Environmental Evidence

SYSTEMATIC MAP PROTOCOL

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What spatially explicit quantitative evidence exists that shows the effect of land tenure on illegal hunting of endangered terrestrial mammals in sub-Saharan Africa? A systematic map protocol

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Abstract

Background: Over the last two decades there has been an increase in the demand for land in Sub Saharan Africa, particularly from foreign agribusiness investment to provide food for an increasing human population. The majority of land outside of protected areas in sub-Saharan Africa is under customary tenure. Due to poor land administration in the region, communities living in undocumented land areas tend to be at greater risk of eviction from increasing liberalisation of land markets. To prevent local displacement and disturbance to investment caused by land disputes tenure clarification is growing in importance on national and international agendas. Land conversion can fragment wildlife habitat while reducing the suitable range areas of terrestrial mammal populations on the continent. Simultaneously illegal hunting is on the rise for a wide variety of taxa driven by a demand for food and income from the sale of animal products. To enable a better understanding of how land tenure arrangements impact upon spatial variations in illegal hunting, this protocol sets out the parameters for an evidence map which will collate and analyse the spatially explicit quantitative evidence that exists showing the effect of land tenure on illegal hunting of endangered terrestrial mammals in sub-Saharan Africa. Sub-Saharan Africa is the region of focus as it contains the highest number of terrestrial mammals listed as vulnerable, endangered or critically endangered by the International Union for Conservation of Nature. Taking stock of what methods have been used to gather data and where evidence exists can guide future research in this area while informing conservation interventions.

Methods: This evidence map will compare: (1) data availability on the spatial distribution of illicit hunting of endangered terrestrial mammals across different land tenure regimes in sub-Saharan Africa; (2) research methodologies that have primarily been used to collect quantitative data on illegal hunting and comparability of existing data; (3) preferences in the research body toward particular taxa and geographical areas, (4) the evidence map will provide an analysis on the influence other environmental and anthropogenic determinants that influence the spatial distribution of illicit hunting incidences, e.g., proximity to roads, water bodies, range patrol bases etc. Eight academic databases and numerous organisation repositories will be searched for relevant studies by three authors. Double screening will be carried out on all articles to locate studies that meet the specified inclusion criteria, for inclusion studies must contain spatially explicit quantitative data on illegal hunting of endangered terrestrial mammals as defined by the International Union for the Conservation of Nature. Relevant information from studies will be extracted to a custom-made

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extraction form. The resulting map will consist of a narrative synthesis, descriptive statistics and a heat map in the form of a matrix. By providing an overview of the evidence base the resulting map can inform future meta-analyses by showing where there is sufficient comparable data while guiding conservation interventions by indicating geographical areas where species are most at risk.

Keywords: Poaching, Snaring, Bushmeat, Fauna, Wildlife management, Tenure, Property rights, Land ownership, Conservation, Protected area

Background

Demarcation of individual land parcels in sub-Saharan Africa began in the late 1880s during the period of European colonisation [1]. In order to regulate hunting national parks and game management areas were established. Wildlife management areas were created by colonial officers in areas preferential for sport hunting where high concentrations of game could be found [2, 3]. The boundaries of these areas were largely dependent on topographical features such as ridge lines and waterways and the locations of these protected area networks remain largely intact today. The introduction of hunting legislation in the nineteenth century had a significant impact on local communities for whom hunting formed a significant cultural and subsistence activity [4]. Tiered game legislation was enforced via permits that were designed to favour the new settlers while African methods of hunting using pitfalls, snares, traps, nets and drives were regarded as uncivilised and were largely prohibited [5]. The legal distinction between hunting using firearms and traditional hunting methods was introduced in Kenya in 1928 and the use of snares was made illegal in Southern Rhodesia in 1938. Game regulation provided a means of territorial control for the colonial authorities and profit from wildlife products provided economic support to European expansion [6]. The introduction of firearms allowed large numbers of animals to be hunted in shorter time periods and the settlers opened up new markets for wildlife products fuelling demand [7]. Southern Africa witnessed a very dramatic decline in wildlife resources in the space of half a century between 1850 and 1900 [8].

