

# Major Trade Sensitive Diseases and Problems in the Afar's Dromedary Camels Market Chain and its Impact on Livelihood of the Pastoral Community in Afar Region, North East Ethiopia

Samrawit Melkamu<sup>1\*</sup>, Angesom Hadush<sup>1</sup>, Teshager Dubale<sup>1</sup> and Mulat Asrat<sup>2</sup>

<sup>1</sup>College of Veterinary Medicine, Samara University, Russia

<sup>2</sup>School of Veterinary Medicine, Wollo University, Ethiopia

## Abstract

A Participatory epidemiological study was carried out to identify the most economically important trade-sensitive diseases which constrain trade and to quantify and rank the major diseases along the camel market chain originating from Afar pastoral community. A retrospective case-control study design was used to collect data on trade-sensitive disease problems in the market chains using epidemiological techniques of a semi-structured interview, disease ranking, and matrix scoring. Information was collected from producers, key informants, and participants in the Camel market chains. Purposive sampling was used to select a total of 153 producers, 29 traders, and 7 exporters were interviewed with separate semi-structured questionnaires to collect information on the quality constraints of a traded camel along the export market chain. Adiatu, Aysaita, Awash 7, Elewha, Chifra, Gedamayetu, Endufo, and Logia and Adama-Mojoquarantine stations were selected purposely. The collected data was coded, managed, and validated in an excel spreadsheet. The level of agreement between informant groups was assessed using Kendal's coefficient of concordance (W) calculated using the Statistical Package for the Social Sciences (SPSS, 2007). The income sources of the Afara pastoralists were livestock (79.3%) and mixed (livestock and integrated) (20.7%). In the present survey majority of respondents (74.6%) used camels as a milking production system; social status (13.4%); source of income (9.3) and only 2.7% used for another social purpose. The most important diseases in Afar originated camels were camel pox (36.8%), trypanosomiasis (21.5%), pasteurellosis (12.8%), mange mites (9.4%), Anthrax (6.7%), ticks (5.2%), skin wound (4.3%), *Capparis Tomentesa* poisoning (1.9%), and lice (1.4%), are the first, second, third, fourth, fifth, sixth, seventh and eighteenth ranked respectively. The Afars' camels are not preferred for export trade and local users because of their poor body condition and disease problems.

**Keywords:** Afar • Camel • Disease • Market chain • Trade sensitive

## Introduction

Ethiopia is a resourceful country endowed with the largest livestock resource in the African continent. Camel population found in this country is higher with the potential to export substantial numbers of live animals and their products [1]. However, the camel contribution to the economy in general and foreign currency earnings in particular; is very low as per the country's expectations and potential of the sectors. Some of the major factors contributing to the poor performance of the livestock sub-sector include the prevalence of highly contagious trans-boundary animal diseases. These diseases continue to hinder international trade in live camel and their products seriously in an era of globalization. Public concern is growing regarding the rapid transboundary spread of animal diseases through animals and animals products have forced importing countries to apply strict measures so that animals and their products exported should meet international sanitary phytosanitary requirements [2].

Animal diseases could be spread through production and marketing chains [3]. In Ethiopia, live camel market chain actors are not adequately informed of the importance of establishing the source of origin, traceability mechanisms, and related certification processes for marketed animals. Furthermore,

they do not yet appreciate the importance of issues related to food quality, the link between animal health, meat and milk quality, and safety, and why documentation is fundamental in enhancing competitiveness in the global markets. For this reason, transboundary animal's diseases can easily spread along the chain and result in repeated outbreaks. This could affect particularly the economic well-being of the farmers and that of pastoral communities but also more globally the country's economy [4].

For camel production to contribute its full potential to national economic growth and to support the livelihood of the pastoral community, the exported camel from Ethiopia needs to compete in international markets. Therefore, to improve competitiveness, an active strategy to improve the health, safety, and quality requirements of importing countries is crucial. This is achieved mainly by reducing disease risk in value chains to an acceptable level. These involve changes in the behavior of the people involved in the market chain. If such a strategy is to be effective, the different people involved will have to be convinced of its necessity and validity in trade-sensitive diseases prevention and control along the chain. Consequently, intervention along the chain should be based on transparent and evidence-based planning and decision-making which requires methods is to analyze the risk of these diseases in the chains that link production systems, markets, and consumers. Information on the status of trade-sensitive in camel market chains both for local and export from Ethiopia in general and Afar's camel market chain, in particular, is highly scanty. Hence, there is a need for an assessment of these diseases in Afar's camel market chain. The general objective of this research; is to conduct an assessment of trade sensitive diseases and other problem in the market chain for both local and export camels originating from the Afar pastoral community. Its specific objectives were; to identify and quantify trade-sensitive diseases along the camel market chain; to evaluate the impact of trade-sensitive diseases on the livelihood of the Afar pastoral and Agro-pastoral community and camel export and appraise the awareness and concern of camel market chain actors towards these diseases.

