	02-02-23	12-05-23	18-07-23
15	Raghu	6, M	Thenkanikottai, Hosur	26-5-17	189; 1475	Wild	28-11-22	02-02-23	12-05-23	18-07-23
16	Sankar	54, M	Mudumalai	6-4-75	270; 4590	Wild	NC	NC	12-05-23	18-07-23
17	Santhosh	53, M	Theppakadu camp	15-8-71	264; 3441	Rukmani & wild	28-11-22	02-02-23	12-05-23	18-07-23
18	Srinivasan	22, M	Serampadi, Cudalur	4-4-16	254; 3695	Wild	29-11-22	02-02-23	NC	18-07-23
19	Sujay	52, M	Theppakadu camp	25-5-71	255; 3630	Devaki & wild	29-11-22	NC	12-05-23	18-07-23
20	Sumangala	35, F	Jamanamuthur, Tirupathur		255; 3290	Wild	29-11-22	02-02-23	12-05-23	18-07-23
21	Senthilvadivu	52, F	Sathyamangalam		255; 3110	Wild	28-11-22	02-02-23	12-05-23	18-07-23
22	Udhayan	25, M	Theppakadu camp	24-11-98	285; 4220	Kamatchi & Wild	NC	NC	12-05-23	18-07-23
23	Vijay	52, M	Theppakadu camp	25-5-71	273; 4030	Devaki & wild	NC	NC	NC	18-07-23
24	Wilson	35, M	Theppakadu camp	16-4-88	287; 4545	Gowri & wild	29-11-22	NC	12-05-23	18-07-23

Table 3. Details of Elephants at ERRC Camp (Trichy) and SMTR camp from which blood samples were collected

S.No.	Name of the Elephant	Age (Years)	Gender	Location	No. of blood samples collected
1	Rupali	23	Female	ERC, Trichy	1
2	Jayanthi	26	Female	ERC, Trichy	1
3	Malachi	38	Female	ERC, Trichy	1
4	Indhu	39	Female	ERC, Trichy	1
5	Sandhya	48	Female	ERC, Trichy	1
6	Sumathi	57	Female	ERC, Trichy	4
7	Indira	62	Female	ERC, Trichy	1
8	Kirathi	64	Female	ERC, Trichy	4
9	Sundari	67	Female	ERC, Trichy	3
10	Gomathi	70	Female	ERC, Trichy	1
11	Lakshmi	14	Female	SMTR	1
12	Sundaravalli	18	Female	SMTR	1
13	Adhinayaki	23	Female	SMTR	1
14	Kumuthavalli	27	Female	SMTR	1
15	Kurkudivalli	28	Female	SMTR	1
16	Gandhimathi	52	Female	SMTR	1

ERRC - Elephant Rehabilitation and Rescue Centre; SMTR - SrivilliputhurMegamalai Tiger Reserve

Table 4. Haematological parameters of Male Elephants at Kozhikamuthi and Varakalayar camps in Anamalai Tiger Reserve (N = 44)

Sampling	Parameters	Unit	Name of elephant																\bar{X}
			A1M	A2M	A3M	A4M	A5M	A6M	A7M	A8M	A9M	A10M	A11M	A12M	A13M	A14M	A15M	A16M	
	Age	Years	10	14	15	18	19	23	26	27	27	39	40	42	44	51	55	60	
I	WBC	X $10^3/\mu\text{L}$	22.05	16.8	22.05	19.25	16.1	14.1	15.6	17.95	NC	15.55	14.05	14.9	17.95	NC	10.25	14.55	
II			25.1	NC	23.65	NC	20.55	16.2	NC	NC	NC	12.1	NC	NC	20.2	NC	12	NC	
III			19.45	14.35	22.25	16.3	NC	14.05	NC	NC	21.2	NC	13.7	NC	15.55	14.75	8	22.25	
IV			20.4	13.1	17.35	15.45	16.95	18.75	NC	NC	15.95	16.9	NC	NC	18.15	6.5	8.35	21.15	
MEAN			21.75	14.75	21.32	17	17.86	15.77	15.6	17.95	18.57	14.85	13.87	14.9	17.96	10.62	9.65	19.31	16.36
I	Lymph#	X $10^3/\mu\text{L}$	10.05	11.25	11.15	13.2	7.55	3.45	4.35	5.95	NC	10.45	9.3	5.4	12.05	NC	5	5.3	
II			14.6	NC	17	NC	15.45	11.3	NC	NC	NC	9.15	NC	NC	5.25	NC	6.9	NC	
III			13.95	10.75	16.2	12.45	NC	6.85	NC	NC	13.6	NC	10.35	NC	6.65	10.45	5.15	16.8	
IV			14.8	10.2	12.8	5.65	12.45	14.25	NC	NC	12.3	11.9	NC	NC	13.45	2.95	5.85	16.35	
MEAN			13.35	10.73	14.28	10.43	11.81	8.96	4.35	5.95	12.95	10.5	9.82	5.4	9.35	6.7	5.72	12.81	9.57
I	Mon#	X $10^3/\mu\text{L}$	1.7	0.9	1.95	1.45	1.6	1.15	1.9	1.2	NC	0.65	0.8	1.1	0.85	NC	0.85	1.05	
II			1.5	NC	0.6	NC	0.7	0.6	NC	NC	NC	0.35	NC	NC	0.85	NC	0.3	NC	
III			0.6	0.45	0.85	0.45	NC	1	NC	NC	0.9	NC	0.4	NC	0.85	0.35	0.25	0.4	
IV			0.7	0.4	0.35	0.8	0.4	0.5	NC	NC	0.2	0.4	NC	NC	0.5	0.2	0.15	0.45	
MEAN			1.12	0.58	0.93	0.9	0.9	0.81	1.9	1.2	0.55	0.46	0.6	1.1	0.76	0.27	0.38	0.63	0.82
I	Gran#	X $10^3/\mu\text{L}$	10.3	4.65	8.95	4.6	6.95	9.5	9.35	10.8	NC	4.45	3.95	8.4	5.05	NC	4.4	8.2	
II			9	NC	6.05	NC	4.4	4.3	NC	NC	NC	2.6	NC	NC	14.1	NC	4.8	NC	
III			4.9	3.15	5.2	3.4	NC	6.2	NC	NC	6.7	NC	2.95	NC	8.05	3.95	2.6	5.05	
IV			4.9	2.5	4.2	9	4.1	4	NC	NC	3.45	4.6	NC	NC	4.2	3.35	2.35	4.35	
MEAN			7.27	3.43	6.1	5.66	5.15	6	9.35	10.8	5.07	3.88	3.45	8.4	7.85	3.65	3.53	5.86	5.96
I	Lymph%	%	45.35	67.05	50.4	68.5	46.8	24.4	27.75	33.15	NC	67.25	66	36.15	67.05	NC	48.9	36.8	
II			58.2	NC	71.75	NC	74.85	69.5	NC	NC	NC	75.45	NC	NC	26.1	NC	57.05	NC	
III			71.6	74.85	72.8	76.25	NC	49.1	NC	NC	64	NC	75.2	NC	42.8	70.7	64.05	75.2	

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IV			72.45	77.95	73.7	34.1	73.15	75.75	NC	NC	77	70.25	NC	NC	74.65	45.2	70.15	77.35	
MEAN			61.9	73.28	67.16	59.61	64.93	54.68	27.75	33.15	70.5	70.98	70.6	36.15	52.65	57.95	60.03	63.11	57.77
I	Mon%	%	7.95	5.25	9.05	7.75	10.1	8.3	12.25	6.9	NC	4.1	5.7	7.5	5.05	NC	8.5	7.35	
II			5.95	NC	2.7	NC	3.65	4.05	NC	NC	NC	3.05	NC	NC	4.2	NC	2.9	NC	
III			3.15	3.45	3.95	3.1	NC	7.2	NC	NC	4.2	NC	3.1	NC	5.4	2.45	3.35	1.95	
IV			3.55	3.05	2.05	5	2.55	2.85	NC	NC	1.45	2.5	NC	NC	2.6	3.35	2.1	2	
MEAN			5.15	3.91	4.43	5.28	5.43	5.6	12.25	6.9	2.82	3.21	4.4	7.5	4.31	2.9	4.21	3.76	5.13
I	Gran%	%	46.7	27.7	40.55	23.75	43.1	67.3	60	59.95	NC	28.65	28.3	56.35	27.9	NC	42.6	55.85	
II			35.85	NC	25.55	NC	21.5	26.45	NC	NC	NC	21.5	NC	NC	69.7	NC	40.05	NC	
III			25.25	21.7	23.25	20.65	NC	43.7	NC	NC	31.8	NC	21.7	NC	51.8	26.85	32.6	22.85	
IV			24	19	24.25	60.9	24.3	21.4	NC	NC	21.55	27.25	NC	NC	22.75	51.45	27.75	20.65	
MEAN			32.95	22.8	28.4	35.1	29.63	39.71	60	59.95	26.67	25.8	25	56.35	43.037	39.15	35.75	33.11	37.08
I	RBC	X 10 ⁶ /μL	3.38	3.26	2.9	3	2.52	2.96	3.03	3.25	NC	2.445	2.93	3.21	2.785	NC	2.385	2.74	
II			3.51	NC	3.24	NC	2.565	3.125	NC	NC	NC	2.71	NC	NC	3.045	NC	2.36	NC	
III			3.48	3.025	3.32	3.24	NC	3.13	NC	NC	2.78	NC	2.895	NC	2.695	3.2	1.745	2.785	
IV			3.07	2.94	3.115	3.44	3.07	3.345	NC	NC	3.04	2.96	NC	NC	2.725	2.905	2.69	2.685	
MEAN			3.36	3.07	3.14	3.22	2.71	3.14	3.03	3.25	2.91	2.70	2.91	3.21	2.81	3.05	2.29	2.73	2.97
I	HGB	g/dL	14.2	14.4	12.3	12.85	11.3	11.85	13.9	13.65	NC	11.05	13.25	13.5	11.7	NC	10.15	12	
II			14.45	NC	13.8	NC	11.4	11.8	NC	NC	NC	10.9	NC	NC	12.15	NC	9.7	NC	
III			14.05	12.25	12.85	13.05	NC	11.7	NC	NC	10.95	NC	12.15	NC	10.5	12.3	6.75	11.5	
IV			12.35	12.5	12.3	14.05	13.1	12.7	NC	NC	12.55	11.85	NC	NC	11	11.6	10.5	11.3	
MEAN			13.76	13.05	12.81	13.31	11.93	12.01	13.9	13.65	11.75	11.26	12.7	13.5	11.33	11.95	9.27	11.6	12.36
I	HCT	%	39.2	39.05	34.15	35.45	30.5	33.05	37.45	38	NC	29.5	35	37.35	32.3	NC	28.3	32.95	
II			40.4	NC	37.4	NC	31.05	34.3	NC	NC	NC	31.1	NC	NC	34.8	NC	27.95	NC	
III			40	35.7	37.6	37.4	NC	34.35	NC	NC	31.9	NC	34.3	NC	30.6	36.3	20.2	33.5	
IV			35.65	36	36.1	41.5	37.8	37.4	NC	NC	36.4	34.55	NC	NC	32.05	33.8	32.2	32.8	
MEAN			38.81	36.91	36.31	38.11	33.11	34.77	37.45	38	34.15	31.71	34.65	37.35	32.43	35.05	27.16	33.08	34.94
I	MCV	fL	116.05	119.9	117.9	118.35	121.4	111.75	123.75	117.05	NC	120.8	119.7	116.55	116.2	NC	118.75	120.4	

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II			115.2	NC	115.6 5	NC	121.2 5	109.9 5	NC	NC	NC	114.9 5	NC	NC	114.6	NC	118.5 5	NC	
III			115.1 5	118.1 5	113.4	115.5 5	NC	109.8 5	NC	NC	114.8	NC	118.7	NC	113.8	113.5	116.1	120.4 5	
IV			116.2 5	122.6 5	116.1	120.9	123.2 5	111.9 5	NC	NC	119.8 5	116.8 5	NC	NC	117.7 5	116.4	119.9	122.3	
MEAN			115.6 6	120.2 3	115.7 6	118.2 6	121.9 6	110.8 7	123.7 5	117.0 5	117.3 2	117.5 3	119.2	116.5 5	115.5 8	114.9 5	118.3 2	121.0 5	117.7 5
I	MCH	pg	42	44.15	42.35	42.8	44.8	39.95	45.85	42	NC	45.15	45.15	42	41.95	NC	42.55	43.75	
II			41.15	NC	42.55	NC	44.4	37.7	NC	NC	NC	40.15	NC	NC	39.85	NC	41.05	NC	
III			40.3	40.45	38.65	40.2	NC	37.3	NC	NC	39.35	NC	41.9	NC	38.9	38.4	38.65	41.25	
IV			40.15	42.5	39.45	40.8	42.6	37.9	NC	NC	41.25	40	NC	NC	40.35	39.9	39	42.05	
MEAN			40.9	42.36	40.75	41.26	43.93	38.21	45.85	42	40.3	41.76	43.52	42	40.26	39.15	40.31	42.35	41.55
I	MCHC	g/dL	36.2	36.85	35.95	36.2	37	35.8	37.05	35.85	NC	37.45	37.8	36.1	36.15	NC	35.8	36.4	
II			35.7	NC	36.85	NC	36.65	34.4	NC	NC	NC	35	NC	NC	34.85	NC	34.65	NC	
III			35.05	34.25	34.15	34.85	NC	34	NC	NC	34.3	NC	35.35	NC	34.3	33.85	33.35	34.3	
IV			34.6	34.7	34	33.8	34.65	33.9	NC	NC	34.45	34.25	NC	NC	34.3	34.3	32.55	34.4	
MEAN			35.38	35.26	35.23	34.95	36.1	34.52	37.05	35.85	34.37	35.56	36.57	36.1	34.9	34.07	34.08	35.03	35.31
I	RDW	%	13.7	14.2	14.75	14.45	13.8	14.5	14.15	14	NC	13.55	13.5	14.3	13.55	NC	13.75	14.05	
II			15.2	NC	15.1	NC	16.15	16.55	NC	NC	NC	14.3	NC	NC	15.15	NC	14.55	NC	
III			15.6	16.45	15.55	16.05	NC	15.45	NC	NC	15.6	NC	15.55	NC	15.85	15.9	15.2	15.6	
IV			15.5	15.8	14.95	16.15	15.75	16.8	NC	NC	15.45	16.1	NC	NC	15.3	16.85	15.65	16.4	
MEAN			15	15.48	15.08	15.55	15.23	15.82	14.15	14	15.52	14.65	14.52	14.3	14.96	16.37	14.78	15.35	15.05
I	PLT	X 10 ³ /μL	643.5	452.5	470	463	438	384	541	525	NC	622.5	429	455.5	485.5	NC	402.5	474.5	
II			736	NC	597	NC	650.5	747	NC	NC	NC	755	NC	NC	593.5	NC	514.5	NC	
III			765.5	527.5	622.5	594	NC	771	NC	NC	944.5	NC	525.5	NC	552.5	578	1343	682	
IV			781	582	810.5	657	669	820.5	NC	NC	961	655.5	NC	NC	565	630.5	670	615	
MEAN			731.5	520.6 6	625	571.3 3	585.8 3	680.6 2	541	525	952.7 5	677.6 6	477.2 5	455.5	549.1 2	604.2 5	732.5	590.5	613.7 8
I	MPV	fL	4.1	3.35	3.6	3.95	3.65	4.1	4	3.35	NC	3.75	3.55	4	3.6	NC	4.4	4.1	
II			4.3	NC	4.3	NC	3.85	4.05	NC	NC	NC	4.25	NC	NC	3.85	NC	4.15	NC	
III			4.35	3.75	4.1	4.15	NC	4.4	NC	NC	4.1	NC	3.9	NC	4.05	4.1	3.9	4.75	

