Article
Rabies suspected human cases in and around Jimma zone, south west Ethiopia

Hafiz Esmael[*] [ID] and Beshatu Ferede

Wollega University, College of Medical and Health Science, P.O. Box 395, Nekemte, Ethiopia

[*]Corresponding author: Hafiz Esmael, Wollega University, College of Medical and Health Science, P.O. Box 395, Nekemte, Ethiopia. Phone: +251703746038; E-mail: hafizesmael5@gmail.com

Abstract: Rabies, a viral disease affecting warm-blooded animals, poses a significant public health concern in Ethiopia, particularly concerning human transmission through dogs. To shed light on the status of suspected rabies cases in humans in the Jimma zone and surrounding areas, a retrospective study was conducted at the Jimma Town Health Center from November 2021 to May 2022. The area's rabies status had been unknown since 2012. From 2019 to 2022, a total of 2,223 suspected human rabies cases were recorded at the Health Center, with Jimma town and Xiro Afeta districts of Jimma zone reporting the highest (62%) and lowest (0.3%) numbers, respectively. Of these cases, 96.9% (2,155) resulted from dog bites, with children under 15 years old constituting the majority (52.8%) of victims. Town areas accounted for 66.8% (1,378) of the cases. Significantly variable occurrences were observed in relation to religious category, season, source of exposure, affected body part, and districts within the Jimma zone (*P*=0.000). The main challenges identified included an increase in stray dog populations, the absence of control centers, lack of awareness about pre-exposure vaccination for owned dogs, a scarcity of rabies vaccine in local veterinary services, and the unavailability of post-exposure prophylaxis at district health centers. Addressing these issues through awareness campaigns for dog owners on pre-exposure vaccination and ensuring the provision of post-exposure prophylaxis to all district health centers is crucial for controlling and preventing rabies in the study area.

Keywords: health center; Jima town; rabies; retrospective; post-exposure prophylaxis

1. Introduction
Rabies is a rapidly progressing and ultimately fatal encephalitis caused by an RNA virus belonging to the Rhabdoviridae family, specifically the *Lyssavirus* genus. This genus encompasses seven genotypes (Pont *et al*., 2019). While it affects all warm-blooded animals, it predominantly targets terrestrial and airborne mammals, including dogs, wolves, foxes, jackals, cats, lions, mongooses, bats, monkeys, and humans. The disease is widespread globally and has been recognized and feared since ancient times, with indications dating back to the eighth century BC and its origin traced to around 3000 BC, deriving from the word 'rabha,' meaning violence (Davis *et al*., 2013).

Transmission typically occurs through bites from rabid canines, but under uncommon circumstances, it can also happen through the inhalation of aerosolized rabies virus or organ transplantation from infected patients (Campos *et al*., 2020). Animals infected with rabies have high titers of the virus in their salivary glands, exceeding even those in the brain (Campos *et al*., 2020). Although various carnivore and bat species act as natural reservoirs, dogs worldwide account for 99% of human infections, posing a threat to over 3.3 billion

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people. Annually, an estimated 60,000 human deaths occur due to rabies, with the majority in Asia and Africa (World Health Organization, 2019).

The incubation period for the rabies virus is long and variable, typically lasting 20 to 90 days but occasionally extending beyond one year (Moore, 2018). The disease manifests in three clinical phases: prodromal, furious, and dormant/paralytic. "Furious rabies" characterizes animals in which the excitative phase predominates, while "paralytic rabies" refers to cases with a short or absent excitative phase progressing quickly to the paralytic phase (Shipley *et al*., 2019). Rabid foxes may invade yards and houses, attacking dogs and people, while bats flying during the day are likely rabid (Shipley *et al*., 2019).

In Africa, rabies poses a significant public health and economic problem, with Ethiopia experiencing its impact for centuries. The country records a high incidence of rabies, primarily affecting dogs and posing a considerable risk due to frequent human-dog contact. In 1998, Ethiopia reported the highest number of human deaths from rabies in Africa, reaching 43 cases (Assefa *et al*., 2020). Understanding the occurrence of rabies and associated risk factors is crucial for implementing effective control measures, despite the disease being reported as endemic in most parts of Ethiopia (EHNRI, 2018). While a retrospective study covered the period from 2012 to 2017 in Jimma zone and surrounding areas (Tadele *et al*., 2014), there is currently no available information on the rabies status in the study area. Recognizing this research gap, the present study was conducted to assess suspected rabies cases in humans in and around Jimma zone, identify associated risk factors, and evaluate the economic losses resulting from rabies post-exposure prophylaxis in the study area.