**\*Address for Correspondence:** Samrawit Melkamu, College of Veterinary Medicine, Samara University, Russia, Tel: +251921282965, E-mail: samrawit.m2129@gmail.com

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## Materials and Methods

### Study areas

Afar regional state is located in the Great Rift Valley, comprising semi-arid rangeland in northeastern Ethiopia. According to regional estimates, the livestock population of Afar is about 10.12 million TLU and out of this about 859,580 (8.5%) are camels. The Afar Regional State has five administrative zones, which are further subdivided into 32 districts. Pastoralism and agro-pastoralism are the two major livelihood ways practiced in the region. The population of the region is estimated to be about 1.2 million of which 90% are pastoralists and 10% are agro-pastoral [5].

The study was conducted in two zones of Afar Regional State namely zone 1 and 3. Afar is one of nine regional states situated in the North-Eastern part of Ethiopia. The altitude of the region ranges from 1500 meters above sea level in the western highlands to -120 meters below sea level in the Danakil/Dallol depression. The regional capital city, Samara is located in zone 1 (Dubti Woreda) and 588 km North-East of Addis Ababa on the main Addis-Djibouti road. Afar is characterized by an arid and semi-arid climate with low and erratic rainfall. Temperature varies from 20°C in higher elevations to 48°C in lower elevations. Rainfall is bi-modal throughout the region with a mean annual rainfall below 500mm in the semi-arid western escarpments decreasing to 150mm in the arid zones to the east. There are 16 livestock markets in Afar regional state in which only 75% (14) of them are functional. The most important livestock markets in the region used for live camel marketing are Asayita, Awash 7, Chifra, Milli, Aba'alaand Adama-Mojo quarantine stations.

### Study group

The target groups for this study were camel owners, herders, market chain actors, and animal health professionals found in the selected district of the study areas. Data from study groups were collected each month from which research starts in each selected district for a period of one year from December 2016- to May 2017. During the study, the detailed health status of the animals, major trade-sensitive camel diseases, associated risk factors, management practices, and quality problems along the market chain have been assessed and recorded.

### Study design

Both cross-sectional and retrospective study designs were conducted.

### Sampling strategy

A combination of both probability and non-probability sampling methods was applied in this study. At the producers' level, in the selected districts of the Afar pastoral region the most important livestock markets in the region used for live camel marketing are, Adiatu, Aysaita, Awash 7, Elewha, Chifra, Mille, Gedamayetu, Endufo and Logia, and Adama-Mojo quarantine stations, were selected purposely from the Afar regional states. A total of 153 producers, 29 traders, and 7 exporters have been interviewed with separate semi-structured questionnaires to collect information on the quality constraints of a traded camel along the export market chain.

### Study methodology

**Participatory Epidemiological Investigations:** A participatory epidemiological investigation was carried out using focus group discussions, key informants and interviews. The key informants were herders, market chain actors, animal health professionals, and herd owners with good herding and trade experience, and good indigenous knowledge of animal husbandry and management. The challenges and opportunities on both local and export trade of camels and their products were assessed.

**Pairwise comparison and ranking:** Participatory appraisals were conducted mainly through semi-structured interviews of key informants. It was used to assess the local perception of trade-sensitive camel diseases. To list, prioritize and rank the most important camel diseases which affect productivity and marketability. Diseases were identified by their local names and clinical signs described by the participants. A Pairwise ranking of five important camel

diseases was conducted to identify locally perceived indicators (signs). This process was also used to generate indicators for matrix scoring.

