

## Establishment of Hand Rearing Protocols with Respect to Feeding, Physiological and Behavioral Aspects in Abandoned Lion Cubs at Safari Zoo Lahore

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# Establishment of Hand Rearing Protocols with Respect to Feeding, Physiological and Behavioral Aspects in Abandoned Lion Cubs at Safari Zoo Lahore

## Cover Page Footnote

Upkeeping and hand rearing of lion cubs at zoo safari

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## ESTABLISHMENT OF HAND REARING PROTOCOLS WITH RESPECT TO FEEDING, PHYSIOLOGICAL AND BEHAVIORAL ASPECTS IN ABANDONED LION CUBS AT SAFARI ZOO LAHORE

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### ABSTRACT

African lion (*Panthera leo*) being most attractive but vulnerable exhibit of zoos and safaris; need particular attention to breeding plans. At captive sites, lioness neglects newborns commonly; at that stage, hand rearing is preferred. This study will highlight the best practices for hand-rearing lion cubs, including knowledge of early medical issues along with their treatment during the first 4 months of growth. 34 lions (08Male: 17Females: 9Cubs) were housed on 15 acres during 2019-21 at Safari Zoo Lahore. A total of 04 lionesses were found entirely abandoned to 05 newborns (03 males & 02 females). The hand-rearing period was divided into four phases based on age and feeding protocol and every cub was offered formula milk with or without meat depending upon age. The average weight gain of all the cubs was recorded along with problems/ conditions faced during process. The male cub 3 was found highest in weight gain but statistically no age wise or sex wise difference in growth was observed. The major problems faced were constipation, diarrhea, hyperthermia, eye blindness, and hind quarter weakness in 100 %, 100 %, 40 %, 20 %, and 40 % animals, respectively. All five successfully hand-reared cubs were shifted to 03 sub- adult lion's enclosures. The behavioral changes of all the lion cubs were also recorded concerning aggression while feeding and pacing in the enclosure, etc. The study outcomes the protocol for hand rearing abandoned lion cubs, which would ultimately be helpful to the zoo keepers and wildlife conservationists.

**Keywords:** Captivity, hand rearing, cubs, safari zoo, wildlife management.

### INTRODUCTION

Our planet is home to an incredible diversity of organisms. Humans, livestock, and wildlife equally contribute to the ecosystem (Bar-On et al., 2018). The wild mammal comprises a wide range of species, and among them, the lion is considered the fiercest and most magnanimous mammal. The lion (*Panthera leo*) is a mammal and the second largest in the family Felidae, slightly smaller than the tiger (*Panthera tigris*). Until 2017, the lions were broadly

classified into two types (subspecies). One was the African lion (*Panthera leo leo*), and the other was the Asiatic lion (*Panthera leo persica*). However, in 2019, the taxonomy of lions was changed relatively dramatically. Instead, there are now two types of lions recognized today. The two subspecies are *Panthera leo leo*, which includes lion populations in Asia and northern African countries. *Panthera leo melanochaita* which lives across Southern Africa.

According to the International Union for Conservation of Nature (IUCN),

about 20,000 lions are present in Africa and have been declared vulnerable to extinction (Bauer et al., 2015). Asiatic lions persist in the Gir forest of northwest India, consisting of less than 200 mature individuals. This subspecies is critically endangered in the IUCN red list (Breitenmoser et al., 2008). African lions live in plains or savanna habitats with a large prey base. They can also live at high altitudes (Alden et al., 1995). The first male member of pride that reaches a female in heat has mating priority over her. Fighting between pride members over females does not usually occur (Estes et al., 1999).

Female lions are polyestrous, breeding throughout the year and peaking in the rainy season. Female lions tend to have cubs every 2 years (Schaller, 1972). One to six cubs are born after a 3.5-month gestation period. Mother lions hide their cubs until they reach about 8 weeks of age. The cubs are weaned between 7 and 10 months (Alden et al. 1995, Estes et al. 1999). Females are mainly responsible for the care of the young. Females nurse their young but will also nurse the young of their female relatives in the pride if litters are born close together. Cub mortality is lowest when related females in the same pride synchronously reproduce and cross-suckle. Synchronous reproduction is common in feelings of pride (Urban et al., 2004).