2. Materials and Methods
2.1. Ethical approval
This study was approved by the Research Protocol Ethics Committee of the Wollega University, College of Medical and Health Science Board of research and innovative medicine (number 5296, date: 15.06.2023).

2.2. The study area
The research was carried out at Jimma Town Health Center, spanning from November 2021 to May 2022. Situated in the Oromia Regional State, Jimma town is positioned 352 km southwest of Addis Ababa (Figure 1). The town's geographical coordinates range from approximately 7°36' to 8°N latitude and 35°52' to 37°37'E longitude, with an elevation varying between 880 and 3360 meters above sea level. The local climate is characterized by a mean annual rainfall of around 1,530 mm, occurring during long and short rainy seasons. The average annual temperature fluctuates between 14.4 and 26.7 °C, encompassing minimum and maximum values. As of the 2018 census, Jimma town has a total population of 120,600 (CSA, 2018).
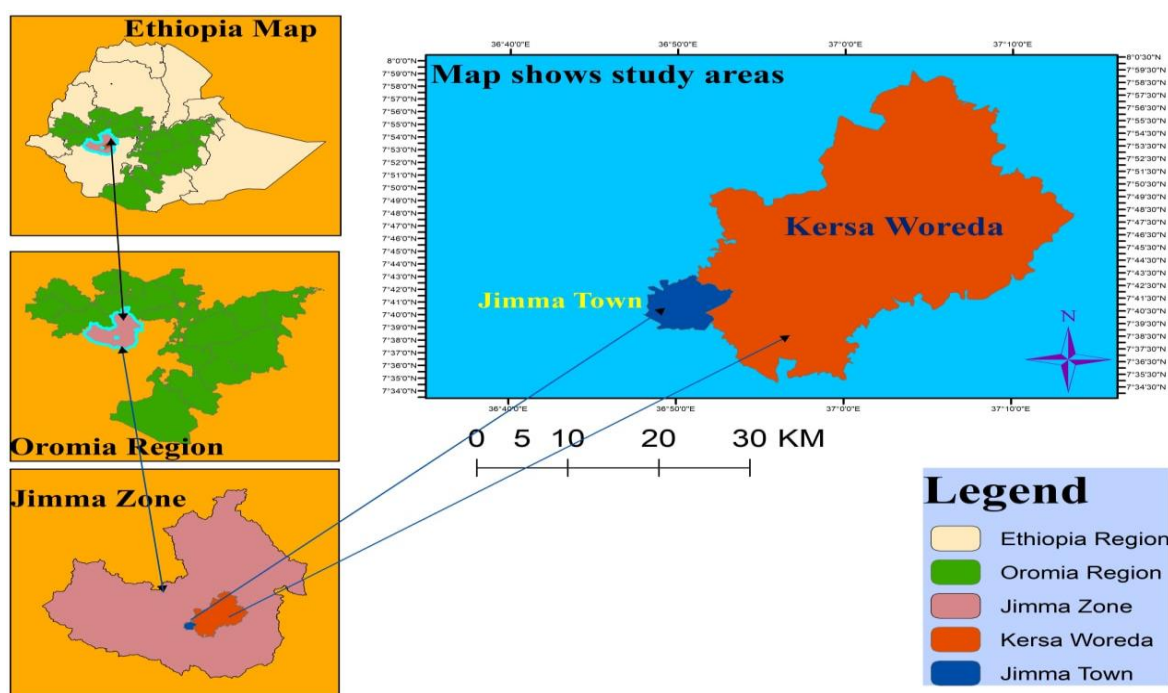

Figure 1. Jimma town health center found in Jimma town and Kersa Woreda.