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IV			4.35	3.75	4.2	4.5	3.8	4.05	NC	NC	3.9	3.95	NC	NC	4	3.85	3.8	4.9		
MEAN			4.27	3.61	4.05	4.2	3.76	4.15	4	3.35	4	3.98	3.72	4	3.87	3.97	4.06	4.58	3.97	
I	PDW		16.45	15.55	15.65	16.35	16	17.1	15.95	15.75	NC	16.15	15.8	15.8	15.85	NC	17.25	16.4		
II			16.35	NC	16.3	NC	15.8	16.05	NC	NC	NC	16.35	NC	NC	15.85	NC	16.85	NC		
III			16.55	15.75	15.95	16.3	NC	16.15	NC	NC	16.05	NC	15.95	NC	16.2	16.4	15.75	16.75		
IV			16.45	15.9	16.15	16.6	15.75	16.15	NC	NC	16	16	NC	NC	16.05	16	15.75	16.9		
MEAN			16.45	15.73	16.01	16.41	15.85	16.36	15.95	15.75	16.02	16.16	15.87	15.8	15.98	16.2	16.4	16.68	16.10	
I	PCT	%	0.263 5	0.151	0.168 5	0.182	0.159 5	0.157	0.216	0.175 5	NC	0.232 5	0.151 5	0.181 5	0.174	NC	0.176 5	0.194 5		
II				0.316	NC	0.256 5	NC	0.261 5	0.302 5	NC	NC	NC	0.320 5	NC	NC	0.228 5	NC	0.213	NC	
III				0.332 5	0.197 5	0.255	0.246	NC	0.339	NC	NC	0.386 5	NC	0.204 5	NC	0.223 5	0.236 5	0.523 5	0.323 5	
IV				0.339 5	0.217 5	0.34	0.295 5	0.253 5	0.332	NC	NC	0.374 5	0.258 5	NC	NC	0.225 5	0.242	0.254	0.301	
MEAN			0.31	0.19	0.25	0.24	0.22	0.28	0.21	0.17	0.38	0.27	0.18	0.18	0.21	0.24	0.29	0.27	0.24	

A1M – SANJEEV; **A2M** – ASHOK; **A3M** – URIGAN; **A4M** – SARAVANAN; **A5M** – NARASIMMAN; **A6M** – MUTHU; **A7M** – RAJAVARATHAN; **A8M** – CHINNATHAMBI; **A9M** – SUYAMBU; **A10M** – VENKATESH; **A11M** – BHARANI; **A12M** – KAPILDEV; **A13M** – PAARI; **A14M** – SURYA; **A15M** – RAMU; **A16M** – KALEEM

WBC = White Blood Cells; Lympho. = Lymphocytes; Mon. = Monocytes; Gran.= Granulocytes; RBC = Red Blood Corpuscle; HGB = Haemoglobin; HCT = Haematocrit (%); MCV= Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; RDW = RBC distribution width; PLT = Platelet; MPV = Mean platelet volume; PDW = Platelet Distribution Width; PCT = Platelet Crit

NC = Not collected

Table 5. Haematological parameters of Female Elephants at Kozhikamuthi and Varakalayar camps in Anamalai Tiger Reserve (N = 34)

Sampling	Parameters	Unit	Name of the elephants									\bar{X}
			A1F	A2F	A3F	A4F	A5F	A6F	A7F	A8F	A9F	
	Age	Years	16	15	20	19	29	63	64	70	74	
I	WBC	X 10 ³ /μL	13.9	NC	15.75	16.35	13.8	15.6	16	15.1	14.5	
II			13	NC	14.65	22.7	13.15	17.75	14.25	14.6	16.4	
III			12.9	15.05	13.55	18.05	10.15	13.95	14.6	17.7	17.5	
IV			14.35	21	14.9	19.45	11.9	12.85	14.05	17	16	
MEAN			13.53	18.02	14.71	19.13	12.25	15.03	14.72	16.1	16.1	15.51
I	Lymph#	X 10 ³ /μL	1.9	NC	0.5	9.85	2.65	4.35	4.85	0.6	9.05	
II			7.1	NC	11.2	11.3	7.85	13.2	10.15	7.95	11.4	
III			9.1	11.6	9.85	12.6	7.75	10.2	10.2	12.7	12.9	
IV			9.8	12.95	11.1	15.05	9.25	9.35	10.3	12.1	0.15	
MEAN			6.97	12.27	8.16	12.2	6.87	9.27	8.87	8.33	8.37	9.04
I	Mon#	X 10 ³ /μL	1.2	NC	0.7	1.2	1.55	1.9	1.7	0.65	0.9	
II			0.6	NC	0.35	1.25	0.55	0.3	0.6	1	0.65	
III			0.45	0.45	0.5	0.75	0.2	0.55	0.5	0.6	0.55	
IV			0.6	0.65	0.4	0.4	0.25	0.45	0.45	0.6	0.35	
MEAN			0.71	0.55	0.48	0.9	0.63	0.8	0.81	0.71	0.61	0.69
I	Gran#	X 10 ³ /μL	10.8	NC	14.55	5.3	9.6	9.35	9.45	13.85	4.55	
II			5.3	NC	3.1	10.15	4.75	4.25	3.5	5.64	4.35	
III			3.35	3	3.2	4.7	2.2	3.2	3.9	4.4	4.05	
IV			3.95	7.4	3.4	4	2.4	3.05	3.3	4.3	15.5	
MEAN			5.85	5.2	6.06	6.03	4.73	4.96	5.03	7.04	7.11	5.78
I	Lymph%	%	13.55	NC	3.4	59.9	19.3	27.75	30.35	3.85	62	
II			54.75	NC	76.4	49.75	59.8	74.1	71.05	54.4	69.2	
III			70.1	76.95	72.75	69.8	76	72.7	69.6	71.6	73.65	

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IV			68.15	62.9	74.65	77.25	77.55	73	73.55	71.05	1.05	
MEAN			51.63	69.92	56.8	64.17	58.16	61.88	61.13	50.22	51.47	58.38
I	Mon%	%	8.8	NC	4.4	7.55	11.3	12.25	10.65	4.5	6.3	
II			4.65	NC	2.45	5.55	4.15	2.05	4.25	6.6	4	
III			3.85	3.1	3.75	4.1	2.3	4.15	3.7	3.65	3.15	
IV			4.45	3.1	2.8	2	2.3	3.4	3.1	3.65	2.25	
MEAN			5.43	3.1	3.35	4.8	5.01	5.46	5.42	4.6	3.92	4.56
I	Gran%	%	77.65	NC	92.2	32.55	69.4	60	59	91.65	31.7	
II			40.6	NC	21.15	44.7	36.05	23.85	24.7	39	26.8	
III			26.05	19.95	23.5	26.1	21.7	23.15	26.7	24.75	23.2	
IV			27.4	34	22.55	20.75	20.15	23.6	23.35	25.3	96.7	
MEAN			42.92	26.97	39.85	31.02	36.82	32.65	33.43	45.17	44.6	37.05
I	RBC	X 10 ⁶ /μL	2.32	NC	2.62	3.25	2.49	3.03	4.42	2.49	2.89	
II			3.16	NC	2.965	3.135	2.575	3.345	3.145	3.03	2.98	
III			2.52	3.62	2.8	3.005	4.45	2.82	3.285	2.765	2.88	
IV			2.72	3.43	2.74	3.14	2.445	3.53	3.025	2.37	2.46	
MEAN			2.68	3.52	2.78	3.13	2.99	3.18	3.47	2.66	2.80	3.02
I	HGB	g/dL	10.15	NC	11.75	14.65	10.95	13.9	20.85	10.5	13.8	
II			13.15	NC	12.35	13	10.95	13.35	13.9	12.5	12.05	
III			10.25	14.25	11.6	12.35	17.65	11.1	14.15	10.75	12.3	
IV			11.4	13.9	11.6	13	10.25	14	13.15	9.85	10.85	
MEAN			11.23	14.07	11.82	13.25	12.45	13.08	15.51	10.9	12.25	12.73
I	HCT	%	28.05	NC	31.85	39.35	29.25	37.45	55.35	29	36.25	
II			37.5	NC	35.8	36.85	30.4	39.2	38.9	34.6	34.85	
III			29.75	41.9	33.85	35.35	52.25	32.8	40.7	31.65	35.3	
IV			33.55	40.35	33.15	37.55	29.5	42.1	38.15	28.05	31.05	
MEAN			32.21	41.12	33.66	37.27	35.35	37.88	43.27	30.82	34.36	36.22
I	MCV	fL	120.95	NC	121.75	121.3	117.7	123.75	125.4	116.75	125.65	
II			118.9	NC	120.8	117.65	118.35	117.4	123.75	114.3	117.2	

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III			118.3	115.85	121	117.9	117.75	116.45	124.15	114.8	122.75	
IV			123.55	117.75	121.15	119.65	120.75	119.5	126.2	118.65	126.4	
MEAN			120.4	116.8	121.1	119.1	118.6	119.2	124.8	116.12	123	119.93
I	MCH	pg	43.7	NC	44.8	45.05	43.95	45.85	47.1	42.15	47.7	
II			41.6	NC	41.6	41.45	42.5	39.9	44.15	41.2	40.45	
III			40.65	39.3	41.4	41.05	39.85	39.3	43	38.85	42.7	
IV			41.85	40.6	42.3	41.35	41.85	39.65	43.4	41.55	44.05	
MEAN			41.95	39.95	42.52	42.22	42.03	41.17	44.41	40.93	43.72	42.10
I	MCHC	g/dL	36.15	NC	36.85	37.15	37.4	37.05	37.55	36.15	38.05	
II			35.05	NC	34.45	35.25	35.95	34	35.7	36.1	34.55	
III			34.4	34	34.25	34.9	33.85	33.8	34.7	33.9	34.8	
IV			33.95	34.5	34.95	34.6	34.7	33.2	34.45	35.05	34.9	
MEAN			34.88	34.25	35.12	35.47	35.47	34.51	35.6	35.3	35.57	35.13
I	RDW	%	14.85	NC	14.9	14.35	13.35	14.15	14.65	13.9	14.25	
II			15.15	NC	15.8	15.5	14.45	15.7	15.25	15.55	14.7	
III			15.7	16.25	15.55	16.6	15.6	15.7	14.75	15.9	15.25	
IV			15.85	16.1	16.05	16.15	15.15	15.55	15.5	15.15	15.25	
MEAN			15.38	16.17	15.57	15.65	14.63	15.27	15.03	15.12	14.86	15.30
I	PLT	X 10 ³ /μL	469.5	NC	467.5	400	525	541	465	517	428.5	
II			494	NC	573	531.5	707	642.5	618	611	697	
III			618.5	364	544.5	538.5	451	575.5	563	596.5	606.5	
IV			649	599.5	538	528.5	786	624	587.5	635.5	662	
MEAN			557.7	481.7	530.7	499.6	617.2	595.7	558.3	590	598.5	558.86
I	MPV	fL	3.4	NC	3.9	4.15	3.8	4	3.8	4	3.85	
II			3.7	NC	4.45	4.3	4.1	4.3	3.9	4.35	4.25	
III			3.9	3.6	4.5	4.3	4.4	4.35	4	4.8	4.45	
IV			3.45	3.65	4.2	4.2	4.1	4.35	4	4.95	4.4	

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MEAN			3.61	3.62	4.26	4.23	4.1	4.25	3.92	4.52	4.23	4.08
I	PDW		15.6	NC	16.4	16.4	16	15.95	16.05	16.3	16.3	
II			15.9	NC	16.75	16.4	16.35	16.55	15.95	16.4	16.5	
III			16.2	15.65	16.8	16.5	16.65	16.7	16.3	16.65	16.65	
IV			15.65	15.9	16.45	16.4	16.3	16.5	16.05	16.9	16.65	
MEAN			15.83	15.77	16.6	16.42	16.32	16.42	16.08	16.56	16.52	16.28
I	PCT	%	0.159	NC	0.182	0.165	0.199	0.216	0.1755	0.206	0.1645	
II			0.1825	NC	0.2545	0.228	0.2895	0.2755	0.2405	0.265	0.295	
III			0.2405	0.1305	0.2445	0.231	0.196	0.2495	0.225	0.286	0.2695	
IV			0.2235	0.218	0.2255	0.2215	0.322	0.2705	0.2345	0.314	0.2905	
MEAN			0.20	0.17	0.22	0.21	0.25	0.25	0.22	0.26	0.25	0.23

A1F – KAVERI; **A2F** – DEIVANAI; **A3F** – DEVI; **A4F** – ABINAYA; **A5F** – DURGA; **A6F** – ANDAL; **A7F** – SELVI; **A8F** – SARATHA; **A9F** - SIVAGAMI

WBC = White Blood Cells; Lympho. = Lymphocytes; Mon. = Monocytes; Gran.= Granulocytes; RBC = Red Blood Corpuscle; HGB = Haemoglobin; HCT = Haematocrit (%); MCV= Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; RDW = RBC distribution width; PLT = Platelet; MPV = Mean platelet volume; PDW = Platelet Distribution Width; PCT = Platelet Crit

NC = Not collected

Table 6. Haematological parameters of Male Elephants at Theppakadu and Abhayaranyam camps in Mudumalai Tiger Reserve (N = 54)