The modern composition of protected areas is largely informed by boundaries defined during the colonial era. In sub-Saharan Africa over 80% of land outside of protected areas is under a customary tenure arrangement [9]. Southern Africa has more land under private and state ownership than in East and West Africa and designated Protected Areas are found on 16% of the continent with the percentage in sub-Saharan Africa ranging from 4.87% in Eritrea to 37.87% in Zambia [10]. In many countries communities can be found living informally within protected area networks. While colonialism radically altered land tenure and wildlife management arrangements, national land acts since independence have further diversified the systems by which land can be occupied and owned. The optimal arrangements for sustainable wildlife management and land governance remains heavily contested and there is a rich body of literature discussing this topic. In particular, the work of Nobel Laureate Elinor Ostrom who demonstrated that widely held assumptions that common pool resource management causes degradation, propagated by Hardin's thesis on the tragedy of the commons, does not hold up to scrutiny [11]. Common pool resource management, as an alternative to private or state ownership, has been advocated as a solution for the sustainable management of wildlife since the 1990s with the hope that it would stem over-exploitation [12, 13]. Southern African has a long record of implementing community-based natural resource management projects (CBNRM) that works from a common pool resource ethic often supported by international development finance [14, 15]. Zimbabwe's Communal Areas Management Programme for Indigenous Resource (CAMPFIRE) was one of the first programmes that implemented community-based management at a national scale, showing varying levels of success [16–21]. Community resource boards were established in Zambia devolving management to the local level [22] and Namibia's community management conservancy model has been developed in over 70 sites across the country [10].

Land tenure

At the same time as support for CBNRM of wildlife resources has grown, increasing liberalisation of global land markets has caused a rise in large scale land acquisition by foreign investors [23–25]. A large proportion of investment comes from foreign agribusiness which has been found to correlate with areas where there is low agricultural productivity; 60% of the world's arable land is found in Africa with the majority of countries meet less than 25% of potential yield, hence these areas are highly attractive to agricultural investors [26]. The neo-classical model of land economics asserts that individualisation of tenure reduces land disputes, and allows transfers to individuals who can extract a higher value from the land thereby increasing production efficiency leading to economic development [27]. Imprecise land

boundaries are not problematic in areas where there is a plentiful supply of land available, however, when demand increases in a neoliberal model of land economics demarcation becomes necessary to regulate prices and allocation. Residents who live in undocumented customary land areas are thus put at higher risk of displacement as investment on the continent increases. When ownership is not statutorily defined, state grants or leases can be made to private investors with little or no consultation of the occupying residents [28, 29]. This issue has received heightened attention on the continent after displacement has occurred due to numerous large scale energy and transportation projects, e.g., the Ethiopia-to-Djibouti Rail Link, Mombasa-Kigali railway, Grand Renaissance Dam in Ethiopia and the East Africa Crude Oil Pipeline.

There are a number of global initiatives that have been developed to secure the rights of unregistered land owners through tenure formalisation programmes [28, 30, 31]. The Global Land Tool Network established in 2006 and overseen by UN Habitat includes over 75 organisations that are working toward stronger tenure security supporting Sustainable Development Goal 1.4.2 'directly tracking progress in strengthening tenure security'. The efficacy of land administration systems is reliant upon accurate and up-to-date maps showing land parcel boundaries; this is complicated in Africa by the fact that large tracts of the continent are very poorly mapped [32]. Much of the information held on land ownership is inaccurate and/or out of date; this is particularly true in urban areas where large informal and undocumented sprawling settlements are growing rapidly.

Effective land administration systems are regarded as an essential prerequisite to minimise investment risk related to land disputes, therefore systematic titling is encouraged by several multilateral development agencies [33]. Green investment has increased over the last two decades in the form of payment for ecosystem service projects and biodiversity offset initiatives [34]. Tenure clarity is required for the success of these initiatives so that financial flows are distributed to correct beneficiaries; Reduction of Emissions from Deforestation and Forest Degradation programmes (REDD+) have focused on tenure clarification as an outcome of programme implementation in many countries [35, 36].

Illegal hunting and wildlife user rights

As conversion of land tenure grows in importance on policy agendas, much of the academic research on this topic has focused on whether formalisation encourages agricultural development [30, 37]. In terms of the impact that changing land ownership mosaics has on wildlife, the academic literature has largely focused on habitat fragmentation caused by agro-investment and expanding transport networks which negatively affect endangered terrestrial mammal populations through reducing suitable range area [38–40]. In addition to habitat fragmentation one of the key threats facing endangered terrestrial mammals is an increase in levels of illegal hunting.