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2.3. Study design and methodology

The research adopted a retrospective record review utilizing a cross-sectional study design to compile information on recorded cases of suspected rabies in humans presenting at Jimma Town Health Center. The study involved a thorough examination of the documented data available at Jimma Town Health Center. The recorded information encompassed various details, including identification numbers, dates, patient names, gender, addresses (region, zone, woreda, kebelle, and house number), type of biting animal, date of the bite, site of the bite, administered vaccines, and the health institution where the vaccine was administered. This data was systematically collected from the records maintained at Jimma Town Health Center.

2.4. Study population

In this record case book, a resident from Jimma town and it's surrounding as well as victims of rabies and rabid bites referred from the surrounding zone found in Oromia regional state, South West Ethiopia and in south nations, nationalities and peoples of Ethiopia were the source of the sampling population.

2.5. Sample size determination and sampling method

Sample size depending on the data of rabies suspected human who bitten by rabid animals and came to Jimma town health center for treatment and as a result they were recorded and stored in card office for four years starting from 2019 to 2022 was purposively taken. From the recorded cases found in this health center for four years 2223 of humans that suffered from rabies contact was found. Sampling method (collection of recorded cases) was purposively searching the recorded cases of rabies found between 2019 to May, 2022 from total accumulation of recorded cases of different diseases.

2.6. Statistical analysis

The information that was gathered through searching from recorded data those found in Jimma town health center and was entered to Microsoft Excel program. The data was analyzed by descriptive statistics using SPSS version 20. By inserting nominated data to SPSS it was analyzed for significance. Then the *P*-value that less than 0.05 taken as significant that means the error is minimized or the sampling is not biased.

3. Results

3.1. Social impact

Post exposure prophylaxis was provided only by the health center where this data was collected from the study area. The recorded cases of rabies suspected human that came to JTHC to get drug of prophylaxis from 2019 up to May, 2022 were 2223. From the total recorded cases the highest numbers of victim were Muslims 1140 (51.3%) and Christians were 1083 (48.7%). Regarding to sexual distribution, the male were mostly affected 1280 (57.6%) than Female. Majority of rabies suspected cases were found between age of 1-15 years old, 1173 (52.8%) but the least were found at the age of above 50 years old, 122 (5.5%) (Table 1).

Table 1. Demographic characteristic of the rabies suspected individuals.

Variables		Numbers (%) of suspected cases with years of registration				Total	P_{-value}	X^2
		2019	2020	2021	2022			
Religion	Muslim	278	272	455	135	1140		
	Crystian	241	290	390	162	1083	0.027	9.213
	Total	519	562	845	297	2223		
Sex	Male	307	328	484	161	1280		
	Female	212	234	361	135	942	0.587	1.929
	Total	519	562	845	296	2223		
Age group	1-15 year	267	308	449	149	1173		
	16-30 year	155	143	233	92	623		
	31-50 year	69	76	120	39	304	0.864	6.904
	above 50 year	28	35	42	17	122		
	Total	**519**	**562**	**845**	**297**	**2223**		

Regarding to the source of exposure dog was the major source which affects 2155 (96.9%) while human was the least which affect 2 (0.1%). The majority of affected body parts of individuals that recorded on rabies suspected record case were on their leg, 1665 (74.9%) while the least were on their head/face, 58 (2.6%). winter was

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season of highest cases recorded 667 (30%). The highest cases were recorded in 2021 which were 845 (38%), following 2021 year, 2020 year held 562 (25.3%), 2019 year held 519 (23.3%), and 2022 the number of human that suspected to rabies case were 297 (13.4%) (Table 2).

Table 2. Distribution of rabies cases in relation to its risk factors and site of bite.