However, there are some reasons in which the mothers abandon their cubs. Occasionally, hungry mothers abandon weak cubs that cannot keep up with their pride (Estes et al., 1999). Sometimes, a female kills a young offspring of the same species; that phenomenon is called infanticide which is common in lions (Filial infanticides). This has been observed where the mother will deliberately abandon her litter when only one cub remains. It has been determined that females will increase their lifetime

reproductive success by abandoning single cubs and investing exclusively in larger litters (Packer et al., 2001). When lions are in permanent captivity, some situations like diseases or injuries can force the hand-rearing of newborns (Najera et al. 2011). Hand-rearing of lion cubs is very challenging but is a vital process due to the lack of maternal care. Hand-rearing is also important in managing endangered wild populations maintained in captivity, especially those that give birth to single offspring per year or the species that bring forth offspring after long durations (Gehlot et al., 2020).

Therefore, the current study was undertaken to set a protocol for hand-rearing of lion cubs abandoned by the lionesses and to identify the problems faced during the rearing process and their management-based solutions.

## MATERIALS AND METHODS

### *Study Area and Study Animals*

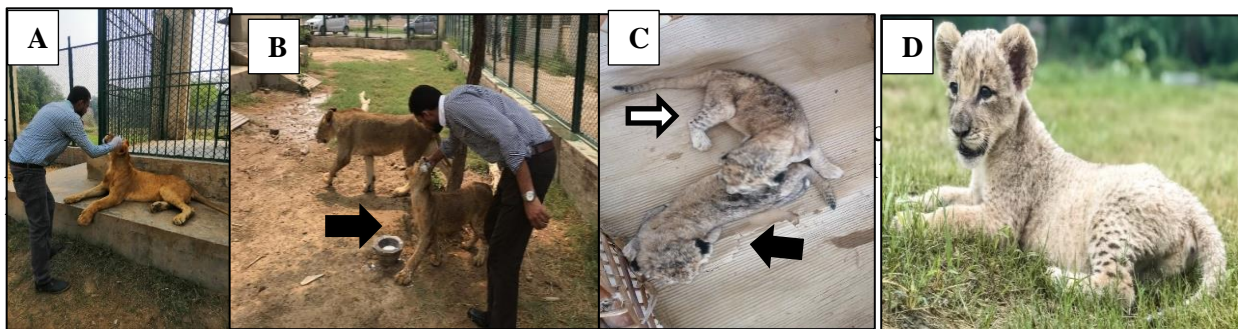
This study was conducted at the Lion Safari enclosure (15 Acres) and the Veterinary Complex of Safari Zoo Lahore (31.38097188527529, 74.21823673720868) during 2019-21. The study sites are mentioned in Figure 1. A total of 34 African lions (*Panthera Leo*) (08 Males: 17 females: 09 cubs) were housed in the study area.

### *Sample Size*

A total of 04 lionesses entirely abandoned their 05 newborns (03 males and 02 females) and above said abandoned lion cubs were our study animals which were hand-reared at Safari Zoo Lahore (Figure 2).



**Figure 1:** Map of Safari Zoo, Lahore, indicating the Lion Safari (Red arrows) occupying total area of 15 acres including open safari & indoor area and Veterinary Complex (Black arrow).



**Figure 2:** Alphabets on upper left corner showing abandoned lion cubs included in the study A: Male cub 1, B: Female cub 1 (Black arrow), C: Male cub 2 (White arrow) and Female cub 2 (Black arrow) and D: Male cub 3

**Hand Rearing Protocols**

**Feeding Management**

The feeding of lion cubs was divided into 4 different phases while using formula milk (Royal Canine Baby Dog Milk for Giant dog breed recommendations, Aimargues, Gard, France) along with the addition of minced chicken and beef meat. The overall feeding protocol in all phases is as under;

**Phase-I:** Only formula milk for 1-45 days.

**Phase-II:** Formula milk and minced chicken 100-250gms for 46-75 days.

**Phase-III:** Formula milk gradually decreased, and minced beef 150gm supplemented with chicken 250gm for 76-90 days.

**Phase-IV:** Formula milk was gradually replaced with an equal quantity of dairy milk (tetra-pack milk). The cubs were also given small pieces of chicken 250gm and 300gm beef instead of minced form for 91-120 days.