**Matrix scoring:** Matrix scoring was used to score the five top-ranking diseases against a list of clinical, epidemiological, and production indicators. The identified diseases were presented using either written names on cards or on paper, or use local objects or pictures based on the literacy of participants and placed along the top X-axis of the matrix. Each of the five diseases in the matrix was scored against a list of 15 clinical signs or causes of the diseases. The indicators have been illustrated along the Y-axis of the matrix. For each indicator, informants were asked to score each disease by dividing piles of 25 stones against the five diseases. A seasonal calendar prepared using local language in table form was used and the participants were put 100 beans prepared for proportional piling to each season in the table prepared for this reason. The beans were placed considering the occurrence of diseases and their impact on productivity and marketability throughout the previous year.

**Proportional piling:** Before performing the proportional piling to estimate the relative incidence and mortality caused by the five most important camel diseases during the past year, informants have been asked to classify the camels into different age groups that fit into the real camel husbandry system. Then every informant was allowed to maintain a pile of 100 beans for each age group, before splitting the pile of beans into two relative numbers of sick and healthy stocks during the past year. The pile of beans representing the sick camel was then subdivided into the five major diseases to show the relative number of camels affected by different diseases during the year. Subsequently, each informant was asked to remove some of the already allocated stones representing the sick to indicate the number of dead animals/survivals during the year for every five prioritized diseases of the camel. Age-specific incidence and mortality rates and 95% confidence limits were calculated with Pearson's correlation coefficient. Finally, the findings of the participatory discussions have been triangulated with field clinical observations, questionnaire surveys, and retrospective studies.

### Questionnaire survey and clinical observation

Information on camel rearing practices, the status of camel diseases and their manifestations, potential challenges, and disease management approaches were collected by personal observation during the visit to herds and a questionnaire survey conducted throughout the study period. The challenges and opportunities for both local and export trade of camels and their products were assessed.

**Semi-structured interviews:** Informal interviews guided by separate checklists for producers and quarantine centers were used to collect information along market chains. At the producers' level, pastoralists are asked to list types of livestock kept, uses of camels, constraints for camel production and marketing, and camel diseases encountered. The interviews also have been collected descriptions of the clinical presentation of diseases of the camel at the production level. Quarantine center owners and their veterinarians were interviewed about major constraints which affect their business, major diseases which challenge their business, buying and selling system inspection, and certification systems along market chains.

### Data management

The data was summarized, cleaned, and compiled after coded data were stored in Microsoft Excel 2007 spreadsheet and transferred to SPSS® Version 20 for statistical analysis. Descriptive and analytic statistics were computed using software SPSS® Version 20. Logistic regression and the Chi-square test ( $\chi^2$ ) have been employed to see the association of risk factors. The degree of the association will be computed using the Odds Ratio (OR) and 95% Confidence Interval (CI). The Odds Ratio (OR) is used to indicate the degree of risk factor associated with the disease occurrence signified by 95% confidence intervals. The odds ratio is the ratio of the odds of disease occurring among individuals exposed to a variable and the odds of the disease occurring among individuals not so exposed [6]. Agreement among the scores of informant groups will be assessed using the Kendall coefficient of concordance [7].

## Results and Discussion

### Market supply chain

Kotler P, et al. [8] indicated that the market is a social and managerial function associated with selling and distributing a products and livestock. Camel market in Afar region is a local standard livestock market with watering, and loading facilities. In the Afar region, not a well-structured camel market, and camel exports, because of many factors, such as poor quality of meat, disease condition, and genetic makeup which leads afar camels were not selected for the export market.

### Characteristics of the participants

Focus group discussion with pastoralists indicated that camels made by far the greatest contribution to livestock-based livelihoods in all study districts. A Study by Jost CC, et al. [9] in the North Eastern Province of Kenya indicated that camels made the greatest contribution to the livelihoods of Kenyan pastoralists. The present study is in line with Schwabe CW [3], who recorded as the main functions of camels in pastoral households are to provide subsistence products (milk, and meat), to meet social obligations (bride price, stock alliances and stock patronages) and to ensure against disaster [2].

The majority (97.3%) of respondents practiced a free-range (extensive) production system and only 2.7% of them practiced a tethering (subsistence) system, while none of them practiced an intensive livestock production system. The main market actors that participated in the Afar's camel trader market were producers, collectors, medium and big traders and a broker. Collectors buy camels from producers of local markets and supply them to small and larger-scale traders. Medium traders are large in number relative to big traders; the volume of their purchases is smaller than that of big traders. Since they buy a smaller number of animals at a time, they have a very limited number of collectors from the primary markets. Big traders purchase a large number of animals from remote production areas and bring them to the terminal markets. They are few in number compared to small traders. Big livestock traders have several smaller agents collecting livestock from the primary markets and producers' villages.