Sampling	Parameters	Unit	Name of elephants																		\bar{X}
			1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	12M	13M	14M	15M	16M	17M	18M	
	Age	Years	6	12	14	22	25	33	35	37	37	37	53	52	52	54	54	60	65	72	
I	WBC	$\times 10^3/\mu\text{L}$	15.9	18.6	21.35	16.5	NC	13.2	10.35	NC	17.2	NC	11.3	NC	12	15.5	NC	NC	13.9	21.1	
II			25.1	19.2	17.1	14.7	NC	14.85	NC	13.05	24.25	18.45	11.4	NC	NC	15.65	NC	124.6	16.35	15.6	
III			20.05	NC	19.3	NC	14.1	14.95	10.2	13.95	NC	16.95	17.6	NC	11.3	15.55	16.15	107.1	32.1	13.2	
IV			29.3	NC	13.15	13.95	15.2	NC	10.65	NC	17.3	15.25	11.65	13.05	13.1	16.1	17.55	174.05	16.8	13.55	
MEAN			22.58	18.9	17.72	15.05	14.65	14.33	10.4	13.5	19.58	16.88	12.98	13.05	12.13	15.7	16.85	135.25	19.78	15.86	22.51
I	Lymph#	$\times 10^3/\mu\text{L}$	10.5	3.45	7.55	11.65	NC	4.2	6	NC	11.35	NC	0.4	NC	6.85	10.15	NC	NC	8.6	13.7	
II			19	14.8	13	11.3	NC	10.6	NC	9.9	17.75	13.7	7.6	NC	NC	11.95	NC	83.75	11.2	11.75	
III			11.4	NC	7.6	NC	9.75	7.15	3.5	3.05	NC	12.65	12.15	NC	5.35	11.05	5.5	71.25	18	8.95	
IV			21.6	NC	9.15	10.35	11.15	NC	7.7	NC	12.6	10.9	7.3	9.3	9.1	10.95	12.15	97.9	12.2	9.85	
MEAN			15.62	9.12	9.32	11.1	10.45	7.31	5.73	6.47	13.9	12.41	6.86	9.3	7.1	11.02	8.82	84.3	12.5	11.06	14.02
I	Mon#	$\times 10^3/\mu\text{L}$	0.95	1.8	2.3	0.7	NC	0.95	0.55	NC	0.95	NC	0.35	NC	0.65	0.85	NC	NC	0.85	0.85	
II			0.4	0.3	0.4	0.3	NC	0.35	NC	0.3	0.5	0.4	0.4	NC	NC	0.3	NC	7.3	0.5	0.4	
III			1.25	NC	1.95	NC	0.85	0.95	1	1.05	NC	0.8	0.55	NC	0.75	0.6	1.15	5.4	0.45	0.6	
IV			0.9	NC	0.5	0.4	0.5	NC	0.2	NC	0.45	0.6	0.5	0.3	0.55	0.6	0.6	13.75	0.4	0.4	
MEAN			0.87	1.05	1.28	0.46	0.67	0.75	0.58	0.67	0.63	0.6	0.45	0.3	0.65	0.58	0.87	8.81	0.55	0.56	1.13
I	Gran#	$\times 10^3/\mu\text{L}$	4.45	13.35	11.5	4.15	NC	8.05	3.8	NC	4.9	NC	10.55	NC	4.5	4.5	NC	NC	4.45	6.55	
II			5.7	4.1	3.7	3.1	NC	3.9	NC	2.85	6	4.35	3.4	NC	NC	3.4	NC	33.55	4.65	3.45	
III			7.4	NC	9.75	NC	3.5	6.85	5.7	9.85	NC	3.5	4.9	NC	5.2	3.9	9.5	30.45	13.65	3.65	
IV			6.8	NC	3.5	3.2	3.55	NC	2.75	NC	4.25	3.75	3.85	3.45	3.45	4.55	4.8	62.4	4.2	3.3	
MEAN			6.08	8.72	7.11	3.48	3.52	6.26	4.08	6.35	5.05	3.86	5.67	3.45	4.38	4.08	7.15	42.13	6.73	4.23	7.35
I	Lymph%	%	65.75	18.35	35.2	70.55	NC	31.65	57.95	NC	66.05	NC	3.75	NC	56.7	65.7	NC	NC	62.1	64.9	
II			75.55	76.85	75.9	76.75	NC	71.3	NC	75.6	73.25	74.25	66.3	NC	NC	76.2	NC	67.2	68.25	74.95	

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III			56.85	NC	39.2	NC	69.4	46.9	34.5	21.8 5	NC	74.55	69.35	NC	47.55	71.1	34.6	66.5	55	67.4	
IV			73.75	NC	69.5	74.25	73.6	NC	71.95	NC	72.75	71.5	62.55	71.1	69.8	67.85	70.05	56.3	72.3	72.5	
MEAN			67.97	47.6	54.95	73.85	71.5	49.95	54.8	48.7 2	70.68	73.43	50.48	71.1	58.01	70.21	52.32	63.33	64.41	69.93	61.85
I	Mon%	%	6.05	10.1	10.8	4.15	NC	7.2	5.55	NC	5.6	NC	3	NC	5.45	5.35	NC	NC	6.1	4.1	
II			1.65	1.95	2.3	2.05	NC	2.45	NC	2.8	1.95	2.25	4.15	NC	NC	2	NC	5.85	3.2	2.9	
III			6.4	NC	10.2	NC	6.1	6.6	9.75	8	NC	4.6	3.25	NC	6.55	3.85	7.3	5.05	1.6	5.2	
IV			2.95	NC	3.9	2.85	3.1	NC	2.45	NC	2.65	4.1	4.15	2.45	4.05	3.8	3.3	7.9	2.65	2.9	
MEAN			4.26	6.02	6.8	3.01	4.6	5.41	5.91	5.4	3.4	3.65	3.63	2.45	5.35	3.75	5.3	6.26	3.38	3.77	4.57
I	Gran%	%	28.2	71.55	54	25.3	NC	61.15	36.5	NC	28.35	NC	93.25	NC	37.85	28.95	NC	NC	31.8	31	
II			22.8	21.2	21.8	21.2	NC	26.25	NC	21.6	24.8	23.5	29.55	NC	NC	21.8	NC	26.95	28.55	22.15	
III			36.75	NC	50.6	NC	24.5	46.5	55.75	70.1 5	NC	20.85	27.4	NC	45.9	25.05	58.1	28.45	43.4	27.4	
IV			23.3	NC	26.6	22.9	23.3	NC	25.6	NC	24.6	24.4	33.3	26.4 5	26.15	28.35	26.65	35.8	25.05	24.6	
MEAN			27.76	46.37	38.25	23.13	23.9	44.63	39.28	45.8 7	25.91	22.91	45.87	26.4 5	36.63	26.03	42.37	30.4	32.2	26.28	33.57
I	RBC	X 10 ⁶ /μL	5.455	2.98	3.41	2.77	NC	3.33	3.12	NC	2.975	NC	2.805	NC	2.41	2.945	NC	NC	2.695	3.14	
II			3.63	2.825	3.23	2.995	NC	2.985	NC	2.99 5	3	3.32	2.905	NC	NC	2.795	NC	2.9	2.55	3.365	
III			3.345	NC	3.235	NC	3.405	2.98	2.8	2.52	NC	2.945	4.31	NC	2.87	3.22	2.935	3.105	3.11	2.9	
IV			3.755	NC	3.035	2.66	3.175	NC	2.93	NC	2.91	3.015	3.105	2.84 5	3.565	3.4	3.95	3.105	2.975	3.37	
MEAN			4.04	2.90	3.22	2.80	3.29	3.09	2.95	2.75	2.96	3.09	3.28	2.84	2.94	3.09	3.44	3.03	2.83	3.19	3.10
I	HGB	g/dL	21	13.25	15	13.45	NC	15.1	13.8	NC	13.6	NC	11.6	NC	11.3	11.5	NC	NC	12.15	13	
II			13.8	12.15	13.35	13.45	NC	12.6	NC	12.1	12.75	14.55	11.5	NC	NC	11.2	NC	13.4	11.15	12.8	
III			12.3	NC	12.75	NC	13	12.65	11.45	10.0 5	NC	12.65	18.6	NC	12	12.4	11.8	12.55	13	10.8	
IV			14	NC	12.15	11.6	12.3	NC	12.45	NC	12.4	12.6	12.05	12.4 5	14.8	13.2	15.85	12.75	12.6	12.8	
MEAN			15.27	12.7	13.31	12.83	12.65	13.45	12.56	11.0 7	12.91	13.26	13.43	12.4 5	12.7	12.07	13.82	12.9	12.22	12.35	12.89
I	HCT	%	60.6	35.9	40.7	35.15	NC	40.9	38.3	NC	36.4	NC	32.2	NC	29.75	31.7	NC	NC	32.6	34.95	
II			39.85	34	37.65	37.45	NC	35.7	NC	34.8	35.35	39.75	33.05	NC	NC	31.55	NC	36.1	30.85	37.35	
III			35.3	NC	37.05	NC	38.05	34.95	32.8	28.7	NC	34.55	51.75	NC	34.1	35.9	33.1	36.05	36.6	31.05	

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IV			40.95	NC	35.7	33.25	36.55	NC	36	NC	35.35	35.95	36.4	35.25	43.6	39.1	46.8	37.45	37	37.55	
MEAN			44.17	34.95	37.77	35.28	37.3	37.18	35.7	31.75	35.7	36.75	38.35	35.25	35.81	34.56	39.95	36.53	34.26	35.22	36.47
I	MCV	fL	111.2	120.7	119.55	127.1	NC	122.95	122.95	NC	122.45	NC	115	NC	123.75	107.85	NC	NC	121.1	111.6	
II			109.95	120.6	116.65	125.35	NC	119.8	NC	116.3	117.95	119.95	114	NC	NC	113	NC	124.65	121.2	111.15	
III			105.65	NC	114.6	NC	11.95	117.55	117.35	114.1	NC	117.35	120.7	NC	119	111.7	113.05	116.15	117.9	107.25	
IV			109.2	NC	117.75	125.15	115.3	NC	122.9	NC	121.65	119.55	117.3	124	122.4	115.15	118.5	120.8	124.65	111.5	
MEAN			109	120.65	117.13	125.86	63.62	120.16	115.2	120.68	118.95	116.75	124	121.71	111.92	115.77	120.53	121.21	110.37	115.25	
I	MCH	pg	38.45	44.4	43.95	48.5	NC	45.3	44.2	NC	45.7	NC	41.3	NC	46.85	39	NC	NC	45.05	41.35	
II			37.95	43	41.25	44.85	NC	42.15	NC	40.35	42.5	43.8	39.55	NC	NC	40.05	NC	46.2	43.7	37.95	
III			36.75	NC	39.4	NC	38.15	42.4	40.9	39.85	NC	42.9	43.5	NC	41.75	38.45	40.15	40.4	41.8	37.2	
IV			37.25	NC	40	43.55	38.7	NC	42.45	NC	42.55	41.8	38.75	43.75	41.45	38.75	40.1	40.95	42.3	37.95	
MEAN			37.6	43.7	41.15	45.63	38.42	43.28	42.51	40.1	43.58	42.83	40.77	43.75	43.35	39.06	40.12	42.51	43.21	38.61	41.68
I	MCHC	g/dL	34.6	36.85	36.8	38.2	NC	36.9	36	NC	37.3	NC	36	NC	37.95	36.2	NC	NC	37.2	37.15	
II			34.6	35.7	35.45	35.9	NC	35.2	NC	34.7	36	36.55	34.75	NC	NC	35.45	NC	37.05	36.1	34.2	
III			34.8	NC	34.35	NC	34.15	36.15	34.9	34.95	NC	36.6	36.05	NC	35.1	34.5	35.6	34.75	35.5	34.75	
IV			34.15	NC	34	34.85	33.6	NC	34.55	NC	35.05	35	33.05	35.3	33.85	33.7	33.9	34	34	34.05	
MEAN			34.53	36.27	35.15	36.31	33.87	36.08	35.15	34.82	36.11	36.05	34.96	35.3	35.63	34.96	34.75	35.26	35.7	35.03	35.33
I	RDW	%	13.85	14.5	14.8	14.35	NC	13.95	14.3	NC	14.6	NC	14.2	NC	14.1	15.15	NC	NC	14.1	14	
II			15.2	15.3	15.25	14.7	NC	15.65	NC	15.7	15.3	14.65	15.9	NC	NC	14.6	NC	14	14.8	14.45	
III			15.35	NC	14.8	NC	15.1	15.7	15.3	15.65	NC	14.75	15.45	NC	14.6	15.45	15.6	15	14.85	15.95	
IV			15.6	NC	15.8	15.65	15.5	NC	15.35	NC	15.2	15.2	15.75	15.45	15.8	15.5	16.3	15.85	15.55	14.95	
MEAN			15	14.9	15.16	14.9	15.3	15.1	14.98	15.67	15.03	14.86	15.32	15.45	14.83	15.17	15.95	14.95	14.82	14.83	15.12
I	PLT	X 10 ³ /μL	469	615	541	488	NC	601.5	550	NC	491	NC	658.5	NC	425.5	512.5	NC	NC	768.5	605.5	
II			911	710	633	732.5	NC	717	NC	551	649.5	664	680.5	NC	NC	662.5	NC	1057	914	771.5	
III			832	NC	813.5	NC	683	684.5	729.5	511	NC	656.5	500	NC	435.5	681.5	495.5	948	659.5	720	

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IV			960.5	NC	614	586.5	829.5	NC	701	NC	694	569.5	603.5	795.5	466.5	644	419	800	715	721.5		
MEAN			793.1	662.5	650.3	602.3	756.2	667.6	660.1	531	611.5	630	610.6	795.5	442.5	625.1	457.2	935	764.2	704.6	661.1	
I	MPV	fL	3.5	3.85	3.5	3.7	NC	3.7	3.6	NC	3.75	NC	3.65	NC	3.9	3.55	NC	NC	3.8	3.9		
II			3.75	4.35	3.9	4.3	NC	4.4	NC	4.6	4.3	4.1	4.05	NC	NC	3.9	NC	3.7	4.25	4.2		
III			4	NC	4.5	NC	4.2	4.35	4.9	5.2	NC	4.35	4.55	NC	5.2	4.2	4.35	3.8	5	4.9		
IV			3.7	NC	3.7	4.05	3.9	NC	4.7	NC	4.6	3.95	4.3	4.4	4.6	4.15	4.15	4.05	4.65	4.35		
MEAN			3.73	4.1	3.9	4.01	4.05	4.15	4.4	4.9	4.21	4.13	4.13	4.4	4.56	3.95	4.25	3.85	4.42	4.33	4.19	
I	PDW		15.8	16.05	15.7	15.85	NC	15.85	15.75	NC	16.05	NC	15.7	NC	16	15.55	NC	NC	15.75	16.1		
II			15.9	16.35	15.8	16.25	NC	16.45	NC	16.4	16.4	16.2	15.95	NC	NC	16	NC	15.85	16.25	16.25		
III			16.05	NC	16.2	NC	16.15	16.2	16.75	17	NC	16.25	16.55	NC	17.15	16.1	16.05	15.85	16.9	16.7		
IV			15.85	NC	15.8	16.1	15.8	NC	16.7	NC	16.35	15.95	16.3	16.4	5	16.6	16.1	16.25	16.3	16.55	16.3	
MEAN			15.9	16.2	15.87	16.06	15.97	16.16	16.4	16.7	16.26	16.13	16.12	16.4	5	16.58	15.93	16.15	16	16.36	16.33	16.20
I	PCT	%	0.16	0.23	0.19	0.18	NC	0.22	0.19	NC	0.18	NC	0.24	NC	0.16	0.18	NC	NC	0.29	0.23		
II			0.34	0.30	0.24	0.31	NC	0.31	NC	0.25	0.28	0.27	0.27	NC	NC	0.25	NC	0.39	0.38	0.32		
III			0.33	NC	0.36	NC	0.28	0.29	0.35	0.26	NC	0.28	0.23	NC	0.22	0.28	0.21	0.36	0.33	0.35		
IV			0.35	NC	0.22	0.23	0.32	NC	0.33	NC	0.32	0.22	0.26	0.35	0.21	0.26	0.17	0.32	0.33	0.31		
MEAN			0.29	0.27	0.25	0.24	0.30	0.27	0.29	0.26	0.26	0.26	0.25	0.34	0.20	0.24	0.19	0.35	0.33	0.30	0.27	

1M - RAGHU; **2M** - KRISHNA; **3M** - GIRI; **4M** - SRINIVASAN; **5M** - UDHAYAN; **6M** - JOHN; **7M** - WILSON; **8M** - JAMBU; **9M** - CHERAN; **10M** - C.SHANKAR; **11M** - SANTHOSH; **12M** - VIJAY; **13M** - SUJAY; **14M** - GANESH; **15M** - SANKAR; **16M** - MOORTHY; **17M** - ANNA; **18M** - INDHAR

WBC = White Blood Cells; Lympho. = Lymphocytes; Mon. = Monocytes; Gran.= Granulocytes; RBC = Red Blood Corpuscle; HGB = Haemoglobin; HCT = Haematocrit (%); MCV= Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; RDW = RBC distribution width; PLT = Platelet; MPV = Mean platelet volume; PDW = Platelet Distribution Width; PCT = Platelet Crit NC = Not collected