Variables		Numbers of suspected cases with years of registration				Total	$P_{\text{-value}}$	X^2
		2019	2020	2021	2022			
Jimma and Neighbors' zone	Jimma zone	495	545	815	287	2142		
	Ilu-Abbabor zone	6	5	4	0	15		
	Bench-Maj zone	5	2	7	4	18	0.28	17.66
	Kefa zone	7	4	11	6	28		
	Dawuro zone	6	6	8	0	20		
	Total	**519**	**562**	**845**	**297**	**2223**		
Residence	Town	350	365	568	203	1486		
	Rural	169	197	277	94	737	0.72	1.35
	Total	**519**	**562**	**845**	**297**	**2223**		
Source of exposure	Dog	497	543	825	290	2155		
	Cat	13	9	17	3	42		
	Bovine	3	3	0	0	6		
	Equine	1	4	1	0	6	0.03	26.37
	Human	2	0	0	0	2		
	Fox	3	3	2	4	12		
	Total	**519**	**562**	**845**	**297**	**2223**		
Affected body parts of humans	Leg	391	431	624	219	1665		
	arm/hand	96	89	176	69	430		
	head/face	11	16	22	9	58	0.005	23.35
	Others	21	26	23	0	70		
	Total	**519**	**562**	**845**	**297**	**2223**		
Season	Autumn	106	70	266	189	631		
	Winter	199	163	197	108	667		
	Spring	116	115	235	0	466	0.000	454.36
	Summer	98	214	147	0	459		
	Total	**519**	**562**	**845**	**297**	**2223**		

Distribution of the rabies cases based on the origin of the exposed individual , the highest number of suspected humans cases were from Jimma town which hold 1379 (62%), while Seka district was second rank by having 115(5.2%) number and the least number were from Xiro Afeta district which were 7 (0.3%). From a total of 2223 recorded case, 2142 (96.4%) affected individual were from Jimma zone while the rest were from other surrounding zone. Accordingly, most affected number of human was urban resident 1486 (66.8%) and the number of rural resident used post exposure prophylaxis were 737 (33.2%) (Table 3).

Table 3. Distribution of rabies case in all districts of Jima zone.

Name of areas	Years				Total
	2019	2020	2021	2022	
Jimma town	318	343	519	198	1378
Kersa	22	11	35	4	72
Manna	25	25	36	17	103
Dedo	16	18	46	15	95
Gomma	34	28	27	8	97
Seka	18	27	50	20	115
Gumay	3	8	8	5	24
L/Kossa	21	24	15	2	62
L/Seka	9	2	7	6	24
Shabe	3	8	8	0	19
C/Botor	3	1	8	0	12

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Table 3. Contd.

Name of areas	Years				Total
	2019	**2020**	**2021**	**2022**	
N/Benja	0	2	9	0	11
Sokoru	5	6	13	3	27
O/Nadda	5	20	21	6	52
Sigimo	2	7	2	0	11
Setema	2	5	2	0	9
Gera	7	6	9	2	24
X/Afeta	2	4	1	0	7
Total	**495**	**545**	**816**	**286**	**2142**

3.2. Economic impact of rabies in the study area

The cost of post exposure prophylaxis was not constant throughout these four years. In 2019, 2020, 2021 and 2022, cost of the PEP for a single person was 36, 36, 48, and 80 USD respectively. The highest cost per rabies suspected individual was occurred in 2022 which was 130 Ethiopian birr per individual. Total economic burdens of the post exposure prophylaxis that were expend by rabies suspected individual came and treated by anti-rabies drug in Jimma town health center from 2019 up to may, 2022 were calculated to be 103,236 USD. Generally, the economic loss due to post exposure prophylaxis was calculated as below (Table 4).

Table 4. Number of victim individuals and calculated economic loss.

Years	Number of victim	Cost per individual in USD	Total expend money (USD)
2019	519	36	18,684
2020	562	36	20,232
2021	845	48	40,560
2022	297	80	23,760
Total	**2,223**		**103,236**

4. Discussion

Jimma Town Health Center serves as the sole provider of post-exposure prophylaxis (PEP) for all districts under the administration of Jimma Zone. Additionally, this health center extends its services to the surrounding zones of the Oromia Regional State and the South Nations, Nationalities, and Peoples' Regional State of Ethiopia (Tadele *et al*., 2014). Annually, the application of PEP surpasses 20 million treatments, serving as an effective preventive measure against rabies virus infection for over a century (Merritt *et al*., 2018). According to the findings of this study, approximately 2,223 individuals with suspected rabies cases sought PEP at this health center from 2019 to 2022. This observation aligns with the results of a study conducted by Jackson (2018). The notable prevalence of cases in this area may be attributed to its forested landscape, coffee cultivation, and diverse wildlife. These environmental factors likely contribute to the easy transmission of rabies between domesticated dogs and wild canines in the study area.