Endangered terrestrial mammals are the focus of this evidence map as this is the taxonomic class which makes up the largest share of aggregated seizures on the World Wise database, which monitors the illegal trafficking of flora and fauna [41]. Sub-Saharan Africa is the geographic region of focus as there are increasing levels of illegal hunting of endangered terrestrial mammals for both trafficking into international markets and as a source of domestic bushmeat [42, 43]. While these two markets have very different cultural and socio-economic drivers, the impact of the kill on population dynamics is the same. The harvest of wild meat for subsistence purposes is permitted in some countries under a quota system and is commonly referred to as 'game meat', whereas illegally harvested wild meat is termed 'bushmeat'. The evidence map this protocol outlines is concerned with the spatial distribution of incidences of illegal hunting and the quantitative methods used to collect data. While mortality levels of endangered terrestrial mammals are impacted by a multitude of factors including zoonotic disease, loss of prey, habitat fragmentation, casualties on transport corridors, war and pollution, etc., the resulting map is only concerned with the threat of illegal hunting.

This topic is suitable for an evidence map as there is a wide diversity of taxa that has been studied over a variety of geographical areas using disparate methodologies. It is not known from existing literature whether there is sufficient comparable data to conduct a full systematic review. By generating an understanding of the quality and quantity of evidence across various species, countries and land management areas research gluts and gaps can be identified for future review while highlighting emergent trends in the evidence base. Illicit activities are by their nature difficult to document. One commonly employed method is interviewing hunters or hunting follows which are used to quantify offtake while providing the location of capture sites. This requires strong rapport to be built so that hunters trust that data will not be used to reprimand them [44, 45]. Another common method is recording carcass locations where the cause of death is identified as hunting and monitoring the location and distribution of cartridges, snares, drives and traps. While interviews and surveys with hunters, households or bushmeat market sellers provide an insight into how much meat is consumed or sold these methods often do not provide accurate data on capture locations unless collected via hunter recall. The number of bushmeat studies has increased over the last two decades, increasing the

quantity of data. However, comparing capture over different spatiotemporal scales remains challenging due to differing research methodologies and a lack of longitudinal studies [42]. One long-term global dataset that exists showing the spatiotemporal distribution of illegal poaching incidences is the monitoring the illegal killing of elephants (MIKE) programme, compiled by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This programme has compiled data on elephant mortality levels since 2001 collected by national wildlife authorities; carcasses found in the designated MIKE sites are recorded with the suspected cause of death. The proportion of illegally killed elephants (PIKE) is then calculated allowing for spatiotemporal comparisons. This globally co-ordinated dataset on the location of poaching incidences is unique and does not exist for any other endangered species at the same scale. While most species listed in the endangered categories by IUCN have the majority of their range in protected areas, this is not the case for all species, e.g., cheetah [46]. The kind of wildlife user rights that exist in different land areas largely depends on how land is owned and managed which varies considerably between countries. Hunting regulations are commonly stipulated in national wildlife and land acts with wildlife considered either 'res nullius' (without ownership), or under the regulation and control of the state, private entity or community [47]. In some countries subsistence hunting is allowed without a permit (e.g., Angola, Malawi and Mozambique) while in other countries acquisition of a permit allows subsistence and trophy hunting in certain areas of land. Illegal hunting occurs due to a number of drivers including local and international demand for animal derived products, e.g. food, medicine, jewellery, clothing. Another key driver of species decline is from retaliatory killing by farmers who have lost livestock from carnivore predation or whose crops have been raided by elephants. The latter driver is a result of increased occupation of land from a rising human population which reduces the space wild mammals have to roam without encroaching on community land. Several studies have found that proximity to human settlements, markets and roads correlate with areas of high offtake as these variables allow hunters to transport illegal harvests speedily to a point of sale [48–50]. What evidence there is to support these claims will be highlighted in the resulting map.