Table 7. Haematological parameters of Female Elephants at Theppakadu and Abhayaranyam camps in Mudumalai Tiger Reserve (N = 23)

Sampling	Parameters	Unit	Name of elephants						\bar{X}
			1F	2F	3F	4F	5F	6F	
	Age	Years	3	16	27	35	52	64	
I	WBC	X 10 ³ /μL	14.75	17.05	21	19.4	13.65	15.05	
II			20.65	18.55	19.55	15.95	16.9	13.7	
III			17.7	22.65	19.45	19.45	17.6	33.2	
IV			19.1	27.45	NC	16.15	15.35	11.9	
MEAN			18.05	21.42	20	17.73	15.87	18.46	18.59
I	Lymph#	X 10 ³ /μL	4	10.05	3.6	12.15	4.45	9.85	
II			15.55	13.75	13.3	10.7	12.95	9.55	
III			8.25	6.1	7.65	5.7	12.15	28	
IV			14.4	19.8	NC	11.75	11.25	8.85	
MEAN			10.55	12.42	8.18	10.07	10.2	14.06	10.91
I	Mon#	X 10 ³ /μL	1.45	1.35	1.6	1.2	0.95	1.05	
II			0.35	0.45	0.85	0.45	0.35	0.5	
III			0.95	0.95	1.1	1.4	0.55	0.45	
IV			0.45	1.05	NC	0.5	0.45	0.35	
MEAN			0.8	0.95	1.18	0.88	0.57	0.58	0.83
I	Gran#	X 10 ³ /μL	0.95	0.95	1.1	1.4	0.55	0.45	
II			4.75	4.35	5.4	4.8	3.6	3.65	
III			8.5	15.6	10.7	12.35	4.9	4.75	
IV			4.25	6.6	NC	3.9	3.65	2.7	
MEAN			4.61	6.87	5.73	5.61	3.17	2.88	4.81
I	Lymph%	%	27.2	58.65	17.35	62.7	37.05	65.6	
II			75.3	74	67.95	66.9	76.7	69.65	
III			46.6	27	40.1	29.95	69.35	84.1	

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IV			75.1	72.1	NC	72.85	73.05	74.35	
MEAN			56.05	57.93	41.8	58.1	64.03	73.42	58.55
I	Mon%	%	9.95	8.1	7.8	6.15	7.1	6.8	
II			1.7	2.55	4.35	3.1	2.05	3.7	
III			5.15	4.2	5.75	7.35	3.25	1.5	
IV			2.55	3.75	NC	3.2	3	3.15	
MEAN			4.83	4.65	5.96	4.95	3.85	3.78	4.67
I	Gran%	%	62.85	33.25	74.85	31.15	55.85	27.6	
II			23	23.45	27.7	30	21.25	26.65	
III			48.25	68.8	54.15	62.7	27.4	14.4	
IV			22.35	24.15	NC	23.95	23.95	22.5	
MEAN			39.11	37.41	52.23	36.95	32.11	22.78	36.76
I	RBC	X 10 ⁶ /μL	2.775	2.665	3.115	2.705	3.515	2.345	
II			3.07	2.925	3.31	2.995	2.84	2.06	
III			2.91	3.075	3.585	3.18	4.31	5.845	
IV			2.865	2.925	NC	3.03	4.16	2.515	
MEAN			2.90	2.89	3.33	2.97	3.70	3.19	3.17
I	HGB	g/dL	12.3	12.05	13.45	12.2	16.45	10.75	
II			13.6	12.7	13.65	12.6	12.8	9.05	
III			12.4	13.45	14.05	12.2	18.6	24.75	
IV			12.35	12.25	NC	11.85	18.15	10.95	
MEAN			12.66	12.61	13.71	12.21	16.5	13.87	13.59
I	HCT	%	33.95	32.8	36.6	32.65	44.55	29.25	
II			36.85	36	38.1	35.7	35.45	25.2	
III			35.2	36.65	40.55	36.4	51.75	70.3	
IV			35.5	35.45	NC	35.4	51.95	31.5	
MEAN			35.37	35.22	38.41	35.03	45.92	39.06	38.17
I	MCV	fL	122.5	123.3	117.7	120.9	126.9	125	
II			120.2	123.2	115.3	119.3	124.9	122.5	

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III			121.15	119.4	113.15	114.5	120.7	120.35	
IV			124.1	121.25	NC	116.95	125.1	139	
MEAN			121.98	121.78	115.38	117.91	124.4	126.71	121.36
I	MCH	pg	44.3	45.15	43.15	45.05	46.8	45.8	
II			44.25	43.4	41.2	42.05	45	43.9	
III			42.55	43.7	39.15	38.3	43.5	42.3	
IV			43.05	41.8	NC	39.1	43.6	43.5	
MEAN			43.53	43.51	41.16	41.12	44.72	43.87	42.99
I	MCHC	g/dL	36.2	36.7	36.7	37.35	36.9	36.7	
II			36.85	35.3	35.75	35.2	36.05	35.9	
III			35.2	36.65	34.6	33.5	36.05	35.2	
IV			34.75	34.5	NC	33.45	34.85	34.7	
MEAN			35.75	35.78	35.68	34.87	35.96	35.62	35.61
I	RDW	%	14.35	13.75	13.95	13.75	14.35	14	
II			15.7	14.95	16.15	14.75	15.05	14.8	
III			14.8	14.75	15.7	14.9	15.45	15.9	
IV			14.65	15.35	NC	15.25	15.35	15.2	
MEAN			14.87	14.7	15.26	14.66	15.05	14.97	14.92
I	PLT	X 10 ³ /μL	503.5	560	516	580.5	548.5	554	
II			689	594.5	475	793.5	628	894	
III			653.5	773	712.5	754	500	536.5	
IV			703	702	NC	714	577.5	719.5	
MEAN			637.25	657.37	567.83	710.5	563.5	676	635.41
I	MPV	fL	3.65	3.6	3.1	3.7	3.8	3.45	
II			4.05	3.9	3.5	4.05	4.25	3.9	
III			4.5	4.25	3.85	4.3	4.55	3.95	
IV			4.2	4.4	NC	3.95	4.3	3.85	
MEAN			4.1	4.03	3.48	4	4.22	3.78	3.93
I	PDW		15.8	15.75	15.15	16.25	16	15.6	

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II			16.15	15.95	15.65	16	16.25	15.95	
III			16.45	16.05	15.8	16.15	16.55	15.75	
IV			16.2	16.7	NC	15.9	16.15	15.85	
MEAN			16.15	16.11	15.53	16.07	16.23	15.78	15.98
I	PCT	%	0.183	0.201	0.1595	0.214	0.208	0.1905	
II			0.2785	0.232	0.1655	0.321	0.2665	0.3485	
III			0.2935	0.328	0.274	0.3235	0.229	0.2115	
IV			0.295	0.308	NC	0.2815	0.249	0.2765	
MEAN			0.26	0.26	0.20	0.28	0.24	0.25	0.25

1F - BOMMI; **2F** - MASINI; **3F** - INDRA; **4F** - SUMANGALA; **5F** - SENTHILVADIVU; **6F** - KAMATCHI

WBC = White Blood Cells; Lymph. = Lymphocytes; Mon. = Monocytes; Gran.= Granulocytes; RBC = Red Blood Corpuscle; HGB = Haemoglobin; HCT = Haematocrit (%); MCV= Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; RDW = RBC distribution width; PLT = Platelet; MPV = Mean platelet volume; PDW = Platelet Distribution Width; PCT = Platelet Crit

NC - Not Collected

Table 8. Average haematological values for all age-group male and female elephants at ATR and MTR camps

Sl. No.	Haematological Parameter	Unit	ATR camps		MTR camps	
			Male (N = 44)	Female (N = 34)	Male (N = 54)	Female (N = 23)
1	WBC	$\times 10^3/\mu\text{L}$	16.36 \pm 3.33	15.51 \pm 2.12	22.51 \pm 28.30	18.59 \pm 1.92
2	Lymph#	$\times 10^3/\mu\text{L}$	9.57 \pm 3.13	9.04 \pm 1.97	14.02 \pm 17.74	10.91 \pm 2.05
3	Mon#	$\times 10^3/\mu\text{L}$	0.82 \pm 0.39	0.69 \pm 0.13	1.13 \pm 1.93	0.83 \pm 0.23
4	Gran#	$\times 10^3/\mu\text{L}$	5.96 \pm 2.25	5.78 \pm 0.88	7.35 \pm 8.81	7.81 \pm 1.56
5	Lymph%	%	57.77 \pm 14.01	58.38 \pm 6.60	61.85 \pm 9.59	58.55 \pm 10.37
6	Mon%	%	5.13 \pm 2.30	4.56 \pm 0.90	4.57 \pm 1.26	4.67 \pm 0.80
7	Gran%	%	37.08 \pm 12.16	37.05 \pm 6.47	33.57 \pm 8.78	36.76 \pm 9.61
8	RBC	$\times 10^6/\mu\text{L}$	2.97 \pm 0.27	3.02 \pm 0.32	3.10 \pm 0.30	3.17 \pm 0.31
9	HGB	g/dL	12.36 \pm 1.21	12.73 \pm 1.44	12.89 \pm 0.86	13.59 \pm 1.56
10	HCT	%	34.94 \pm 3.02	36.22 \pm 4.08	36.47 \pm 2.62	38.17 \pm 4.18
11	MCV	fL	117.75 \pm 3.09	119.93 \pm 2.80	115.25 \pm 13.65	121.36 \pm 4.15
12	MCH	pg	41.55 \pm 1.87	42.10 \pm 1.37	41.68 \pm 2.27	42.99 \pm 1.50
13	MCHC	g/dL	35.31 \pm 0.86	35.13 \pm 0.48	35.33 \pm 0.66	35.61 \pm 0.38
14	RDW	%	15.05 \pm 0.63	15.30 \pm 0.46	15.12 \pm 0.31	14.92 \pm 0.22
15	PLT	$\times 10^3/\mu\text{L}$	613.78 \pm 122.32	558.86 \pm 46.84	661.10 \pm 121.08	635.41 \pm 59.17
16	MPV	fL	3.97 \pm 0.28	4.08 \pm 0.30	4.19 \pm 0.28	3.93 \pm 0.26
17	PDW		16.10 \pm 0.28	16.28 \pm 0.31	16.20 \pm 0.23	15.98 \pm 0.26
18	PCT	%	0.24 \pm 0.05	0.23 \pm 0.03	0.27 \pm 0.04	0.25 \pm 0.02

WBC = White Blood Cells; Lympho. = Lymphocytes; Mon. = Monocytes; Gran.= Granulocytes; RBC = Red Blood Corpuscle; HGB = Haemoglobin; HCT = Haematocrit (%); MCV= Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; RDW = RBC distribution width; PLT = Platelet; MPV = Mean platelet volume; PDW = Platelet Distribution Width; PCT = Platelet Crit

Table 9. Serum Biochemical parameters of Male Elephants at Kozhikamuthi and Varakalayar camps in Anamalai Tiger Reserve (N = 29)

Sampli ng	Paramet ers	Unit	Name of elephants															\bar{X}
			A1M	A2M	A3M	A4 M	A5 M	A6M	A7 M	A8 M	A9 M	A10 M	A11 M	A12 M	A13M	A14M	A15 M	
	Age	Years	10	14	15	18	19	23	26	27	27	39	40	42	44	55	60	
I	Glu	mg/dL	95	88	79	95	103	91	87	91	NC	63	102	138	91	90	157	
II			109	NC	46	NC	66	40	NC	NC	NC	133	NC	NC	64	35	NC	
III			NC	26	30	<10	NC	23	NC	NC	36	NC	NC	NC	11	18	<10	
MEAN			102	57	51.6 6	95	84.5	51.33	87	91	36	98	102	138	55.33	47.66	157	83.56
I	Crea	mg/dL	0.8	1.2	1.1	2.2	1.1	2	2.3	1.5	NC	1.2	0.9	2.1	1.5	0.7	2.2	
II			1.1	NC	1.2	NC	1.1	2	NC	NC	NC	1.2	NC	NC	1.6	0.7	NC	
III			NC	1.4	1.5	2.4	NC	2.5	NC	NC	1.5	NC	NC	NC	1.7	0.7	2.8	
MEAN			0.95	1.3	1.26	2.3	1.1	2.16	2.3	1.5	1.5	1.2	0.9	2.1	1.6	0.7	2.5	1.56
I	BUN	mg/dL	12	12	14	11	7	7	10	13	NC	5	11	12	8	4	4	
II			9	NC	12	NC	9	8	NC	NC	NC	9	NC	NC	2	2	NC	
III			NC	12	11	14	NC	3	NC	NC	10	NC	NC	NC	12	5	6	
MEAN			10.5	12	12.3 3	12.5	8	6	10	13	10	7	11	12	7.33	3.66	5	9.35
I	BUN/Crea a		16	10	12	5	7	3	4	9	NC	5	12	5	6	6	2	
II			8	NC	10	NC	9	4	NC	NC	NC	8	NC	NC	1	3	NC	
III			NC	9	7	6	NC	1	NC	NC	6	NC	NC	NC	7	7	2	
MEAN			12	9.5	9.66	5.5	8	2.66	4	9	6	6.5	12	5	4.66	5.33	2	6.79
I	P	mg/dL	6.2	5.6	5.4	5.9	4.5	5.5	5.2	5.3	NC	4.5	5.3	4.4	4.5	3	4.1	
II			6.2	NC	6.3	NC	5.2	6.4	NC	NC	NC	4.8	NC	NC	5	4.2	NC	
III			NC	9.1	8.5	15.7	NC	6.8	NC	NC	8.3	NC	NC	NC	14.1	6.1	11.8	
MEAN			6.2	7.35	6.73	10.8	4.85	6.23	5.2	5.3	8.3	4.65	5.3	4.4	7.86	4.43	7.95	6.37
I	Ca	mg/dL	10.3	10.2	10.5	10	9.8	9.5	10.6	10.1	NC	9.9	10.1	10	9.9	8.8	8.9	
II			10.5	NC	10.5	NC	10.1	10.1	NC	NC	NC	9.5	NC	NC	10.1	8.9	NC	