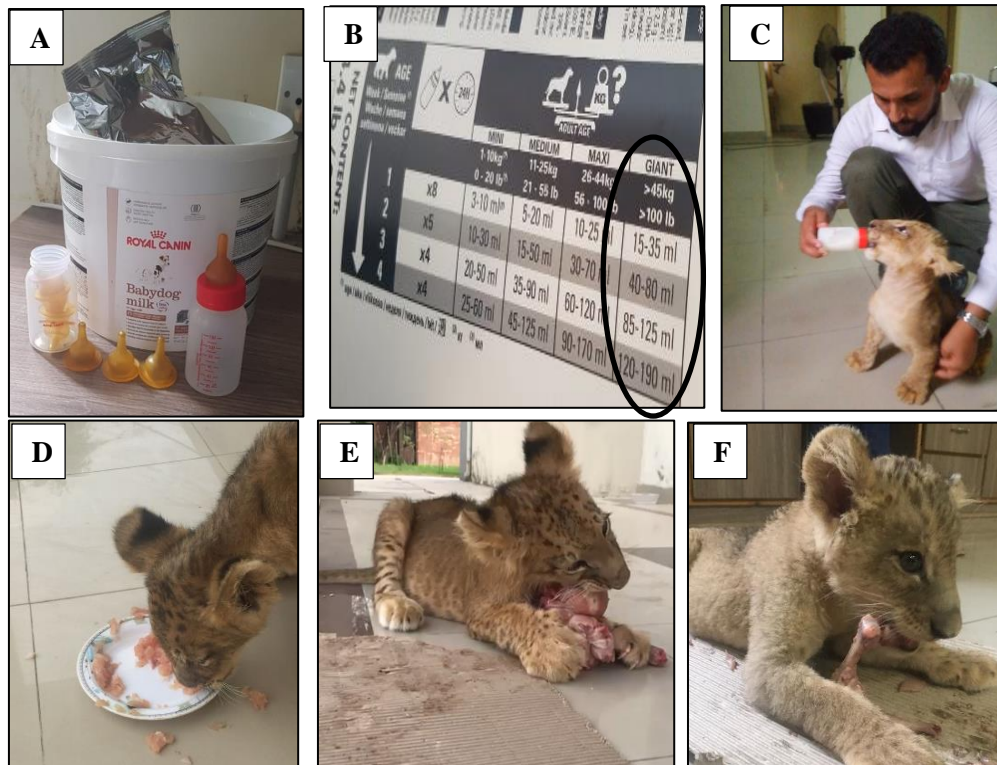


Figure 3: Alphabets on upper left corner showing A: Royal Canin Formula Milk Pack, Imported from Germany, B: Royal Canin Formula Milk recommendations for Giant breed dogs, C: Milk feeding of lion cub in feeding bottle, D: Minced Meat feeding of lion cub, E & F: Feeding of meat by lion cub in the form of pieces.



Figure 4: Alphabets on upper left corner showing A: Sitting on raised platform within cage, B: Playing with football within cage C: Teeth health management by using tree shoots and D: Regular walk of lion cub.

The Royal Canine Baby Dog Milk feeding schedule is as follows in Table-1, while the Royal Canin Baby dog milk is displayed below in Figure 3 indicating the formula pack, feeding recommendations, feeding posture of lion cubs and meat feeding of lion cubs at different age phases.

### Enclosure Management

The lion cubs while keeping in temporary cage were provided with some amusement tools that enhanced the enrichment and playing activities. The tree shoots were also provided to keep teeth health up to the mark. Some of their enclosure related activities are shown in Figure 4. After successful rearing process

of 90 days, cubs were shifted into lions' enclosure area along with other cubs.

### ***Prophylaxis and other Management Practices***

Prophylactic measures and other management practices like eye washes to avoid eye infections, rectal glands' massages to instigate defecation, supplementations with vito-minerals to avoid deficiencies, use of dewormers and feline vaccinations were also practiced in routine hand rearing process.

### ***Statistical Analysis***

The data regarding weight gain was represented in the form of mean, while of problems/ conditions faced during hand rearing process and their recovery was represented in the form of percentages while age wise and gender wise comparative weight gain was analyzed through analysis of variance using SPSS. 20.