Objective of the review

The objective of the systematic evidence map this protocol outlines is to document what spatially explicit quantitative data exists on incidences of illegal hunting of endangered terrestrial mammals and which land tenure areas have been the focus of such analyses. While qualitative data is important as it can provide nuanced insights into the contextual factors surrounding hunting, the evidence map outlined here will only include studies that have included a quantitative measure on hunting as this facilitates insight into whether the strength of the effect of land tenure could be quantified through a future meta-analysis. If there are enough studies comparing similar variables, findings could be used to construct weights in geospatial models that seek to assess the probability of hunting occurring in certain locations.

The resulting map will be displayed as a matrix showing how studies relate to the different criteria outlined under population, exposure and outcome. There is a huge variety of taxa that is under threat from illegal hunting, this map will show how the distribution of research varies across species, geographical areas and according to different hunting drivers. The main methods employed to collect data will be documented, e.g., observing snaring patterns, hunting follows, bushmeat market surveys while also documenting who has mainly been responsible for collecting data, e.g., communities, law enforcement agencies, academic researchers. The outcome of studies will be synthesised to show any detectable trends in terms of how hunting varies across tenure sites or on a gradient around one site, e.g. from the border of a protected area. An understanding of the spatial distribution of illegal hunting can be used to identify high-risk areas and guide conservation actors on where it would be most beneficial to locate wildlife ranger posts. The map will determine whether the impact of illegal hunting varies across land tenure sites and what evidence is available to support claims that one tenure arrangement, e.g. CBRNM is more effective at sustainable wildlife management compared with others.

Primary question

What spatially explicit quantitative evidence exists that shows the effect of land tenure on illegal hunting of endangered terrestrial mammals in sub-Saharan Africa?

Population

Endangered terrestrial mammals in sub-Saharan Africa categorised as vulnerable, endangered and critically endangered by the International Union for Conservation of Nature and for whom human hunting and trapping is listed as a threat.

Exposure

Tenure arrangements on the land where the above population resides, e.g. protected area, customary land, community conservancy etc.

Comparator

The comparator will be between study sites where the land tenure varies, e.g. protected vs partially protected area (spatial comparator). Studies will also be included if they compare differences in one area where the land tenure arrangement has changed over time, e.g. customary land converted to leasehold (temporal comparator) or when studies have made a comparison of a site in varying proximity to another land tenure area, e.g. customary village land with varying distance to protected area.

Outcome

Frequency and intensity of illegal hunting.

Methods

Searching for articles

The review team validated the search terms across databases by testing alternative search strings. The terms were tested against four known articles, these articles were selected as the benchmark articles as they cover a selection of research approaches that are relevant to this evidence map including monitoring snares, analysis of PIKE distribution data and patrol data on poaching incidences (Additional file 1). The search strings were developed in the Web of Science Core Collection and have only been adjusted slightly to fit the differing Boolean logic across databases. The search strategy was designed with assistance from information specialists at both the Oxford Bodleian Library and at the University of Exeter to ensure that all variations of relevant terms are included and that the Boolean logic applied is consistent across databases.

All results will be exported into EndNote X8, the searches from Web of Science Core Collection and SCOPUS will be used as the reference set for deduplication. The preliminary search terms and results per database are recorded in Additional file 1, there was no issue accessing any of the relevant databases or full texts, access is provided by the University of Oxford Bodleian Library institutional license. Only studies conducted between 1990 and 2018 will be included as this will be commensurate with the data derived from institutional databases, the majority of which do not predate 1990. Due to time and reviewer limitations only studies published in English will be consulted from both the academic databases and organisation websites. The search string will be applied under topic subject covering title, abstract and keywords.

Search string in web of science core collection:

TS = ((mammal* OR fauna OR wildlife OR animal*) AND tenure OR land NEAR/2 (ownership OR right* OR holding* OR title OR administration OR management OR tenan* OR deed* OR pastoral OR private OR commun* OR customary OR state) OR "natural resource" NEAR/2 (ownership OR right* OR management OR regim* OR private OR commun* OR customary OR state) OR "property regime" OR area NEAR/2 (communal OR protected OR communit* OR freehold OR "free leasehold" OR "Wildlife Management") OR ownership NEAR/2 (pastoral OR private OR commun* OR customary OR state) AND (hunt* OR poach* OR bushmeat OR trap* OR snar* OR vulnerabl* OR endangered OR threatened OR risk OR "conservation dependent" OR extinct*)).