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III			NC	9.7	10.1	10.1	NC	9.6	NC	NC	10.1	NC	NC	NC	9.6	8.9	9.3	
MEAN			10.4	9.95	10.36	10.05	9.95	9.73	10.6	10.1	10.1	9.7	10.1	10	9.86	8.86	9.1	9.92
I	TP	g/dL	9.3	8.5	8	9.3	7.8	8.4	8.3	7.7	NC	9	8.6	8	8.6	6.5	7.4	
II			8.9	NC	8.4	NC	8.2	8.7	NC	NC	NC	7.9	NC	NC	9.7	6.7	NC	
III			NC	9.7	8.5	9.7	NC	8.2	NC	NC	11.5	NC	NC	NC	9.9	7.2	8.9	
MEAN			9.1	9.1	8.3	9.5	8	8.43	8.3	7.7	11.5	8.45	8.6	8	9.4	6.8	8.15	8.62
I	Alb	g/dL	2.9	3	3	3	2.7	2.7	3	2.6	NC	2.5	3	2.7	2.5	1.8	1.9	
II			2.8	NC	3.2	NC	2.9	2.9	NC	NC	NC	2.2	NC	NC	2.8	1.8	NC	
III			NC	2.8	3.2	2.9	NC	2.7	NC	NC	2.9	NC	NC	NC	2.9	1.9	2.2	
MEAN			2.85	2.9	3.13	2.95	2.8	2.76	3	2.6	2.9	2.35	3	2.7	2.73	1.83	2.05	2.70
I	Glob	g/dL	6.4	5.6	5	6.2	5.1	5.6	5.3	5	NC	6.5	5.6	5.3	6.1	4.7	5.5	
II			6	NC	5.2	NC	5.3	5.8	NC	NC	NC	5.6	NC	NC	6.9	4.9	NC	
III			NC	6.9	5.3	6.7	NC	5.5	NC	NC	8.6	NC	NC	NC	6.9	5.3	6.7	
MEAN			6.2	6.25	5.16	6.45	5.2	5.63	5.3	5	8.6	6.05	5.6	5.3	6.63	4.97	6.1	5.89
I	Alb/Glob		0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.5	NC	0.4	0.5	0.5	0.4	0.4	0.3	
II			0.5	NC	0.6	NC	0.5	0.5	NC	NC	NC	0.4	NC	NC	0.4	0.4	NC	
III			NC	0.4	0.6	0.4	NC	0.5	NC	NC	0.3	NC	NC	NC	0.4	0.4	0.3	
MEAN			0.5	0.45	0.6	0.45	0.5	0.5	0.6	0.5	0.3	0.4	0.5	0.5	0.4	0.4	0.3	0.46
I	ALT	U/L	<10	24	14	<10	11	15	13	18	NC	19	19	14	23	12	15	
II			18	NC	12	NC	15	21	NC	NC	NC	19	NC	NC	15	16	NC	
III			NC	17	18	24	NC	19	NC	NC	18	NC	NC	NC	16	32	18	
MEAN			18	20.5	14.66	24	13	18.33	13	18	18	19	19	14	18	20	16.5	17.60
I	ALP	U/L	111	79	212	112	127	147	111	100	NC	39	59	75	102	50	101	
II			179	NC	222	NC	173	169	NC	NC	NC	87	NC	NC	99	76	NC	
III			NC	93	179	90	NC	176	NC	NC	75	NC	NC	NC	56	91	144	
MEAN			145	86	204.33	101	150	164	111	100	75	63	59	75	85.66	72.33	122.5	107.58

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I	GGT	U/L	0	0	0	2	0	0	0	0	NC	0	0	0	0	2	13	
II			0	NC	0	NC	0	0	NC	NC	NC	0	NC	NC	1	5	NC	
III			NC	0	0	0	NC	0	NC	NC	0	NC	NC	NC	0	6	18	
MEAN			0	0	0	1	0	0	0	0	0	0	0	0	0.33	4.33	15.5	1.41
I	Bil	mg/dL	1	0.4	0.2	0.5	0.2	0.3	0.3	0.2	NC	0.4	0.3	0.2	0.2	<0.1	<0.1	
II			0.1	NC	0.1	NC	<0.1	0.3	NC	NC	NC	0.1	NC	NC	0.2	<0.1	NC	
III			NC	0.2	0.2	0.4	NC	<0.1	NC	NC	0.4	NC	NC	NC	0.6	0.1	0.3	
MEAN			0.55	0.3	0.16	0.45	0.2	0.3	0.3	0.2	0.4	0.25	0.3	0.2	0.33	0.1	0.3	0.29
I	Chol	mg/dL	47	41	19	50	42	31	39	41	NC	38	25	60	36	22	41	
II			43	NC	30	NC	58	37	NC	NC	NC	52	NC	NC	39	33	NC	
III			NC	56	40	75	NC	32	NC	NC	60	NC	NC	NC	54	61	65	
MEAN			45	48.5	29.6 6	62.5	50	33.33	39	41	60	45	25	60	43	38.66	53	44.91
I	Amy	U/L	1585	1697	1331	162 6	168 3	1699	140 5	172 2	NC	168 9	183 8	171 0	1419	1127	1705	
II			1660	NC	1369	NC	180 7	1713	NC	NC	NC	181 5	NC	NC	1283	1195	NC	
III			NC	1460	1332	182 0	NC	1837	NC	NC	145 4	NC	NC	NC	1223	1175	1972	
MEAN			1622 .5	1578 .5	1344	172 3	174 5	1749. 66	140 5	172 2	145 4	175 2	183 8	171 0	1308. 33	1165. 66	1838 .5	1597. 07
I	Lip	U/L	<10	<10	12	<10	<10	<10	14	29	NC	<10	23	<10	13	<10	18	
II			19	NC	42	NC	40	16	NC	NC	NC	41	NC	NC	36	30	NC	
III			NC	11	<10	62	NC	<10	NC	NC	<10	NC	NC	NC	<10	16	39	
MEAN			19	11	27	62	40	16	14	29	0	41	23	0	24.5	23	28.5	23.86
I	Na	mmol/ L	129	125	128	128	125	124	129	127	NC	132	129	129	129	127	129	
II			132	NC	128	NC	130	135	NC	NC	NC	133	NC	NC	135	131	NC	
III			NC	128	125	124	NC	128	NC	NC	127	NC	NC	NC	126	127	128	
MEAN			130. 5	126. 5	127	126	127. 5	129	129	127	127	132. 5	129	129	130	128.3 3	128. 5	128.4 5

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I	K	mmol/ L	8.2	5.8	4.6	5.6	4.9	5	5.9	5.4	NC	5.9	5.9	4.5	4.9	5.6	4.5	
II			5.6	NC	4.5	NC	4.6	6	NC	NC	NC	5.1	NC	NC	4.6	6.4	NC	
III			NC	5.8	5.7	9.5	NC	5.6	NC	NC	7.9	NC	NC	NC	9.5	6.9	7	
MEAN			6.9	5.8	4.93	7.55	4.75	5.53	5.9	5.4	7.9	5.5	5.9	4.5	6.33	6.3	5.75	5.93
I	Na/K		16	21	28	23	25	25	22	24	NC	22	22	28	27	23	29	
II		24	NC	29	NC	28	23	NC	NC	NC	26	NC	NC	29	21	NC		
III		NC	22	22	13	NC	23	NC	NC	16	NC	NC	NC	13	18	18		
MEAN			20	21.5	26.33	18	26.5	23.66	22	24	16	24	22	28	23	20.66	23.5	22.61
I	Cl	mmol/ L	95	93	93	94	91	93	95	93	NC	97	94	93	93	94	95	
II			95	NC	93	NC	93	94	NC	NC	NC	96	NC	NC	98	97	NC	
III			NC	96	92	93	NC	91	NC	NC	92	NC	NC	NC	91	97	93	
MEAN			95	94.5	92.66	93.5	92	92.66	95	93	92	96.5	94	93	94	96	94	93.85
I	Osm	mmol/ kg	265	252	256	258	250	248	259	256	NC	261	260	260	258	252	259	
II			266	NC	253	NC	257	268	NC	NC	NC	267	NC	NC	264	259	NC	
III			NC	254	249	xxx	NC	252	NC	NC	256	NC	NC	NC	256	252	xxx	
MEAN			265.5	253	252.66	258	253.5	256	259	256	256	264	260	260	259.33	254.33	259	257.75

A1M – SANJEEV; **A2M** – ASHOK; **A3M** – URIGAN; **A4M** – SARAVANAN; **A5M** – NARASIMMAN; **A6M** – MUTHU; **A7M** – RAJAVARATHAN; **A8M** – CHINNATHAMBI; **A9M** – SUYAMBU; **A10M** – VENKATESH; **A11M** – BHARANI; **A12M** – KAPILDEV; **A13M** – PAARI; **A14M** – RAMU; **A15M** – KALEEM

Glu=Glucose; **Crea**=Creatinine; **BUN**=Blood Urea Nitrogen; **BNU/Crea**=Blood Urea Nitrogen/Creatinine; **P**=Phosphate; **Ca**=Calcium; **TP**=Total Protein; **Alb**=Albumin; **Glob**=Globulin; **Alb/Glob**=Albumin/Globulin; **ALT**=Alanine Aminotransferase; **ALP**=Alkaline Phosphatase; **GGT**=Gamma Glutamyl Transferase; **Bil**=Total Bilirubin; **Chol**=Cholesterol; **Amy**=Amylase; **Lip**=Lipase; **Na**=Sodium; **K**=Potassium; **Na/K**= Sodium/Potassium; **Cl**=Chloride; **Osm**=Osmolality

NC – Not Collected

Table 10. Serum Biochemical parameters of Female Elephants at Kozhikamuthi and Varakalayar camps in Anamalai Tiger Reserve

(N = 24)

Sampling	Parameters	Unit	Name of elephants									\bar{X}
			A1F	A2F	A3F	A4F	A5F	A6F	A7F	A8F	A9F	
	Age	Years	16	15	20	19	29	63	64	70	74	
I	Glu	mg/dL	88	NC	92	205	82	79	95	83	202	
II			51	NC	35	48	84	21	66	85	99	
III			11	34	NC	21	<10	16	23	<10	14	
MEAN			50	34	63.5	91.33	83	38.66	61.33	84	105	67.87
I	Crea	mg/dL	0.9	NC	1.2	1	1.3	1.4	2	1	1.6	
II			1.1	NC	1.3	1.3	1.6	1.5	1.1	1.2	1.5	
III			1.2	1.9	NC	1.5	1.7	1.4	1.4	1.3	1.9	
MEAN			1.06	1.9	1.25	1.26	1.53	1.43	1.5	1.16	1.66	1.42
I	BUN	mg/dL	17	NC	10	11	11	15	9	9	3	
II			10	NC	9	10	9	9	7	11	6	
III			13	7	NC	13	10	15	12	11	6	
MEAN			13.33	7	9.5	11.33	10	13	9.33	10.33	5	9.86
I	BUN/CREA		20	NC	8	12	8	11	4	9	2	
II			9	NC	7	8	6	6	7	9	4	
III			11	4	NC	8	6	11	9	9	3	
MEAN			13.33	4	7.5	9.33	6.66	9.33	6.66	9	3	7.65
I	P	mg/dL	5.1	NC	5.9	4.9	3.9	4.6	5.9	4.2	4.7	
II			4.9	NC	5.9	5	4.8	5	4.3	5.1	5.3	
III			9.9	7.7	NC	11.8	11.9	9.8	9.4	13.2	7.1	

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MEAN			6.63	7.7	5.9	7.23	6.86	6.46	6.53	7.5	5.7	6.72
I	Ca	mg/dL	10.2	NC	10.4	10.4	10.5	9.4	10.2	9.4	9.7	
II			10.4	NC	10.5	10.5	10.1	10.6	10.3	9.8	10.1	
III			10.4	10.1	NC	11	10	10	10.7	9.3	9.9	
MEAN			10.33	10.1	10.45	10.63	10.2	10	10.4	9.5	9.9	10.16
I	TP	g/dL	8.5	NC	7.5	9.5	7.6	7	9.7	9.1	8.6	
II			9	NC	7.7	9.8	8	8.8	9.9	9.6	9.3	
III			9.7	8	NC	xxx	8	8.6	11.4	9.2	10	
MEAN			9.06	8	7.6	9.65	7.86	8.13	10.33	9.3	9.3	8.80
I	Alb	g/dL	2.7	NC	2.8	2.9	2.2	2.2	2.9	2.5	2.5	
II			2.8	NC	2.9	3.1	2.3	2.8	2.9	2.4	2.6	
III			3.4	3	NC	3.4	2.3	2.7	3.2	2.5	2.7	
MEAN			2.96	3	2.85	3.13	2.26	2.56	3	2.46	2.6	2.76
I	Glob	g/dL	5.8	NC	4.7	6.6	5.4	4.8	6.7	6.6	6.1	
II			6.2	NC	4.9	6.7	5.7	6	7	7.2	6.7	
III			6.3	5	NC	xxx	5.8	5.9	8.1	6.7	7.2	
MEAN			6.1	5	4.8	6.65	5.63	5.56	7.26	6.83	6.66	6.05
I	Alb/Glob		0.5	NC	0.6	0.4	0.4	0.5	0.4	0.4	0.4	
II			0.4	NC	0.6	0.5	0.4	0.5	0.4	0.3	0.4	
III			0.5	0.6	NC	xxx	0.4	0.5	0.4	0.4	0.4	
MEAN			0.46	0.6	0.6	0.45	0.4	0.5	0.4	0.36	0.4	0.46
I	ALT	U/L	<10	NC	10	<10	16	16	15	27	25	
II			16	NC	13	15	20	20	13	25	14	
III			23	16	NC	10	17	30	14	31	19	
MEAN			19.5	16	11.5	12.5	17.66	22	14	27.66	19.33	17.80
I	ALP	U/L	69	NC	100	70	75	67	133	25	75	
II			177	NC	110	116	91	80	142	61	128	
III			67	152	NC	61	66	49	102	46	122	
MEAN			104.33	152	105	82.33	77.33	65.33	125.66	44	108.33	96.03

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I	GGT	U/L	0	NC	0	0	0	0	0	4	0	
II			0	NC	0	0	0	0	0	8	0	
III			0	0	NC	0	0	0	0	10	0	
MEAN			0	0	0	0	0	0	0	7.33	0	0.81
I	Bil	mg/dL	0.6	NC	0.2	0.6	0.2	<0.1	0.4	0.7	0.4	
II			0.1	NC	<0.1	0.2	0.1	0.1	0.2	0.3	0.2	
III			0.4	<0.1	NC	0.1	<0.1	0.4	0.4	0.4	0.2	
MEAN			0.36	0	0.2	0.3	0.15	0.25	0.33	0.46	0.26	0.26
I	Chol	mg/dL	32	NC	50	45	50	44	44	38	22	
II			44	NC	52	44	48	63	54	46	40	
III			50	14	NC	57	50	75	70	66	57	
MEAN			42	14	51	48.66	49.33	60.66	56	50	39.66	45.70
I	Amyl	U/L	1124	NC	1167	1700	1772	1796	1668	1650	182	
II			1178	NC	1236	1780	1776	1933	1669	1758	185	
III			1102	1503	NC	2003	1862	1797	1581	1585	161	
MEAN			1134.66	1503	1201.5	1827.66	1803.33	1842	1639.33	1664.33	176	1421.31
I	Lip	U/L	<10	NC	<10	32	<10	<10	71	12	27	
II			26	NC	46	42	26	63	49	40	48	
III			18	31	NC	<10	21	19	55	13	64	
MEAN			22	31	46	37	23.5	41	58.33	21.66	46.33	36.31
I	Na	mmol/L	131	NC	133	133	129	132	132	127	130	
II			133	NC	128	130	134	134	136	132	131	
III			128	131	NC	122	133	132	125	135	134	
MEAN			130.66	131	130.5	128.33	132	132.66	131	131.33	131.66	131.01
I	K	mmol/L	5.5	NC	5.1	5.2	5.5	4.6	4.6	5.8	5.2	
II			4.4	NC	6.1	4.9	5.3	6.8	4.6	5.2	4.4	
III			6.7	5.3	NC	8.5	9.2	7.2	8.4	7.6	6.4	
MEAN			5.53	5.3	5.6	6.2	6.66	6.2	5.86	6.2	5.33	5.87
I	Na/K		24	NC	26	26	24	29	29	22	25	