## **RESULTS**

### ***Weight Gain in Hand-Reared Lion Cubs***

Overall, weight gain during Phase I was slow, while in Phase III & IV, it was fast, possibly due to protein supplementation. The weight gain of male lion cubs during the age period from week 1 to week 16 is represented below in Figure 5, which shows that the overall weight gain of male cub 3 was highest from the other two male lion cubs. The weight gain of two female lion cubs during the age period from week 1 to week 16 is represented below in Figure 6, which shows the overall high weight gain in female lion cub 2 as compared to female lion cub 1.

The comparative weight gain and variations among the weight of male and female lion cubs are represented in Figure 7, which shows the highest weight gain in

male lion cub 3 among all the cubs while the lowest in female lion cub 1.

Statistically, the gender-wise or age-group-wise difference in average weight gains among lion cubs was found non-significant with  $p$ -value < 0.05.

### ***Diseases/Conditions Faced during the Rearing Process***

The health conditions/diseases faced during the hand rearing of lion cubs were constipation, diarrhea, hyperthermia, eye blindness, and hind quarter weakness. The constipation was remarkably very high, with a 100 % occurrence rate in cubs. The 02 male cubs even suffered from this problem till six months of age, while in the 01 male and 02 female lion cubs, it was cured within the first three months of their age. Similarly, diarrhea was also seen in 100 % of lion cubs, including 03 males and 2 females. This condition was randomly seen at any age of lion cubs alternate to the constipation. Hyperthermia was seen in 40 % of lion cubs, including 1 male and 1 female lion cub; eye blindness occurred in only one male lion cub (20 %), while hind quarter weakness was represented by 40 % of lion cubs, including two female lion cubs.

### ***Management-based Solutions of Diseases/Conditions***

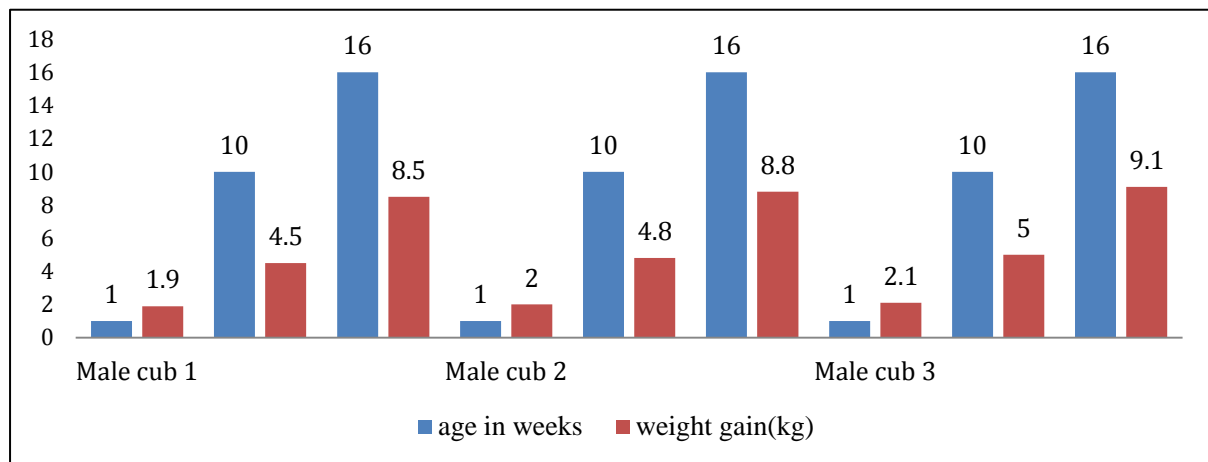
The treatment of different conditions/diseases faced during the hand-rearing process of lion cubs through feeding, housing, and routine activities' management practices were found effective. The tendency towards recovery from constipation and diarrhea in 60 % of hand-reared lion cubs was observed through formula milk and other feeding management. On the other hand, 50 % hyper thermic cases were recovered through cub's body and room temperature management. The eye problems were not completely recovered through routine cold water eye washes, but the chances of eye problems in other lion cubs were

minimized by making the cub's enclosure free of pointed objects. The 50 % of cubs with hind quarter impairment were recovered by taking them out of the enclosure for walks and other healthy activities, making them active, improving body structure and growth, and making