### Health and quality indicators at producers' levels

According to the interview result, 68.7% of pastoralist offers camel for sales to meet their urgent needs at any time during the year. About 21.3% of the producers' sales during drought are due to feeding shortages, while only 11% of the producers indicated that they supply camels according to seasonal variation in demand, and select the appropriate type of camel according to function (Hajj, Ramadan, or another holiday).

### Major camel health problems and disease ranking

**Semi-structured interviews:** Informal semi-structured interviews were used at the household level to rank major problems and diseases of a camel which has an impact on livestock-derived livelihoods. Informants groups ranked animals' diseases secondly in terms of impact on livestock-driven livelihood. The informant group ranked feed and water shortage; drought, and lack of veterinary service feed as first, third, and fourth constraints that impact camel-driven livelihood. Access to get feed is becoming a serious concern in the areas. In the area, livestock is dying due to a lack of feed.

**Major diseases ranking:** The result of pair-wise ranking of diseases revealed that selected district pastoralists in the Afar region ranked camel-pox as the first highest ranking disease for camels in terms of impact on livelihoods. Informants groups ranked Camel diseases in the Afar are many in number are serious and can cause losses and reduced production (Figures 1 and 2). The most important diseases in the Afar originated camels are camel pox (36.8%), trypanosomiasis (21.5%), pasteurellosis (12.8%), mange mites(9.4%), Anthrax (6.7%), ticks (5.2%), skin wound (4.3%), *Capparis Tomentesa* poisoning (1.9%), and lice(1.4%), are the first, second, third, fourth, fifth, sixth, seventh and eighteenth ranked respectively (Table 1). Of the ectoparasitic infections, two are of a real nuisance to camels and their owners: mange mites infestation (Figure 2) and tick infestation. This information can be used to design better animal health projects and delivery systems, more successful, timely and sensitive surveillance and control strategies, or as new perspectives for innovative research hypotheses in ecological epidemiology (Table 1) [3].

**Matrix scoring:** The results of pair-wise comparisons were the basis for further characterization and selection of diseases for matrix scoring. The



**Figure 1.** Camel trypanosomiasis confirmed at quarantine causes camel emaciation.



Figure 2. Camel **mange infestation** causes losses and reduced their production.



Figure 3. Quarantine level of a camel at Addis Ababa abattoir enterprise Akaki branch.

Table 1. Ranking of camel diseases.

Disease	Mean Rank
Camel pox	36.8%
Trypanosomiasis	21.5%
Pasteurellosis	12.8%
Mange mites	9.4%
Anthrax	6.7%
Ticks	5.2%
Skin wound	4.3%
<i>Capparis Tomentosa</i> poisoning	1.9%
Lice	1.4%

results of matrix scoring for major diseases of camel are stated as strong agreement,  $W= 0.675$  to  $1.00$ ;  $P=0.000$  and  $W= 0.631$  to  $1.00$ ;  $P=0.000$  were observed among 16 informant groups for all camel diseases indicators, respectively. The informant groups indicated that high mortality rate, nose discharges,

sudden death, abortions, and diarrhea were common indicators of camel pox. They also indicated that abnormally heavy rains, occurrence during drought; occurrence.

**Animal health and quality problems at quarantine level**

The Camel which was collected from producers was admitted to privately owned quarantine facility which was found in Awash 7, Mojo, and Akaki (Figure 3) for 21 days. All quarantine centers have concrete fences with secure gates. Feed and water are supplied in concrete or metallic feeding troughs. There is at least one loading and unloading ramp in each quarantine facilities. However, none of the ramp was fitted with crushes (stanchions) that permit the inspection and handling of individual animals.