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II			31	NC	21	27	25	20	29	26	30	
III			19	25	NC	14	14	18	15	18	21	
MEAN			24.66	25	23.5	22.33	21	22.33	24.33	22	25.33	23.38
I	Cl	mmol/L	94	NC	93	93	95	96	94	94	93	
II			95	NC	93	92	94	99	95	96	96	
III			94	96	NC	95	93	99	93	96	95	
MEAN			94.33	96	93	93.33	94	98	94	95.33	94.66	94.74
I	Osm	mmol/kg	265	NC	265	273	258	265	263	256	264	
II			262	NC	255	257	267	266	267	264	260	
III			256	258	NC	249	xxx	265	254	xxx	264	
MEAN			261	258	260	259.66	262.5	265.33	261.33	260	262.66	261.16

A1F – KAVERI; **A2F** – DEIVANAI; **A3F** – DEVI; **A4F** – ABINAYA; **A5F** – DURGA; **A6F** – ANDAL; **A7F** – SELVI; **A8F** – SARATHA; **A9F** – SIVAGAMI

Glu=Glucose; **Crea**=Creatinine; **BUN**=Blood Urea Nitrogen; **BNU/Crea**=Blood Urea Nitrogen/Creatinine; **P**=Phosphate; **Ca**=Calcium; **TP**=Total Protein; **Alb**=Albumin; **Glob**=Globulin; **Alb/Glob**=Albumin/Globulin; **ALT**=Alanine Aminotransferase; **ALP**=Alkaline Phosphatase; **GGT**=Gamma Glutamyl Transferase; **Bil**=Total Bilirubin; **Chol**=Cholesterol; **Amy**=Amylase; **Lip**=Lipase; **Na**=Sodium; **K**=Potassium; **Na/K**= Sodium/Potassium; **Cl**=Chloride; **Osm**=Osmolality

NC – Not Collected

Table 11. Serum biochemical parameters of Male Elephants at Theppakadu and Abhayaranyam camps in Mudumalai Tiger Reserve (N = 54)

Sam pling	Paramete rs	Unit	Name of the Elephant																		\bar{X}
			1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11 M	12 M	13M	14 M	15 M	16 M	17M	18 M	
	Age (years)		6	12	14	22	25	33	35	37	37	37	53	52	52	54	54	60	65	72	
I	Glu	mg/dL	116	126	114	45	NC	89	118	NC	55	NC	70	NC	37	89	NC	NC	72	25	
II			72	85	93	93	NC	56	NC	59	95	81	80	NC	NC	86	NC	67	80	89	
III			122	NC	97	NC	82	37	76	42	NC	86	58	NC	66	69	94	80	42	100	
IV			59	NC	91	103	39	NC	54	NC	80	174	33	61	82	92	122	95	97	100	
MEAN			92.25	105.5	98.75	80.33	60.5	60.66	82.66	50.5	76.6	113.66	60.25	61	61.66	84	108	80.66	72.75	78.5	79.34
I	Crea	mg/dL	1.1	1	1.2	1.5	NC	2.4	1.4	NC	1.1	NC	1	NC	0.9	0.6	NC	NC	1.2	1.9	
II			1.1	1.1	1.1	2.1	NC	1.3	NC	0.9	1	1.7	1	NC	NC	0.7	NC	1.9	1.1	2	
III			1.2	NC	1.3	NC	1.9	1.6	1.1	1.2	NC	1.4	1.3	NC	1.1	1.1	1	1.6	1.2	2	
IV			1.1	NC	1.3	1.6	1.9	NC	1.3	NC	1.4	1.4	1.2	1	1	0.8	1.2	1.5	1.3	1.9	
MEAN			1.125	1.05	1.22	1.73	1.9	1.76	1.26	1.05	1.16	1.5	1.12	1	1	0.8	1.1	1.66	1.2	1.95	1.31
I	BUN	mg/dL	11	12	10	11	NC	7	11	NC	12	NC	8	NC	5	12	NC	NC	2	2	
II			11	14	11	2	NC	9	NC	<3	5	3	11	NC	NC	12	NC	5	<2	2	
III			11	NC	5	NC	9	11	7	14	NC	6	11	NC	6	13	9	5	3	6	
IV			11	NC	10	12	10	NC	9	NC	5	9	8	7	6	13	7	7	4	4	
MEAN			11	13	9	8.33	9.5	9	9	14	7.33	6	9.5	7	5.66	12.5	8	5.66	3	3.5	8.38
I	BUN/Crea		10	12	89	7	NC	3	8	NC	11	NC	8	NC	5	18	NC	NC	2	1	
II			10	13	10	1	NC	7	NC	xxx	5	2	11	NC	NC	17	NC	2	xxx	1	
III			9	NC	3	NC	5	7	6	11	NC	4	9	NC	5	12	9	3	3	3	
IV			10	NC	8	8	5	NC	7	NC	3	6	6	7	6	16	6	4	3	2	
MEAN			9.75	12.5	27.5	5.33	5	5.66	7	11	6.33	4	8.5	7	5.33	15.75	7.5	3	2.66	1.75	8.08

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I	P	mg/dL	5.6	4.9	5.3	6.3	NC	5.1	4.4	NC	4.6	NC	5	NC	5.3	4	NC	NC	5.5	3.5	
II			5.3	5.4	4.9	6	NC	5.3	NC	3.6	4.2	5	4.9	NC	NC	2.4	NC	4.5	4.5	3.9	
III			5.1	NC	4.7	NC	4.6	5.2	5.6	5	NC	4.2	4.3	NC	3.8	3.6	3.7	4.4	2.8	3.9	
IV			5.5	NC	4.3	6.1	5.2	NC	4.1	NC	4.2	4.8	4.5	5.2	3.7	3.9	4.9	3.1	4.1	4.7	
MEAN			5.375	5.15	4.8	6.13	4.9	5.2	4.7	4.3	4.33	4.66	4.67	5.2	4.26	3.47	4.3	4	4.22	4	4.64
I	Ca	mg/dL	10.9	10.7	10.2	10.3	NC	9.8	9.4	NC	10.2	NC	9.9	NC	10.1	9.1	NC	NC	10.5	9.9	
II			10.2	10.4	9.6	10.3	NC	10.5	NC	9.3	9.9	10.7	9.4	NC	NC	9.3	NC	10.3	10.7	9.7	
III			9.6	NC	9.5	NC	9.8	9.7	9.4	9.5	NC	9.9	8.7	NC	9.4	9.1	9.4	9.5	9.8	8.9	
IV			10.5	NC	9.4	10.2	9.8	NC	9.5	NC	9.7	9.8	9.3	9.8	9.3	9.1	9.5	12.8	10.8	9.2	
MEAN			10.33	10.55	9.67	10.26	9.8	10	9.43	9.4	9.93	10.13	9.32	9.8	9.6	9.15	9.45	10.86	10.45	9.42	9.86
I	TP	g/dL	8.4	7.7	9	8.4	NC	8.4	7.7	NC	7.9	NC	9.3	NC	8.7	8.6	NC	NC	8.5	8.6	
II			9.1	8.5	8.4	8.8	NC	8.3	NC	9	7.7	8.6	9.4	NC	NC	8.8	NC	11	9.3	8.8	
III			7	NC	7.9	NC	7.5	7.8	7.3	8.7	NC	8	8.9	NC	8.2	8.8	8.2	9.3	8.9	8.1	
IV			9.3	NC	8.5	9.1	8.4	NC	8.6	NC	7.7	8.8	9.7	8.7	8.8	9.4	10.1	9.5	10	9.1	
MEAN			8.45	8.1	8.45	8.76	7.95	8.16	7.86	8.85	7.76	8.46	9.32	8.7	8.56	8.9	9.15	9.93	9.175	8.65	8.62
I	Alb	g/dL	2.8	2.6	2.9	2.8	NC	2.6	2.3	NC	2.2	NC	2.3	NC	2.6	2.2	NC	NC	2.4	2.3	
II			3	2.8	2.6	2.8	NC	2.5	NC	2.6	2.1	2.7	2.2	NC	NC	2.2	NC	2.6	2.4	2.3	
III			2.4	NC	2.5	NC	2.3	2.5	2.1	2.5	NC	2.6	2.2	NC	2.4	2.3	2.3	2.3	2.5	2.1	
IV			3.2	NC	2.7	3	2.6	NC	2.3	NC	1.9	2.8	2.4	2.6	2.5	2.4	2.7	2.3	2.7	2.3	
MEAN			2.85	2.7	2.67	2.86	2.45	2.53	2.23	2.55	2.06	2.7	2.27	2.6	2.5	2.27	2.5	2.4	2.5	2.25	2.49
I	Glob	g/dL	5.5	5.1	6.1	5.6	NC	5.8	5.5	NC	5.7	NC	7	NC	6	6.4	NC	NC	6.1	6.3	
II			6.1	5.7	5.8	6	NC	5.8	NC	6.4	5.6	6	7.2	NC	NC	6.6	NC	8.4	6.8	6.5	
III			4.6	NC	5.4	NC	5.2	5.3	5.2	6.2	NC	5.4	6.8	NC	5.8	6.5	5.9	7	6.4	6	
IV			6	NC	5.8	6.1	5.8	NC	6.3	NC	5.8	6	7.3	6.1	6.4	6.9	7.4	7.1	7.2	6.8	
MEAN			5.55	5.4	5.77	5.9	5.5	5.63	5.66	6.3	5.7	5.8	7.07	6.1	6.06	6.6	6.65	7.5	6.62	6.4	6.12
I	Alb/		0.5	0.5	0.5	0.5	NC	0.4	0.4	NC	0.4	NC	0.3	NC	0.4	0.3	NC	NC	0.4	0.4	

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II	Glob		0.5	0.5	0.4	0.5	NC	0.4	NC	0.4	0.4	0.4	0.3	NC	NC	0.3	NC	0.3	0.4	0.3		
III			0.5	NC	0.5	NC	0.4	0.5	0.4	0.4	NC	0.5	0.3	NC	0.4	0.3	0.4	0.3	0.4	0.3		
IV			0.5	NC	0.5	0.5	0.4	NC	0.4	NC	0.3	0.5	0.3	0.4	0.4	0.3	0.4	0.3	0.4	0.3		
MEAN			0.5	0.5	0.47	0.5	0.4	0.43	0.4	0.4	0.3	0.46	0.3	0.4	0.4	0.3	0.4	0.3	0.4	0.3		0.4
I	ALT	U/L	16	13	16	15	NC	20	20	NC	18	NC	18	NC	18	20	NC	NC	17	14		
II			16	12	17	19	NC	18	NC	29	22	17	19	NC	NC	18	NC	26	16	17		
III			18	NC	26	NC	25	22	24	21	NC	21	22	NC	22	25	21	37	32	22		
IV			14	NC	19	18	22	NC	27	NC	14	23	26	23	25	26	23	33	23	23		
MEAN			16	12.5	19.5	17.33	23.5	20	23.66	25	18	20.33	21.25	23	21.66	22.25	22	32	22	19	21.05	
I	ALP	U/L	191	94	153	101	NC	119	80	NC	163	NC	52	NC	111	19	NC	NC	89	112		
II			275	144	178	83	NC	117	NC	37	165	130	69	NC	NC	36	NC	370	79	76		
III			194	NC	115	NC	85	94	83	59	NC	110	74	NC	96	42	106	226	68	76		
IV			165	NC	116	97	86	NC	96	NC	138	100	66	10	0	105	38	111	158	65		71
MEAN			206.25	119	140.5	93.66	85.5	110	86.33	48	155.33	113.33	65.25	10	104	33.75	108.5	251.33	75.25	83.75	109.98	
I	GGT	U/L	0	0	0	1	NC	0	0	NC	24	NC	0	NC	0	0	NC	NC	2	6		
II			0	0	0	0	NC	0	NC	0	21	0	1	NC	NC	0	NC	22	0	2		
III			0	NC	0	NC	0	0	4	0	NC	0	0	NC	0	0	6	25	0	4		
IV			0	NC	0	0	0	NC	2	NC	26	0	0	5	0	0	4	34	0	3		
MEAN			0	0	0	0.33	0	0	2	0	23.66	0	0.25	5	0	0	5	27	0.5	3.75	3.75	
I	Bil	mg/dL	0.2	0.2	0.3	0.2	NC	0.2	0.2	NC	0.3	NC	0.2	NC	0.2	0.3	NC	NC	0.2	0.1		
II			0.2	0.1	0.1	0.2	NC	0.3	NC	<0.2	0.2	0.3	0.3	NC	NC	0.3	NC	5.4	0.2	0.2		
III			0.2	NC	0.3	NC	0.3	0.3	0.3	0.4	NC	0.3	0.3	NC	0.3	0.3	0.3	0.3	4.8	0.3		0.3
IV			0.4	NC	0.2	0.1	0.2	NC	0.2	NC	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.3	4.8	0.3		0.2
MEAN			0.25	0.15	0.22	0.16	0.25	0.26	0.23	0.4	0.25	0.3	0.27	0.2	0.23	0.3	0.3	5	0.25	0.2	0.51	
I	Chol	mg/d	35	47	49	62	NC	46	37	NC	64	NC	47	NC	37	36	NC	NC	39	46		

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II		L	50	54	50	67	NC	60	NC	14	56	70	47	NC	NC	38	NC	61	41	55	
III			49	NC	61	NC	61	76	58	71	NC	86	61	NC	58	64	59	80	46	74	
IV			56	NC	21	73	65	NC	65	NC	85	75	66	83	60	54	78	91	66	65	
MEAN			47.5	50.5	45.25	67.33	63	60.66	53.33	42.5	68.33	77	55.25	83	51.66	48	68.5	77.33	48	60	59.28
I	Amyl	U/L	191	174	1765	1346	NC	1809	1795	NC	177	NC	170	NC	1853	177	NC	NC	1688	188	
II			185	182	1811	1377	NC	1911	NC	157	182	1453	166	NC	NC	165	NC	133	1659	189	
III			203	NC	2165	NC	194	2185	2139	131	NC	1368	192	NC	2252	214	208	174	2090	225	
IV			xxx	NC	1738	1197	165	NC	1758	NC	201	7	1220	159	17	1797	168	180	144	1696	181
MEAN			193.6	1787.5	1869.75	1306.66	180.5	1968.33	1897.33	144.5	187.5	1347	172.1	17.90	1967.33	181.5	194.65	151.0	1783.25	196.05	1762.00
I	Lip	U/L	18	<10	<10	<10	NC	26	15	NC	58	NC	<10	NC	<10	<10	NC	NC	<10	19	
II			94	27	47	61	NC	26	NC	<20	84	121	34	NC	NC	67	NC	42	20	56	
III			21	NC	24	NC	30	20	31	16	NC	38	31	NC	25	33	45	27	41	27	
IV			81	NC	58	23	35	NC	63	NC	NC	72	51	50	54	30	77	82	38	45	
MEAN			53.5	27	43	42	32.5	24	36.33	16	71	77	38.66	50	39.5	43.33	61	50.33	33	36.75	43.05
I	Na	mmol /L	131	128	138	134	NC	130	126	NC	135	NC	132	NC	131	133	NC	NC	131	131	
II			135	133	127	137	NC	126	NC	xxx	129	133	127	NC	NC	132	NC	133	129	132	
III			129	NC	128	NC	131	131	138	126	NC	130	134	NC	129	132	128	129	123	125	
IV			128	NC	127	134	132	NC	132	NC	xxx	132	130	12	7	130	128	126	130	127	128
MEAN			130.75	130.5	130	135	131.5	129	132	126	132	131.66	130.75	12.7	130	131.25	127	130.66	127.5	129	130.08
I	K	mmol /L	5.1	4.8	5.4	4.7	NC	4.6	4.3	NC	4.8	NC	4.9	NC	4.9	4.7	NC	NC	5	5.1	
II			4.1	4.5	5	5.2	NC	4.7	NC	xxx	5	4.7	4.4	NC	NC	5.3	NC	5.3	4.3	5.4	
III			4.3	NC	4.8	NC	5.4	4.9	5.2	5.4	NC	4.5	4.5	NC	5.1	5.1	4.9	4.6	5.1	4.8	
IV			5.5	NC	4.5	4.5	5.7	NC	4.9	NC	xxx	4.9	5.7	5	4.5	5.5	5.3	4.6	5.4	5.1	
MEAN			4.7	4.6	4.92	4.8	5.5	4.73	4.8	5.4	4.9	4.7	4.8	5	4.83	5.1	5.1	4.8	4.95	5.1	4.94