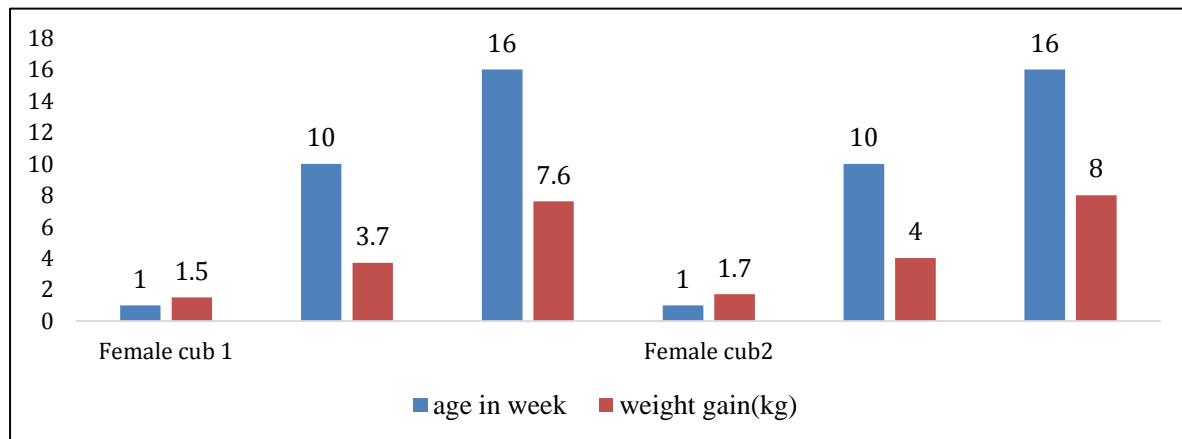
strong nails/teeth. The remaining 50 % cubs were not recovered from hind quarter impairment through management practices and were treated symptomatically using market-available medicines as per the requirement to avoid worse conditions.

**Table 1: Schedule of Milk feeding to abandoned lion cubs from age of week 1 to week 16**

Age (weeks)	Formula milk powder (Number of spoons)	Luke warm water (ml)	No. of feedings in 24 hours
01	01	20	08
02	02	40	06
03	03	60	05
04	04	80	04
05-10	05	100	04
11-12	06	120	03
13-16	Dairy milk 140-200ml was offered twice a day according to age		



**Figure 5: Graphical representation of weight gain in three male lion cubs at age of 1, 10 and 16 weeks**



**Figure 6: Graphical representation of weight gain in two female lion cubs at age of 1, 10 and 16 weeks**



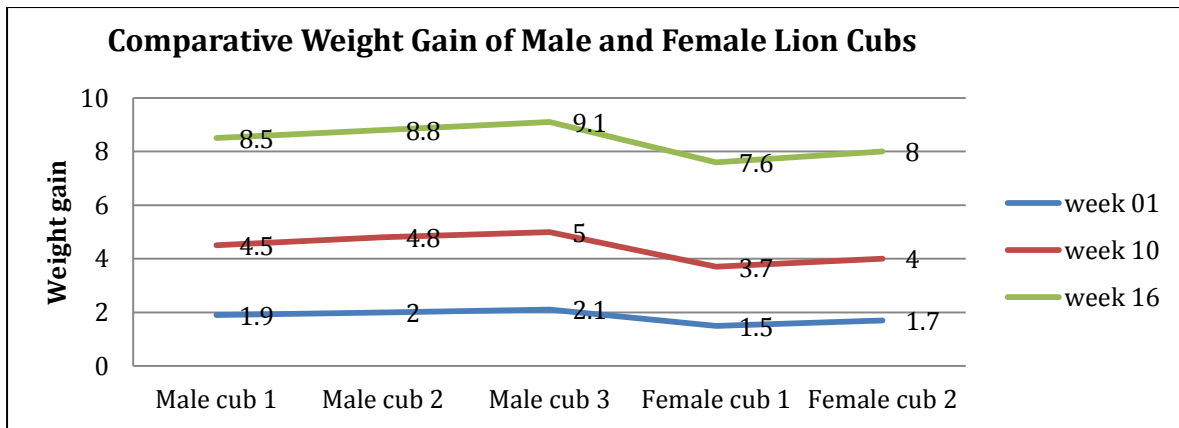


Figure 7: Comparative weight gain of male and female lion cubs at age of 1, 10 and 16 weeks

### Behaviors of Hand-Reared Lion Cubs

All the animals were found behaviorally more liking towards human beings than other cage partners. In the start, the cubs showed reluctance towards mixing up with other mates of almost the same age group, but after a few days, they became normal. Other instinctive behaviors like pacing and aggression while feeding were also observed less distinctive in almost all the lion cubs, but later on, they turned their behaviors towards average trends after spending time with their other naturally mother-nursed mates.

