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Situational analysis of Laboratory Animal Sciences (LAS) status in Gulf Cooperation Council (GCC).

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ABSTRACT

Laboratory Animal Sciences play a pivotal role in scientific research, significantly contributing to various fields such as medicine, biology, and toxicology. This discipline is crucial in advancing scientific knowledge, improving healthcare outcomes, and ensuring animals' ethical and responsible use in research. Animal health is paramount in this field, yet it is sometimes neglected during experimentation. To address this concern, many countries have developed their regulations for animal welfare. Moreover, globally, the WOAH (World Organisation for Animal Health) has introduced guidelines and regulations mandating research organizations to prioritize animal health. An international organization is ICLAS (International Council for Laboratory Animal Science) which is dedicated to advancing laboratory animal science worldwide, promoting the ethical use of animals in scientific research, and ensuring their welfare. In conjunction with ICLAS, several other organizations share responsibilities for promoting good animal practices globally.

This paper provides a comprehensive overview of the Laboratory Animal Sciences within the GCC countries. A brief infrastructure detail that supports animal welfare and the significance of these facilities in facilitating cutting-edge research is explored, alongside an analysis of the accreditation and management protocols crucial for their effective operation. Additionally, the paper scrutinizes the current laws and regulations governing laboratory animal welfare and experimentation in the GCC region. As a forward-looking contribution, the paper outlines prospective developments and expansion opportunities for laboratory animal sciences in the GCC, aiming to propel scientific advancements in the region. This research provides a valuable resource for scientists, policymakers, and stakeholders invested in promoting ethical and effective laboratory animal research practices in the Gulf region.

Keywords: Gulf Cooperation Council, Laboratory Animal Sciences, Animal Welfare.

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INTRODUCTION

Animal models have been used to address a variety of scientific questions. They are used in the development and assessment of vaccines and therapeutic drugs. Many disease mechanisms are 90% similar to animals and humans. For instance, conditions such as diabetes, cancer, allergies, myopathies, epilepsy, and so on. Most vaccines that save millions of human and animal lives have been possible because of testing on animal models. Many surgical techniques have been developed using animal models before their application to humans and thus have led to many advancements in surgery. Nowadays cellular therapies involving tissue regeneration are being constructed and engineered by testing on animals (Barré-Sinoussi & Montagutelli, 2015). The use of animal models in scientific experimentation dates to 500 BC in Greece (Miziara et al., 2012). For centuries, animal experimentation has been the standard practice for learning medicine and biology, and it has proven to yield outstanding results in research. A few examples from the Middle Eastern region, such as the Arab surgeon Abu Marwan Abd al-Malik ibn Zuhr who practiced dissection and introduced animal testing as an experimental method for evaluating surgical treatments before applying them to human patients in the 12th century, are worth mentioning (Aciduman & Aşkit, 2022). Ibn al-Nafis gave precise accounts of description of animal blood circulation in 1242; which were later expanded upon by William Harvey (Akmal et al., 2010).

Having seen such great contributions regarding animal-related scientific discoveries in the past, the purpose of this article is to provide information on Laboratory Animal Science in the Gulf Cooperation Council area. The GCC (Gulf Cooperation Council) region comprises six countries - Bahrain, Saudi Arabia, Qatar, United Arab Emirates, Oman, and Kuwait (Shehnaz & Agarwal, 2014). The word "Laboratory Animal Science" is scantily used in these regions along with the lack of specific national legislation that addresses the welfare of Laboratory animals (Mohr et al., 2017). The general approach towards researching animals and their utilization is slowly gaining traction in this part of the world. But the big question is - Does Lab animal science exist in the GCC regions? The answer is Yes. In this part of the world Lab animal science exists as a practice mildly integrated into education and bio-medical research. This article may not be a comprehensive review since the information is difficult to source, but we tried to incorporate every important aspect related to laboratory animal sciences in the region which may serve as a guide for future progress in addressing challenges.

Figure 1- Countries covered in the Global Cooperation Council region

Laboratory Animal Facilities and Research Capabilities in the GCC Region

Laboratory Animal Sciences (LAS) constitute a vital component of scientific research, serving as indispensable tools in advancing knowledge across diverse disciplines such as medicine, biology, and toxicology. Despite their crucial role, the welfare of animals involved in research endeavors sometimes receives inadequate attention, raising ethical concerns within the scientific community.