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			5	5			5					7			5		3				
I	Na/K		26	26	26	29	NC	28	29	NC	28	NC	27	NC	27	28	NC	NC	26	26	
II			33	29	26	26	NC	27	NC	xxx	26	28	29	NC	NC	25	NC	25	30	25	
III			30	NC	27	NC	25	27	27	23	NC	29	29	NC	26	26	26	28	24	26	
IV			23	NC	28	30	23	NC	27	NC	xxx	27	23	25	29	23	24	28	24	25	
MEAN			28	27.5	26.75	28.33	24	27.33	27.66	23	27	28	27	25	27.33	25.5	25	27	26	25.5	26.43
I	Cl	mmol /L	95	93	99	93	NC	93	91	NC	94	NC	92	NC	94	97	NC	NC	91	96	
II			96	94	91	100	NC	91	NC	xxx	96	97	93	NC	NC	96	NC	95	93	96	
III			94	NC	92	NC	93	92	100	91	NC	92	97	NC	90	95	90	96	95	96	
IV			101	NC	92	93	94	NC	98	NC	xxx	100	99	94	98	95	92	96	95	99	
MEAN			96.5	93.5	93.5	95.33	93.5	92	96.33	91	95	96.33	95.25	94	94	95.75	91	95.66	93.5	96.75	94.38
I	Osm	mmol /kg	264	258	xxx	264	NC	258	254	NC	267	NC	261	NC	257	265	NC	NC	257	255	
II			267	265	256	270	NC	249	NC	xxx	256	261	254	NC	NC	265	NC	262	xxx	262	
III			258	NC	253	NC	262	258	273	252	NC	258	265	NC	255	264	255	254	242	249	
IV			256	NC	253	268	262	NC	260	NC	xxx	268	257	25	258	257	254	257	252	255	
MEAN			261.25	261.5	254	267.33	262	255	262.33	252	261.5	262.33	259.25	25	256.66	262.75	254.66	257.33	250.33	255.25	258.20

1M - RAGHU; **2M** - KRISHNA; **3M** - GIRI; **4M** - SRINIVASAN; **5M** - UDHAYAN; **6M** - JOHN; **7M** - WILSON; **8M** - JAMBU; **9M** - CHERAN; **10M** - C.SHANKAR; **11M** - SANTHOSH; **12M** - VIJAY; **13M** - SUJAY; **14M** - GANESH; **15M** - SANKAR; **16M** - MOORTHY; **17M** - ANNA; **18M** - INDHAR

Glu=Glucose; **Crea**=Creatinine; **BUN**=Blood Urea Nitrogen; **BNU/Crea**=Blood Urea Nitrogen/Creatinine; **P**=Phosphate; **Ca**=Calcium; **TP**=Total Protein; **Alb**=Albumin; **Glob**=Globulin; **Alb/Glob**=Albumin/Globulin; **ALT**=Alanine Aminotransferase; **ALP**=Alkaline Phosphatase; **GGT**=Gamma Glutamyl Transferase; **Bil**=Total Bilirubin; **Chol**=Cholesterol; **Amy**=Amylase; **Lip**=Lipase; **Na**=Sodium; **K**=Potassium; **Na/K**= Sodium/Potassium; **Cl**=Chloride; **Osm**=Osmolality

NC – Not Collected

Table 12. Serum Biochemical parameters of Female Elephants at Theppakadu and Abhayaranyam camps in Mudumalai Tiger Reserve (N = 22)

Sampling	Parameters	Unit	Name of the elephant						\bar{X}
			1F	2F	3F	4F	5F	6F	
	Age	Years	3	16	27	35	52	64	
I	Glu	mg/dL	185	125	35	65	73	88	
II			123	NC	78	62	87	60	
III			114	128	79	84	119	43	
IV			113	89	NC	93	94	38	
MEAN			133.75	114	64	76	93.25	57.25	89.70
I	Crea	mg/dL	1.2	1.1	1.2	1.2	1.5	1.3	
II			1.2	NC	1.1	1.4	1.1	1.4	
III			1.6	2.1	1.5	1.5	1.4	1.7	
IV			1.1	1.2	NC	1.3	1.5	1.5	
MEAN			1.27	1.46	1.26	1.35	1.37	1.47	1.36
I	BUN	mg/dL	9	8	13	13	10	10	
II			7	NC	10	11	7	9	
III			5	6	11	8	8	6	
IV			9	11	NC	10	8	10	
MEAN			7.5	8.33	11.33	10.5	8.25	8.75	9.11
I	BUN/Crea		7	7	11	11	7	8	
II			6	NC	9	8	6	6	
III			3	3	7	5	6	3	
IV			9	10	NC	8	5	7	
MEAN			6.25	6.66	9	8	6	6	6.98

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I	P	mg/dL	5.6	4.2	6.6	5.8	4.3	4.3	
II			6	NC	6	4.8	3.4	5.2	
III			5.7	4.3	4.6	5.2	4.8	5	
IV			6.1	4.5	NC	4.5	4.3	5.4	
MEAN			5.85	4.33	5.73	5.075	4.2	4.975	5.02
I	Ca	mg/dL	9.9	9.9	10.8	10.9	11.7	10.2	
II			10.2	NC	12.2	11.2	11.4	10.5	
III			9.7	10	10.6	10.5	10.3	9.6	
IV			10.4	9.9	NC	10.3	11.2	9.6	
MEAN			10.05	9.93	11.2	10.72	11.15	9.97	10.50
I	TP	g/dL	6.7	8	10.1	10.9	9.2	8.9	
II			7.7	NC	12.7	9.5	9.2	9.7	
III			7.2	8.1	10.3	8.9	8.8	8.9	
IV			7.9	8.3	NC	9.5	9.4	9.5	
MEAN			7.37	8.13	11.03	9.7	9.15	9.25	9.10
I	Alb	g/dL	2.4	2.5	3.4	3.6	3	2.7	
II			2.5	NC	3.9	3.2	3	2.8	
III			2.3	2.7	3.6	3	2.9	2.6	
IV			2.6	2.6	NC	3	3.1	2.8	
MEAN			2.45	2.6	3.63	3.2	3	2.725	2.93
I	Glob	g/dL	4.3	5.5	6.7	7.3	6.2	6.2	
II			5.2	NC	8.8	6.3	6.3	6.9	
III			4.9	5.4	6.7	5.9	5.9	6.3	
IV			5.3	5.7	NC	6.4	6.3	6.7	
MEAN			4.92	5.53	7.4	6.47	6.17	6.52	6.16
I	Alb/Glob		0.5	0.5	0.5	0.5	0.5	0.4	
II			0.5	NC	0.4	0.5	0.5	0.4	
III			0.5	0.5	0.5	0.5	0.5	0.4	

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IV			0.5	0.4	NC	0.5	0.5	0.4	
MEAN			0.5	0.46	0.46	0.5	0.5	0.4	0.47
I	ALT	U/L	<10	21	18	<10	13	12	
II			18	NC	39	10	<10	20	
III			25	26	14	28	24	26	
IV			24	25	NC	24	20	28	
MEAN			22.33	24	23.66	20.66	19	21.5	21.85
I	ALP	U/L	134	99	77	27	83	48	
II			220	NC	86	70	111	68	
III			158	76	118	65	90	85	
IV			148	62	NC	54	95	72	
MEAN			165	79	93.66	54	94.75	68.25	92.44
I	GGT	U/L	0	0	0	0	0	0	
II			0	NC	0	0	0	0	
III			0	0	0	0	0	0	
IV			0	0	NC	0	0	0	
MEAN			0	0	0	0	0	0	0
I	Bil	mg/dL	0.4	0.1	0.4	1.2	0.2	0.6	
II			0.2	NC	<0.2	0.2	0.2	0.4	
III			0.3	0.3	0.5	0.3	0.3	0.3	
IV			0.2	0.1	NC	0.3	0.1	0.3	
MEAN			0.27	0.16	0.45	0.5	0.2	0.4	0.33
I	Chol	mg/dL	33	39	21	4.2	22	22	
II			47	NC	<12	48	27	31	
III			68	72	51	62	42	50	
IV			69	57	NC	58	38	51	
MEAN			54.25	56	36	43.05	32.25	38.5	43.34
I	Amyl	U/L	1202	1784	1461	1818	1798	1455	

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II			1352	NC	2529	1780	1839	1526	
III			1420	2157	2009	2137	2152	1734	
IV			1310	1667	NC	1730	1688	1344	
MEAN			1321	1869.33	1999.66	1866.25	1869.25	1514.75	1740.04
I	Lip	U/L	24	<10	21	<10	13	<10	
II			61	NC	49	22	50	29	
III			38	41	37	27	26	30	
IV			69	51	NC	54	103	39	
MEAN			48	46	35.66	34.33	48	32.66	40.77
I	Na	mmol/L	128	133	128	129	137	132	
II			131	NC	xxx	132	133	134	
III			131	130	131	131	135	129	
IV			130	127	NC	128	130	132	
MEAN			130	130	129.5	130	133.75	131.75	130.83
I	K	mmol/L	4.6	4.4	5	5.3	4.9	5.2	
II			5.1	NC	xxx	5.2	4.1	5.3	
III			4.8	4.6	4.5	4.8	4.1	4.4	
IV			4.7	4.8	NC	5.1	4.3	4.9	
MEAN			4.8	4.6	4.75	5.1	4.35	4.95	4.75
I	Na/K		28	31	26	24	28	26	
II			26	NC	xxx	25	33	25	
III			27	29	29	27	33	29	
IV			27	26	NC	25	30	27	
MEAN			27	28.66	27.5	25.25	31	26.75	27.69
I	Cl	mmol/L	92	93	92	92	97	94	
II			92	NC	xxx	95	95	98	
III			92	94	90	97	99	91	
IV			96	93	NC	95	96	98	
MEAN			93	93.33	91	94.75	96.75	95.25	94.01

I	Osm	mmol/kg	259	266	254	257	271	264	
II			262	NC	xxx	263	262	266	
III			261	260	261	260	268	253	
IV			260	253	NC	256	259	261	
MEAN			260.5	259.66	257.5	259	265	261	

1F - BOMMI; 2F - MASINI; 3F - INDRA; 4F - SUMANGALA; 5F - SENTHILVADIVU; 6F - KAMATCHI

Glu=Glucose; **Crea**=Creatinine; **BUN**=Blood Urea Nitrogen; **BNU/Crea**=Blood Urea Nitrogen/Creatinine; **P**=Phosphate; **Ca**=Calcium; **TP**=Total Protein; **Alb**=Albumin; **Glob**=Globulin; **Alb/Glob**=Albumin/Globulin; **ALT**=Alanine Aminotransferase; **ALP**=Alkaline Phosphatase; **GGT**=Gamma Glutamyl Transferase; **Bil**=Total Bilirubin; **Chol**=Cholesterol; **Amy**=Amylase; **Lip**=Lipase; **Na**=Sodium; **K**=Potassium; **Na/K**= Sodium/Potassium; **Cl**=Chloride; **Osm**=Osmolality

NC – Not Collected

Table 13. Average serum biochemical values for all age-group male and female elephants at ATR and MTR camps

Sl. No.	Haematological Parameter	Unit	ATR camps		MTR camps	
			Male (N = 29)	Female (N = 24)	Male (N = 53)	Female (N = 22)
1	Glucose	mg/dL	83.56±34.38	67.87 ± 24.49	79.34 ± 18.57	89.70 ± 29.81
2	Creatinine	mg/dL	1.56 ± 0.58	1.42 ± 0.26	1.31 ± 0.34	1.36 ± 0.09
3	BUN	mg/dL	9.35 ± 2.98	9.86 ± 2.65	8.38 ± 3.03	9.11 ± 1.47
4	BUN/Creatinine		6.79 ± 3.12	7.65 ± 3.09	8.08 ± 6.01	6.98 ± 1.24
5	Phosphate	mg/dL	6.37 ± 1.80	6.72 ± 0.67	4.64 ± 0.62	5.02 ± 0.68
6	Calcium	mg/dL	9.92 ± 0.45	10.16 ± 0.34	9.86 ± 0.48	10.50 ± 0.59
7	Total Protein	g/dL	8.62 ± 1.05	8.80 ± 0.93	8.62 ± 0.55	9.10 ± 1.26
8	Albumin	g/dL	2.70 ± 0.36	2.76 ± 0.29	2.49 ± 0.22	2.93 ± 0.43
9	Globulin	g/dL	5.89 ± 0.92	6.05 ± 0.85	6.12 ± 0.58	6.16 ± 0.86
10	Albumin/Globulin		0.46 ± 0.08	0.46 ± 0.08	0.40 ± 0.06	0.47 ± 0.04
11	ALT	U/L	17.60 ± 3.00	17.80 ± 5.06	21.05 ± 4.10	21.85 ± 1.88
12	ALP	U/L	107.58 ± 42.03	96.03 ± 32.59	109.98 ± 52.82	92.44 ± 38.76
13	GGT	U/L	1.41 ± 4.05	0.81 ± 2.44	3.75 ± 8.05	0
14	Total Bilirubin	mg/dL	0.29 ± 0.11	0.26 ± 0.13	0.51 ± 1.12	0.33 ± 0.14
15	Cholesterol	mg/dL	44.91 ± 11.10	45.70 ± 13.47	59.28 ± 12.14	43.34 ± 9.80
16	Amylase	U/L	1597.07 ± 210.71	1421.31 ± 534.15	1762.00 ± 214.70	1740.04 ± 261.95
17	Lipase	U/L	23.86 ± 15.93	36.31 ± 12.81	43.05 ± 15.62	40.77 ± 7.28
18	Sodium (Na)	mmol/L	128.45 ± 1.71	131.01 ± 1.21	130.08 ± 2.21	130.83 ± 1.62
19	Potassium (K)	mmol/L	5.93 ± 0.95	5.87 ± 0.46	4.94 ± 0.23	4.75 ± 0.26
20	Na/K		22.61 ± 3.18	23.38 ± 1.53	26.43 ± 1.48	27.69 ± 1.96
21	Chloride	mmol/L	93.85 ± 1.36	94.74 ± 1.53	94.38 ± 1.80	94.01 ± 2.00
22	Osmolality	mmol/kg	257.75 ± 3.80	261.16 ± 2.13	258.20 ± 4.70	260.44 ± 2.54

BUN = Blood Urea Nitrogen; **ALT**=Alanine Aminotransferase; **ALP**=Alkaline Phosphatase; **GGT**=Gamma Glutamyl Transferase

Table 14. Haematological values of temple elephants at ERRC camp in Trichy and at SMTR camp