The following online databases will be searched:

- Agricola [http://agricola.nal.usda.gov].
- AGRIS [http://agris.fao.org/].
- BIOSIS: Biological Abstracts (Accessed via Web of Science).
- CAB Abstracts (Accessed via Ovid).
- PAIS Index (Accessed via ProQuest).
- SCOPUS (http://www.scopus.com).
- Web of Science: Core Collection.
- Zoological Record (Accessed via Ovid).

The only database selected for inclusion that does not include any of the benchmark articles in its repository is PAIS Index from looking at the results it appears that there is enough relevance to warrant it for inclusion. The following websites and repositories will be searched. Before settling on this list, a preliminary search was conducted across a number of related institutional websites. When no relevant searches were returned which covered the topic of wildlife it was decided that these would not be included. The search terms will be kept as consistent as possible and all searches will be recorded so they can be repeated.

- CIRAD: [https://agritrop.cirad.fr].
- Coalition of European Lobbies for East African Pastoralism (http://www.celep.info).
- Columbia International Affairs Online (https://www.ciaonet.org).
- Consultative Group for International Agricultural Research (CGIAR):
  - Centre for International Forestry Research (https://www.cifor.org/library/) & Bushmeat Research map (https://www.cifor.org/bushmeat/resources/bushmeat-data-map/).
  - International Crops Research Institute for the Semi-Arid Tropics [http://oar.icrisat.org/].
  - International Livestock Research Institute and The International Food Policy Research Institute [http://data.ilri.org/portal/organization].
- Digital Library of the Commons [https://dlc.dlib.indiana.edu].

- FAO Library Catalogue [http://unfao.koha-ptfs.eu/].
- Institute of Development Studies (https://www.eldis.org).
- OECD iLibrary (https://www.oecd-ilibrary.org/).
- Open DOAR: Directory of Open Access Repositories (http://www.opendoar.org/).
- PLAAS: Institute for Poverty, Land and Agrarian Studies (http://www.plaas.org.za).

Article screening and study eligibility criteria

Screening process

The inclusion criteria will be applied during title and abstract screening, when there is an ambiguous title and/or an uninformative abstract the study will be earmarked for full text screening. Articles will undergo double screening, split between three reviewers. Once 20% of the studies have been screened for each database the two corresponding reviewers will meet to check consistency in applying the inclusion criteria, discrepancies and differences will be discussed and if necessary elements of the inclusion criteria will be revised to ensure better coherence. Articles set aside for inclusion after abstract screening will be doubles screened at the level of full text.

Eligibility criteria

Eligible population

Endangered terrestrial mammals that are listed as vulnerable, endangered or critically endangered on the IUCN Redlist and whose geographical range falls in sub-Saharan Africa as defined by the United Nations which includes all African countries that are fully or partially located south of the Sahara of which there are 46 (Additional file 2). The list of included species is further restricted to those for whom the IUCN threat assessment has included hunting and trapping of which there are 172 species (listed in Additional file 2). Many studies include multi-predator and prey species, studies including at least one of the listed species will be included.

Eligible exposure

Tenure arrangements on the land where the above population resides, e.g. protected area, customary land, community conservancy, etc.

Eligible comparator(s)

The comparator will be between study sites where the land tenure varies, e.g., protected vs partially protected area (spatial comparator). Studies will also be screened for inclusion if they have a comparison in one area where the land tenure arrangement has changed over time, e.g., community land area that receives statutory recognition (temporal comparator) or when studies have made a comparison of a site in varying proximity to another land tenure area, e.g., hunting incidences in a customary land area at varying proximity to a protected area.

Eligible outcomes

Relevant outcome measures to assess the level of illegal hunting include geo-located data on the location of hunting collected via hunting follows, interviews and/or surveys with hunters, records of carcass locations or signs of hunting, e.g. shrapnel or used snares and hunter arrest records. Outcomes will also include variation in the consumption of illegal species collected through dietary recall where there is data on the location where meat was harvested. Evidence from markets surveys will also be included as an outcome measure if the source location of illegal species is included. In addition to hunting frequency and intensity other elements will be recorded in the extraction sheet (Additional file 3) including:

1. The land tenure site(s) where the kill was recorded and the locality, region and country where the study was located, the total area surveyed and the length of data collection.
2. Taxa included in the study and the category of endangerment, i.e. vulnerable, endangered or critically endangered, plus the hunting driver, e.g. subsistence hunting, retaliatory killing.
3. The method used for data collection, who collected the data and what precisely is measured, e.g., numbers of snares found during line transect survey.
4. Confounding variables that are mentioned will be recorded and any stated hypotheses that are tested.