Of the total 80% of the facility are designed for large animals. Almost all staffs working in quarantine centers have direct contact with quarantined animals. The staff was coming in contact directly with the camels for several reasons at all stages of the production cycle including tagging, prophylaxis treatments, vaccinations, medication of sick animals, blood sample collections,

and disposal of dead bulls. Indirect contacts also occur during feeding, and watering. In all quarantine facility, all staffs did not use any protective clothes while handling dead camels, and also did not use sanitary and disinfection facilities to avoid contamination. Formal training for quarantine centers workers on biosecurity was offered in none of the quarantine center. Daily record such as mortality, cull, prophylaxis and treatments were kept in all quarantine centers. Those animals were not subjected to any tests before they were moved into facilities. There was no primary inspection at the point of entry before animals are accepted for quarantine. Therefore, camels were admitted into quarantine facilities with all their problems. After collection of animals was completed, animals are examined individually and identified with ear tags before vaccination. The most important diseases ranked by quarantine centers owners'/managers' are summarized in Table 1. Because of the recorded disease, poor body condition and their genetic makeup there is no export opportunity for the Afar camels and there was no strict quarantine and test of any problems (Figure 3).

**Source of income**

The Market is a social and managerial function associated with selling and distributing products and livestock. Camel market in the Afar region is structured so that marketable livestock from Afar pastoral area reaches to final consumer passing through complex channels along supply chains. A supply chain is a series of interlinking steps that determine the nature, character and value of camels at time of receipt by consumer. The supply chain in the Afar's camel comprises two functional groups livestock production and mixed-income sources. The income sources of the Afara pastoralists were livestock (79.3%) and mixed (livestock and integrated) (20.7%). The enabling factors for the live animal market business environment are critical factors and trends that are shaping the market chain environment and operating conditions which are generated by structures and institutions (policies and regulations) that are beyond the direct control of the market participants. Inputs and from other service from another enterprises or service provider organizations are provided for all participants' in the chain which will allow actors to grow and maintain their competitiveness in the supply chain [10].

**Purpose of camel rearing**

The salt mine has created full and part-time jobs for many individuals who participate in the different salt trade value chain stages. The presence of the salt transporters is vital for another salt trade value chain participant whose livelihoods depend on the salt mine. If the camels do not transport the salt from the mining area to the market, the salt miners, and shapers will not have a buyer for their salt, and the salt store owners, and indirectly the wholesalers, retailers and final consumers would not have a salt supplier. Also, it is the salt transporters who pay the miners, shapers and daily workers who unload the salt from the camels. Since camel renters are enablers of income generation for the groomers who rent camels from them, they are positioned as credit-granting institutions (lenders). In the present survey majority of respondents (74.6%) used camels as a a milking system; social status (13.4%); source of income (9.3) and only 2.7% used for another social purpose (Table 2). Eventually, the groom can earn sufficient funds to build up his own team of camels. According to Schwabe CW [3] the main functions of the Afar camel in pastoral households are to provide subsistence products (milk, meat and source of income), to meet social obligations (bride price, stock alliances and stock patronages) and to ensure against disaster (Table 2).

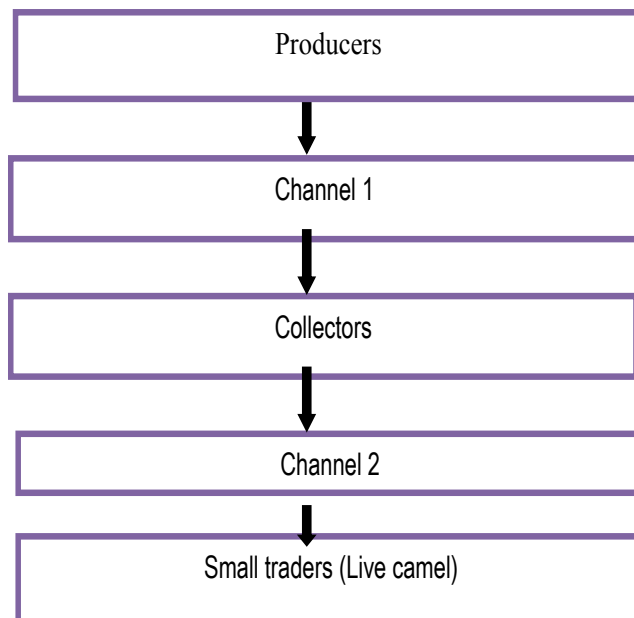
**Camel production constraints**

Yesihak Y, et al. [11] reports as drought is a natural cause, and while difficult to avoid altogether, the effects of drought can be reduced. Disease and rustling can be avoided with some effort. Disease prevalence can be reduced by improving access to veterinary services. The government has been providing security services to tackle rustling, but this has not eradicated the problem. To ensure optimal production and the sustainability of the trade, existing security arrangements should be strengthened and sustained.