On this study result sex wise distribution of cases indicate high exposure of male individuals (N=1280; 57.6%) than females (N=942; 42.4%) of all age group. Major number of male exposure which was encountered in present study is in agreement with the study conducted previously by Tadele *et al*. (2014). According to Muslim religion females work only indoor and did not go out of home and also Muslim society has negative attitude to dog since they think dog as unclean and so low participation in dog breeding (Jenny, 2014). This might be reduced the number of women that work at home who has low chances of contact with dog. In other side, outdoor activities and close contact of the male with the dogs than females might have increased the risk of exposure. Since the facts of Jimma town resident are mostly Muslim followers, this may be the reason that the numbers of affected females by rabies cases were lower and also most of the affected humans are males of Muslim followers (N=1140) (51.3%).

In the present study, cases of rabies were more frequent among the children aged between 1-15 years (N=1173; 52.8%).This study result is in agreement with the WHO report which indicate the most (30 to 50%) of the victims of rabies reported from Africa and Asia are children's (Warrell, 2019). The study that was conducted in Addis Ababa and its surrounding by Assefa *et al*. (2018) and in Jimma Town by Tadele *et al*. (2014) also similar with this finding. This might be due to several reasons. some of these reasons could be , children take message from one family to others where they come across rabid dog, they also spent more of their time playing on the

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road and may encountered by rabid dogs. Additionally they are unable to protect them self from dog bite and could be due to immaturity to identify rabid animals from the normal.

Rabies case is endemic in many parts of the Ethiopian country (EHNRI, 2019). The current study result also indicates that this disease is also common in every district of Jimma and the surrounding zone. From the total 2223 case, 2142 (96.40%) were from the Jimma zone while the rest 81 (3.60%) were from the surrounding zones like Ilu Ababor 15(0.7%), Bench Maj zone 18 (0.80%), Kefa zone 28(1.20%) and Dawuro zone 20 (0.90%). From the case that recorded in Jimma zone, the highest was Jimma town 1379 (62%) which followed by Seka district 115 (5.20%) and the least number of case were from Xiro Afeta 7 (0.30%). This study result is in line with the Asefa *et al.* (2010) finding who reported great number of cases from Oromia regional state than any other region and also in agreement with Tadele *et al.* (2014) who reported rabies in all district of Jimma zone. As the distance from Jimma town increase the number of case record were decreases. This may probably due to long distance travel and also as their distance increase from the town, awareness of the society on post exposure prophylaxis decrease so as a result they may use traditional medicine.

Urban rabies is essentially maintained by dogs wherever it is endemic world-wide. It is estimated that the dog/human population is one to six in urban areas and one to eight in rural areas (EHNRI, 2019). Also this study result is in line with this statement as majority of people bitten by rabid animals and recorded on data of JTHC PEP were urban resident. The number of rabies suspected human came to this health center and treated with anti-rabies were two times more than those came from rural area 1486 (66.8%). This probably due to the migration of dogs from rural to town and increment number of stray dog in urban which similarly, reported by Abraham *et al.* (2020).

Rabies in Ethiopia predominantly affects dogs, posing an increased risk to the general population due to the common occurrence of contact between humans and dogs (Assefa *et al.*, 2020). This aligns with the findings of the present study conducted at Jimma Town Health Center, where a significant majority of recorded cases of suspected rabies in humans were attributed to dog bites. Between 2019 and 2022, 96.2% of the cases (2,155 individuals) reported exposure to rabies through dog bites. Several factors contribute to this high incidence, with a primary factor being the growing population of stray dogs, consistent with findings by Abraham *et al.* (2010). Notably, in the months of March and April 2022, there was a substantial increase in the number of rabid dogs, leading to a significant rise in the number of individuals bitten by rabid dogs. This sudden surge in cases during this period underscores the urgency of addressing the issue of stray dogs and implementing effective control measures to reduce the risk of rabies transmission in the community.

As a result, Jimma town health center was appealed this situation to Jimma town municipal office. Jimma town municipal office response were killing the stray dogs by preparing meat for them and adding killer poison into that meat and distributed it in every corners of Jimma town by car at night from 08:00 pm to 11:00 pm local time. After doing this for two consecutive days they were started to collect dead dogs. By collecting dead dogs for two to three consecutive days they have got more than 2000 dead dogs and graved/buried the dead dogs in Kofe bush by digging deep hole. Then after, the number of rabies suspected human come to JTHC were started to decrease and at the last the case come from district and other zone which were very low in number were left alone. Similarly, Damodar *et al.* (2019) indicated the necessity of stray dog elimination as control measures towards canine rabies.