Eligible types of study design

A broad range of study designs will be included in the map as part of the purpose is to document the main methodologies that have been used to collect data. The focus is only on incidences of mortality caused by illegal human hunting and not from zoonotic disease or other anthropogenic causes. The study must include the geographical location of the kill site(s).

Exclusion criteria

Studies that are purely demographic and have collected data on species abundance and distribution and only mention illegal hunting as a threat without collecting data on occurrence will be excluded. Similarly studies that have only collected data on species behavior in response to perceived threats, e.g., flight initiation distance will be excluded. Studies that infer the level of illegal hunting by providing proxies, e.g., bushmeat price as

an indicator of supply will not be included. The location of the kill sites must be included as primary data and not referenced from other studies. The focus is on unregulated illegal hunting hence studies on trophy hunts are excluded as this is a regulated form of hunting where the government sets quotas taking into account local population dynamics, if species are hunted in trophy hunting concession off quota, i.e. illegally these will be included. All articles that are excluded at full text will be recorded with a description of the focus of the article and the reason for exclusion.

We will exclude the following kinds of articles:

- Theoretical or modeling studies, purely qualitative research that does not include any quantitative data.
- Editorials and commentaries.
- Social commentaries that do not include any quantitative data.
- Literature reviews.
- Studies that are part of projects that have not been completed.

Data coding strategy

We will use a bespoke, standard data extraction form to extract descriptive data from all studies meeting our inclusion criteria (Additional file 3). Data extracted will include bibliographic details, information on the study context including: type of land tenure site included in study, country(s), region and/or district, size of study area surveyed and a list of the species included in the study that are in the relevant population criteria outlined above. Information on study design will be collected including data collection method, unit of analysis used, e.g., village or market and the size of the area surveyed. Who funded and conducted the study will be recorded and whether the organisation(s) is sub-national, national or international. Whether any of the authors are registered at an organisation in the country of data collection will be recorded. As an evidence map the comprehensiveness of the data coding strategy is vital, all data that will be extracted can be found in the data extraction form (Additional file 3). When designing the data extraction form a subset of 20 studies were screened to ensure clarity and ease of use. To ensure the data extraction form is used consistently between reviewers a subset of 20% of articles that are included after full text screening will be double coded to check the same data is being extracted, any discrepancies will be discussed and the extraction form will be altered accordingly. At both the level of abstract and title screening and full text a kappa statistic will be generated. To be included in the evidence map only studies that meet the criteria outlined above will be included. All articles screened at full text that are excluded will be recorded with the reason as to why they are excluded.

Study mapping and presentation

The output will be a systematic map published in this journal with the data presented as descriptive statistics and through a matrix to show corresponding findings between the different elements of the inclusion criteria. Findings on the frequency and intensity of hunting across different land tenure areas will be analysed with a detailed description of how this evidence varies across taxa and regions. The impact of hunting incidences in relation to other variables including proximity to roads, water bodies and urban settlements will be recorded to tentatively show whether any trends emerge across studies. We will provide a narrative synthesis discussing the range of methods used to collect data on illegal hunting and any methodological challenges in harmonising findings. The authors of this protocol have not authored any articles that are eligible to be included in the review.

Additional files

Additional file 1. List of benchmark articles, databases and search strings.

Additional file 2. Inclusion criteria.

Additional file 3. Extraction form.

Authors' contributions

ID conceived the study, wrote the manuscript and developed the parameters of the search strategy and inclusion/exclusion criteria with input from TH and RG. ID, TH and MB implemented the scoping of the search strategy with assistance from Oliver Bridle and Alison Bethel. All authors read and approved the final manuscript.

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Competing interests

The authors declare they have no competing interests.

Availability of data and materials

Availability of data and materials needed in this study has been checked and acquired.

Consent for publication
Not applicable.

Ethics approval and consent to participate
Not applicable.

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