Developing camel production could offer a suitable alternative for meeting chronic and often escalating challenges of food insecurity in eastern Africa [12]. However, performance and hence livelihood and economic contribution of

**Table 2.** Purpose of camel rearing in Afar region.

Purpose of Camel Rearing	Mean Rank
Milk	74.6%
Social status	13.4%
Source of income	9.3%
Another social purpose	2.7%



**Figure 4.** Major camel marketing channels.

regional camel populations is very low owing to complex constraints such as; poor husbandry systems, widespread feed shortage and diseases, inadequate health and extension services [11]. Camel disease in Afar, are serious and causes losses and reduced production. The most important diseases are trypanosomiasis, pasteurellosis and helmenthiasis. Of the ectoparasites infection, two are of real nuisance to camel and their owner; mange and tick infestation.

**Camel marketing constraints**

Camel marketing constraints were studied as production is not business oriented; lack of established market chain and other socio-cultural problems. The generalized supply chains and marketing channels for live camel local traders is depicted in Figure 4. The export livestock marketing chain actors for Afar camel are those who transact a particular product as it moves along the chain from primary producers to end users: producers, middlemen and traders. The enabling factors for live animal market business environment are critical factors and trends that are shaping the market chain environment and operating conditions which are generated by structures and institutions (policies and regulations) that are beyond direct control of the market participants [10].

Majority of markets in Afar region performed below their capacity. In the present study among the three constraints there was no market chain for the Afar camels. This might be due to livestock production systems in pastoral areas have evolved largely as a result of influence of natural production environments, absence of exporters and socio-economic circumstances of pastoralists [13-15] (Figure 4).

**Conclusion**

In Afar pastoral area, livelihoods depend, at least in part, on livestock and small ruminant made by far the greatest contribution to livestock-based livelihoods in all study districts. Majority pastoralist offers camel for sale to meet their urgent needs at any time during the year. Majority of markets in Afar region performed below their capacity. Majority of the producers have no

specific target to sale their camel. Animal characteristics in terms of health, quality and other criteria required by importers were not known by majority producers. Pastoralist motioned Pasteurellosis, camel pox, External parasite as most important diseases in terms of impact on livelihoods. There was no veterinarian performing pre-purchase inspection and selection for quality assurance for live camel at various points in market chain. Quarantine centers listed pasteurellosis, camel pox and external parasite most important disease of camel in terms of impact on businesses. Most of the diseases motioned by quarantine centers as major diseases are also the major diseases prevailing at the producer level. On the basis of the above findings, the following recommendations are made for actions to improve the functioning and efficiency of market chain and for approaches to future studies and research. Strategies are needed to improve veterinary service delivery by field staff and laboratories. Improved veterinary health services will reduce disease incidence, mortality and morbidity and improve the quality of marketed animals. In the medium to long term, health facilities and laboratories need to be better equipped and the number of veterinary staff in the public and private sectors should be increased.

Regular and periodic complementary serological studies and examination of clinical records for validation are required to build a reliable system for disease diagnosis, reporting and control. An effective biosecurity plan such as proper disposal of carcasses, isolation of sick animals in such a way to prevent cross contamination and cleaning of all equipment used on sick animals and between animals should be designed and implemented in the quarantine centered. Awareness should be given to exporters, livestock traders, dealers and marketers on key epidemiological factor in the spread transboundary diseases. Emphasis should be placed on the importance of doing the "right thing" about sourcing animals from disease-free areas where possible; not buying any sick stock; following rules about quarantine, vaccination, testing or identification of animals; and keeping records. The potential consequences of the occurrence of a disease on national and international trade should be emphasized. Vaccination programmes employing for trans-boundary diseases should base surveillance activities which provide serotypes or subtypes circulating within the country to ensure that the most appropriate vaccine strains can be selected for use in the country. Vaccination should also be timed appropriately, taking into consideration seasonal animal husbandry and livestock movement patterns.

## Ethical Statement

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to and the appropriate ethical review committee approval has been received.

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## Conflict of Interest

None.

## Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Consent for Publication

Not applicable.

## Competing Interests

The authors declare that they have no competing interests.

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