The second line source of exposure was the Cat, while all most all of the individuals that were bitten by the cats were affected on the hand/arm of body parts. This finding is similar to that of study carried out by Yizengaw *et al.* (2018). This may probable due to humans fighting with hand when they become excited and tried to scratch and bite, also during feed provision they may bite hand. The third source of exposure were fox which is wild life and while the Bovine and Equine were the fourth source of exposure and human being self is the source of rabies transmission in this study.

In the current study, a notable 74.9% of the individuals sustaining injuries were bitten on their legs, aligning with the findings reported by Servat (2019), where leg bites were the most common among rabid animals. This pattern is consistent with Shah *et al.* (2012), which also highlighted a majority of victims being bitten on their lower limbs. The prevalence of leg bites may be attributed to the proximity of dogs, the primary source of cases, to the lower body part. Conversely, the smaller percentage of cases affecting areas around the shoulder, back, and head/neck region may be linked to interactions with animals such as equines, bovines, and other humans. This observation is in line with the work of Dacheux and Bourhy (2018), which suggested possible human-to-human transmission of rabies in Ethiopia. Additionally, Beteleheim *et al.* (2012) reported instances of human rabies cases and PEP given due to contacts with rabid human subjects.

In terms of seasonal variation, the study revealed a higher number of cases during the winter season compared to other seasons, with the lowest incidence recorded in summer. The peak occurrence of rabies cases, with 30%

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recorded from December to February and 28% from September to November, coincides with the breeding season, as observed in prior reports by Tadele *et al*. (2014). This contrasts with findings by Vos *et al*. (2017), who identified the highest number of rabies cases between June and September. The discrepancy may be attributed to the breeding season's influence on the onset and peak of rabies outbreaks. The study determined that the seasonal variation was statistically significant (P=0.000), corroborating the findings of Centoamore (2020), who reported a statistically significant difference in the mean number of confirmed rabies cases across 12 months in and around Addis Ababa.

In present study there is a great economic burden as the cost of drug were increasing throughout the consecutive three years and as the number of victim were enormous. Highest price was seen in the 2022 year which is 80 USD per individual. Totally those people who got post exposure prophylaxis expend 103,236 USD in the last consecutive four year at the study area. This great economic loss due to post exposure prophylaxis is indicated in report of World Health Organization (2018).

The suspected cases of rabies in humans recorded at the Jimma Town Health Center were alarmingly high, resulting in significant economic losses. Not only did the expenses for post-exposure prophylaxis contribute to this financial burden, but the subsequent 17-day treatment follow-up and transportation costs were also substantial, particularly for individuals traveling from long distances. Conversely, societies in remote areas may resort to traditional medicine, risking their lives due to a lack of awareness about post-exposure prophylaxis drugs. Moreover, individuals bitten by stray dogs may face isolation, living alone in separate quarters for three months, leading to potential psychological distress or death before the end of the isolation period, even in the absence of a confirmed rabies virus case.

5. Conclusions

Rabies which is endemic in Ethiopia is mostly reported from south west Ethiopia, in all parts of Jimma zone. Being forested by coffee cultivation may lead for disease transmission between domestic animals like dog and wild animals like fox which is natural reservoir of the rabies virus. The high population of stray dog in this area make the children the highest vulnerable to this disease in this study areas, while the most affected body part was lower limb. Provision of post exposure prophylaxis to all district health centers, to eliminate those homeless and unvaccinated dogs and close collaboration and coordination between veterinarians and medical authorities at all level of study area is crucial.

Data availability

All relevant data are within the manuscript.

Conflict of interest

None to declare.

Authors' contributions

Conceptualization: Hafiz Esmael; Methodology: Hafiz Esmael and Beshatu Ferede; Formal analysis: Beshatu Ferede; Original draft preparation: Hafiz Esmael; Review and editing: Hafiz Esmael. Both the authors read and approved the final manuscript.

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