PARAMETERS	UNITS	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16
	Age	23	26	38	39	48	57	62	64	67	70	14	18	23	27	28	52
WBC	x10 ³ /μL	17.2	14.7	15.8	12.6	24	16.8	16.7	17.6	18.4	12.1	22.5	18.3	13.6	13.6	15.1	12.7
Lymph#	x10 ³ /μL	12.5	8.9	9.8	7.6	13.8	9.5	11.2	3.1	10.7	0.8	8	7.9	9.5	4.8	5.3	8.1
Mono#	x10 ³ /μL	0.6	1	1.1	0.9	1.8	1.4	0.8	1	1.4	0.7	0.7	0.5	0.7	0.3	0.2	0.6
Gran #	x10 ³ /μL	4.1	4.8	4.9	4.1	8.4	5.9	4.7	13.5	6.3	10.6	9.8	3.5	3.3	1.6	2.4	4
Lymph%	%	72.8	60.4	62.2	60.5	57.6	56.8	66.8	17.4	57.9	6.3	43.5	66.5	70	72.3	66.6	63.6
Mono%	%	3.3	7.2	6.8	7.2	7.3	8.2	5.1	5.9	7.8	5.9	3.9	4.3	5.8	4.3	3.4	5.1
Gran%	%	23.9	32.4	31	32.3	35.1	35	28.1	76.7	34.3	87.8	52.6	29.2	24.2	23.4	30	31.3
RBC	x10 ⁶ /μL	3.23	2.99	3.12	2.73	2.56	2.87	2.79	2.66	3.04	3.13	5.18	5.13	2.77	4.6	3.09	2.42
HGB	g/dL	12.6	13.6	14.6	11.7	11.3	11.9	12.6	10.9	12.1	12.5	21.6	18.1	12.6	21.3	13.4	10.3
HCT	%	35.3	37.1	39.3	32.6	30.8	32.1	34.4	30.3	34.1	34.8	58.9	55.4	33.9	63.8	39.5	31.5
MCV	fL	109.4	124.1	126.1	119.7	120.7	111.9	123.3	114.1	112.2	111.5	113.8	128.6	132.3	137.9	128	128.3
MCH	pg	39	45.4	46.7	42.8	44.1	41.4	45.1	40.9	39.8	39.9	41.6	41.9	42.2	46.1	43.3	42.1
MCHC	g/dL	35.6	36.6	37.1	35.8	36.6	37	36.6	35.9	35.4	35.9	36.6	32.6	32	33.4	33.9	32.8
RDW	%	15.8	15.9	14.7	16.4	15.6	16	16	13.7	15.3	15.5	15.3	16	16.4	15.4	15.6	15.4
PLT	x10 ³ /μL	588	469	536	683	620	592	534	700	661	642	575	544	558	456	574	812
MPV	fL	4.8	4.2	4.4	4.1	3.7	3.6	3.8	3.4	3.6	4	3.8	4.8	5.2	4.5	5.2	4.7
PDW		17.1	16.6	16.5	16.4	15.9	15.7	16	15.8	15.8	16.2	16	16.7	17.1	16.5	17	16.3
PCT	%	0.282	0.196	0.235	0.28	0.229	0.213	0.202	0.238	0.237	0.256	0.218	0.261	0.29	0.205	0.298	0.328

T1 – RUPALI; T2 – JAYANTHI; T3 – MALACHI; T4 – INDHU; T5 – SANDHYA; T6 – SUAMTHI; T7 – INDIRA; T8 – KIRATHI; T9 – SUNDARI; T10 – GOMATHI; T11 – LAKSMI; T12 – SUNDARAVALLI; T13 – ADHINAYAKI; T14 – KUMUTHAVALLI; T15 – KURUKUDIVALLI; T16 – GANDHIMATHI

WBC = White Blood Cells; Lympho. = Lymphocytes; Mon. = Monocytes; Gran.= Granulocytes; RBC = Red Blood Corpuscle; HGB = Haemoglobin; HCT = Haematocrit (%); MCV= Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; RDW = RBC distribution width; PLT = Platelet; MPV = Mean platelet volume; PDW = Platelet Distribution Width; PCT = Platelet Crit

Table 15. Serum biochemical values of temple elephants at ERRC camp in Trichy and at SMTR camp

PARAMETERS	UNITS	TE1	TE2	TE3	TE4	TE5	TE6	TE7	TE8	TE9	TE10	TE11	TE12	TE13	TE14	TE15	TE16
	Age	23	26	38	39	48	57	62	64	67	70	14	18	23	27	28	52
Glucose	mg/dL	189	210	129	65	202	170	144	172	197	139	197	56	202	160	51	40
Creatinine	mg/dL	1.6	1.3	1.6	1.1	1.1	2	1.4	1.6	1.4	1.4	1.6	1.4	1.6	1.7	1.4	2.7
Blood Urea Nitrogen (BUN)	mg/dL	9	11	10	7	7	6	11	10	6	9	8	7	6	13	10	9
BUN/Creatinine		5	9	7	6	6	3	8	6	4	7	5	5	4	8	7	3
Phosphorus	mg/dL	4.4	4	4.8	5	3.9	4.1	4.6	4.8	5.5	3.7	5.5	5.5	4.4	4.8	5.6	4.3
Calcium	mg/dL	11	10.7	10.7	9.7	10.2	9.9	9.5	9.1	9.5	9.8	9.6	11.1	9.5	10.1	10.5	10.7
Total Protein	g/dL	8.5	8.2	9.3	8.1	8.7	8.8	8.5	7.8	8.4	9.3	8.7	9.5	9.1	9.3	9.7	9.3
Albumin	g/dL	2.9	3.4	3.4	2.9	2.5	3	2.7	2.4	2.4	3.2	3.2	3.5	3.1	3.5	3.8	3.2
Globulin	g/dL	5.6	4.9	5.9	5.1	6.1	5.8	5.8	5.4	5.9	6.1	5.6	6	5.9	5.8	5.8	6.2
Alb/Glob		0.5	0.7	0.6	0.6	0.4	0.5	0.5	0.4	0.4	0.5	0.6	0.6	0.5	0.6	0.7	0.5
ALT	U/L	17	10	12	14	19	< 10	24	18	21	18	13	42	18	23	17	19
ALKP	U/L	156	146	117	94	230	108	89	75	117	92	229	179	90	157	180	167
GGT	U/L	0	0	0	1	0	0	0	2	2	0	0	0	0	0	0	0
Total Bilirubin	mg/dL	< 0.1	0.1	0.2	< 0.1	0.1	< 0.1	0.1	< 0.1	0.1	0.2	0.3	0.3	0.2	0.3	0.4	0.3
Cholesterol	mg/dL	52	37	45	45	41	32	45	40	44	34	38	57	41	54	65	28
Amylase	U/L	171 3	172 6	157 5	174 6	176 7	172 4	164 5	155 8	156 9	1805	1595	1808	1813	1820	1790	1736
Lipase	U/L	22	< 10	< 10	26	19	29	< 10	30	45	13	48	29	46	13	64	65
Sodium	mmol/L	128	135	130	134	132	132	130	131	128	133	127	131	127	129	126	129
Potassium	mmol/L	5.9	6.1	6	5.5	5.5	5.2	6.3	5.6	6.8	5.34	4.9	7.3	4.9	5	6.6	7.1
Sodium/Potassium		22	22	22	24	24	25	21	24	19	25	26	18	26	26	19	18
Chloride	mmol/L	94	95	97	95	95	91	98	95	91	97	97	97	96	97	91	97
Osmolality	mmol/Kg	263	277	265	265	269	267	266	268	264	269	259	263	260	263	252	259

TE1 - RUPALI; TE2 - JAYANTHI; TE3 - MALACHI; TE4 - INDHU; TE5 - SANDHYA; TE6 - SUAMTHI; TE7 - INDIRA; TE8 - KIRATHI; TE9 - SUNDARI; TE10 - GOMATHI; TE11 - LAKSMI; TE12 - SUNDARAVALLI; TE13 - ADHINAYAKI; TE14 - KUMUTHAVALLI; TE15 - KURUKUDIVALLI; TE16 - GANDHIMATHI

ALT=Alanine Aminotransferase; ALP=Alkaline Phosphatase; GGT=Gamma Glutamyl Transferase

Table 16. Reference intervals of Haematological parameters for camp elephants at Anamalai and Mudumalai Elephant Camps

Parameters	Units	ATR		MTR		Average	Std. Dev.	LL	UL	LL-Rounded	UL-Rounded	Interval
		Female	Male	Female	Male							
WBC	(x10³/μl)	15.51	16.36	18.59	22.51	18.24	3.12	15.11	21.37	15.12	21.38	15.12-21.38
Lymph#	(x10³/μl)	9.04	9.57	10.91	14.02	10.88	2.23	8.65	13.12	8.66	13.13	8.66-13.13
Mon#	(x10³/μl)	0.69	0.82	0.83	1.13	0.87	0.18	0.68	1.05	0.69	1.06	0.69-1.06
Gran#	(x10³/μl)	5.78	5.96	4.81	7.35	5.98	1.04	4.93	7.02	4.94	7.03	4.94-7.03
Lymph%	%	58.38	57.78	58.55	61.85	59.14	1.83	57.30	60.98	57.31	60.98	57.31-60.98
Mon%	%	4.57	5.13	4.67	4.57	4.73	0.26	4.47	5.00	4.48	5.01	4.48-5.01
Gran%	%	37.05	37.09	36.76	33.57	36.12	1.70	34.41	37.82	34.42	37.83	34.42-37.83
RBC	(x10⁶/μl)	3.02	2.97	3.17	3.10	3.06	0.08	2.98	3.15	2.99	3.16	2.99-3.16
HGB	g/dL	12.73	12.36	13.59	12.89	12.89	0.51	12.37	13.41	12.38	13.42	12.38-13.42
HCT	%	36.22	34.94	38.17	36.47	36.45	1.32	35.12	37.78	35.13	37.79	35.13-37.79
MCV	fL	119.93	117.75	121.36	115.25	118.57	2.66	115.91	121.24	115.92	121.25	115.92-121.25
MCH	pg	42.10	41.56	42.99	41.68	42.08	0.65	41.43	42.73	41.44	42.74	41.44-42.74
MCHC	g/dL	35.13	35.31	35.61	35.33	35.35	0.19	35.15	35.54	35.16	35.55	35.16-35.55
RDW	%	15.30	15.05	14.92	15.12	15.10	0.16	14.94	15.26	14.95	15.26	14.95-15.26
PLT	(x10³/μl)	558.86	613.78	635.41	661.10	617.28	43.48	573.80	660.77	573.80	660.78	573.80-660.78
MPV	fL	4.08	3.97	3.94	4.19	4.05	0.11	3.93	4.16	3.94	4.17	3.94-4.17
PDW		16.28	16.10	15.98	16.20	16.14	0.13	16.01	16.27	16.02	16.28	16.02-16.28
PCT	%	0.23	0.24	0.25	0.27	0.25	0.02	0.23	0.27	0.24	0.28	0.24-0.28

WBC - White Blood Cells; Lymph - Lymphocytes; Mon - Monocytes; Gran - Granulocytes; RBC - Red Blood Corpuscle; HGB - Haemoglobin; HCT - Haematocrit (%); MCV - Mean corpuscular volume; MCH - Mean corpuscular haemoglobin; MCHC - Mean corpuscular haemoglobin concentration; RDW - RBC distribution width; PLT - Platelet; MPV - Mean platelet volume; PDW - Platelet Distribution Width; PCT - Platelet Crit; LL - Lower Limit; UL - Upper Limit

Table 17. Reference intervals of serum biochemical parameters for camp elephants at Anamalai and Mudumalai Elephant Camps

Parameters	Units	ATR		MTR		Average	Std. Dev.	LL	UL	LL- Rounded	UL- Rounded	Interval
		Female	Male	Female	Male							
Glucose	mg/dL	67.87	83.56	89.71	79.35	80.12	9.21	70.92	89.34	70.92	89.34	70.92 - 89.34
Creatinine	mg/dL	1.42	1.56	1.37	1.31	1.41	0.10	1.31	1.53	1.31	1.53	1.31 - 1.53
BUN	mg/dL	9.87	9.35	9.11	8.38	9.18	0.61	8.57	9.80	8.57	9.80	8.57 - 9.80
BUN/CREA		7.65	6.78	6.98	8.08	7.37	0.60	6.77	7.97	6.78	7.98	6.78 - 7.98
Phosphate	mg/dL	6.72	6.37	5.02	4.65	5.69	1.01	4.68	6.70	4.69	6.71	4.69 - 6.71
Calcium	mg/dL	10.16	9.92	10.50	9.86	10.11	0.29	9.82	10.40	9.83	10.41	9.83 - 10.41
Protein	g/dL	8.80	8.62	9.10	8.62	8.79	0.23	8.56	9.02	8.57	9.02	8.57 - 9.02
Albumin	g/dL	2.76	2.70	2.93	2.49	2.72	0.18	2.54	2.90	2.55	2.91	2.55 - 2.91
Globulin	g/dL	6.05	5.89	6.17	6.12	6.06	0.12	5.94	6.18	5.95	6.19	5.95 - 6.19
Alb/Glob		0.46	0.46	0.47	0.40	0.45	0.03	0.42	0.48	0.42	0.49	0.42 - 0.49
ALT	U/L	17.79	17.6	21.86	21.05	19.57	2.19	17.38	21.77	17.39	21.78	17.39 - 21.78
ALP	U/L	96.03	107.58	92.44	109.98	101.51	8.58	92.93	110.09	92.94	110.10	92.94 - 110.10
GGT	U/L	0.81	1.41	0	3.75	1.49	1.61	-0.11	3.10	-0.12	3.11	0 - 3.11
Bilirubin	mg/dL	0.26	0.29	0.33	0.51	0.35	0.11	0.23	0.46	0.24	0.47	0.24 - 0.47
Cholestrol	mg/dL	45.70	44.91	43.34	59.28	48.31	7.38	40.92	55.69	40.93	55.70	40.93 - 55.70
Amylase	U/L	1421.31	1597.07	1740.04	1762	1630.11	157.23	1472.87	1787.34	1472.88	1787.35	1472.88 - 1787.35
Lipase	U/L	36.31	23.86	40.77	43.40	36.09	8.65	27.43	44.75	27.44	44.75	27.44 - 44.75
Na	mmol/L	131.01	128.45	130.83	130.08	130.09	1.16	128.93	131.26	128.94	131.27	128.94 - 131.27
K	mmol/L	5.87	5.93	4.76	4.94	5.37	0.61	4.76	5.99	4.77	6.00	4.77 - 6.00
Na/K		23.38	22.61	27.69	26.44	25.03	2.42	22.61	27.45	22.61	27.46	22.61 - 27.46
Chloride	mmol/L	94.74	93.85	94.01	94.38	94.25	0.39	93.85	94.64	93.86	94.65	93.86 - 94.65
Osmolality	mmol/kg	261.16	257.75	260.44	258.20	259.39	1.67	257.72	261.06	257.73	261.07	257.73 - 261.07

BUN - Blood Urea Nitrogen; **BNU/Crea** - Blood Urea Nitrogen/Creatinine; **Alb/Glob** - Albumin/Globulin; **ALT** - Alanine Aminotransferase; **ALP** - Alkaline Phosphatase; **GGT** - Gamma Glutamyl Transferase; **Na/K** - Sodium/Potassium; **LL** - Lower Limit; **UL** - Upper Limit



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