### DISCUSSION

The measures developed for hand-rearing the five lion cubs were considered satisfactory for physiological and behavioral aspects. It was noticed that weight at the first week of age of male cubs (n=3) was almost 25 % higher than female cubs (n=2), while weight gain at the age of 16 weeks of male cubs (n=3) was almost 17.4 % higher than female cubs (n=2). But if we compare statistically the Mean± S.D of both male and female weight gain, there is no significant difference within the group and among the groups in the end irrespective of age. Regarding weight gain, during Phase I, it was slow, while in Phase III & IV, it was fast, mainly due to protein

supplementation. A study was done by Gehlot HS et al., (2020) in which they reared a lion cub named Kailash, who the mother abandoned. The recorded body weight gain was found 1.110 kg, and Kailash's weekly change of body weight is recorded as a 4kg weight gain in the 10<sup>th</sup> week and 11kg weight gain in the 16<sup>th</sup> week. The weight gain of male lion cub 3 in this paper is 2.1 kg in 1<sup>st</sup> week, 5.0 kg in the 10<sup>th</sup> week, and 9.1kg in the 16<sup>th</sup> week respectively. The similar results were also reported by Senthilkumar and Thirumurugan in 2006 in their *hand rearing study of two striped hyena cubs (Hyaena hyeana)* in India. Similarly Robbins also described wildlife feeding protocols in his academic press release in 1993 from *San Diego CA* entitled "Wildlife feeding and nutrition".

Although the milk replacer used in this study was considered successful for hand-rearing, the authors recommend further studies to create a milk replacer for neonates more similar to lion milk. Gehlot et al., (2020) used Hampshire, USA-made, PetLac kitten milk replacement powder dissolved in mineral water while Royal Canin Baby dog milk was used in the current study. Gehlot et al., (2020) gave a half spoon of milk powder in 20 mL mineral water to Kailash as food for stress-free growth after every 2 hours (10-12 times a day) during 1<sup>st</sup> week of age while in the current research study, 1 table spoon was mixed in 20mL Luke warm water for

8 times in 24 hours throughout the 1<sup>st</sup> week of their age.

Constipation was remarkably high, with 100 % among the medical problems. The 02 male cubs suffered from this problem till six months of birth, while in 01 male and 02 females, it was cured within the first three months of birth. Among other health issues, diarrhea was 100 %, hypothermia was 40 %, blindness was 20 %, and hind quarter weakness was 40 %. Najera et al., (2011) described that the guidelines used for feeding and managing medical problems were most commonly associated with these conditions. Senthilkumar and Thirumurugan in 2006 also described the problems and their solution in hand rearing of striped hyena and Colahan, 2012 in their lion care manual. The behavior changes were also reported by Joslin in 1973 in his study of Asiatic lion's behavior and ecology. The preventive medicines (vaccinations, deworming) and techniques used to avoid potential behavioral disorders proved their effectiveness for the hand-rearing and maintenance of the two lion cubs under their study. All ailments were recovered after proper medication and preventive measures within the first three months, especially by reduction of formula milk in diet and daily walking. All five successfully hand-reared cubs were shifted to sub- adult lion's enclosure.

## CONCLUSION

The current study has set the baseline protocol for the hand-rearing of abandoned lion cubs with respect to the feeding, physiological and behavioral aspects in a simplified and practical manner, along with the identification and treatment of diseases/conditions faced during the process that have never been detailed in any research publication so far. The study would help zoo keepers and wildlife conservationists to care for abandoned lion cubs.

## CONFLICTS OF INTERESTS

The Authors declare that there is no conflict of interest.

## AUTHORS' CONTRIBUTION STATEMENTS

BNK and MA conceived the idea and supervised the work, visualization and help in writing of manuscript, MA, MRK, and BNK conduct the research, BNK, MA, FH and MHS wrote the manuscript, review and editing data on software, ZIK and AR helped in data curation, validation and formal analysis.

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