There is a lack of supporting data in the GCC region, but we have tried to access the websites of respective institutes to gather the information (Table 1). To address these concerns, various countries have developed regulations and guidelines aimed at safeguarding animal welfare during experimentation. Furthermore, international bodies like the WOAH and the ICLAS advocate for ethical practices and welfare standards on a global scale.

Regional Infrastructure and Variety

Lab animal science in the GCC region has benefited from various functional infrastructures available in these regions. One such main infrastructure is the presence of vivarium facilities also called Animal House facilities. Other supportive infrastructures that facilitate lab animal science include Research centers, Institutes, Resource centers, Universities, and Departmental units. There are some examples of the facilities in the GCC region- the Kingdom of Saudi Arabia (KSA) has major Animal House Units harbored in its region within the campuses of King Abdulaziz University (KAU-Animal house), Taif University (TU-Animal house unit), King Saud University (KSU-Animal house unit), King Abdullah University of

Science and Technology (KAU-core labs), King Faisal Specialist Hospital and Research Centre (KFSHRC-AAALAC accreditation) and Imam Abdulrahman bin Faisal University (IAFU-Animal care).

In the kingdom of Qatar, Qatar University's prestigious laboratory – LARC (Laboratory Animal Research Centre) is an unconventional animal facility and holds membership in the American Association for Laboratory Science (AALAS) and the ICLAS (ICLAS-Animal Research center). Additionally, the Vivarium core facility at Weill Cornell Medicine -Qatar is AAALAC International accredited, following OIE standards (QU-Research centers).

In the United Arab Emirates, the United Arab Emirates University has its own Animal House (UAE-Animal Facility). The Animal Facility is one of the core facilities at the Research Institute of Medical and Health Sciences (RIMHS) at the University of Sharjah (US-Animal facility). A special mention of the Central Veterinary Research Institute is a government diagnostic Center accredited by the OIE (International Office of Epizooties), the World Organization for Animal Health in the UAE (CVRL).

The Department of Animal and Veterinary Sciences at Sultan Qaboos University in the Kingdom of Oman is also an extensive organization that accommodates an extensive animal house within its campus (SQU-Agricultural and Marine Sciences). The ARC – Animal Resources Centre at Kuwait University manages the usage and maintenance of lab animals in the HSC- Health Science Centre (KU-Animal Resources house). Another institute that supports the Lab Animal House unit is the Arabian Gulf University which is the only one of its kind in the Kingdom of Bahrain (AGU-Animal House unit).

University	Animal species details	Infrastructure details	Training	AAALAC accredited
Qatar University	-	Yes	Yes	Yes
Kuwait University	Yes	-	-	-
UAE University	-	Yes	-	-
King Saud University	Yes	Yes	Yes	-
King Abdullah University	-	-	Yes	Yes
King Abdulaziz University	Yes	Yes	-	-
Arabian Gulf University	-	-	Yes	-
King Faisal	-	-	-	Yes
University of Sharjah	-	Yes	-	Yes
Sultan Qaboos	Yes	-	-	-

Table 1- Availability of vivarium data on webpages

Strain pool

Strain information across the facilities in the region is not uniformly dispersed. Information is available through communication, official requests, and web-linked sources. Some valuable examples of available strain information include: At the Arabian Gulf University in the Kingdom of Bahrain, the available strains include mice such as the C57BL/6, BALB/c, and PWK, rats such as the White Fischer, and rabbits such as the Californian and New Zealand. Additionally, other strains such as transgenic knockout, SCID, and nude are also maintained (AGU-Animal House Unit). The Animal Resource Center at Kuwait University houses a range of rat strains including Wistar Kyoto, Sprague Dawley, Zucker, Dwarf, Hooded, and Spontaneous Hypertensive Stroke-Prone. Mice strains available at this facility include Balb/c, DB/DB, C57BL/6-NTAC, Non-diabetic, and Alzheimer's 5XFAD. Additionally, the Dunkin-Hartley guinea pig and the White New Zealand rabbit are also housed here (KU-Animal Resources House). King Abdul-Aziz University in the Kingdom of Saudi Arabia provides various pure strains of experimental animals including mice, rats, hyrax, hamsters, rabbits, sheep, monkeys, and dogs (KAU-Animal House).

Given the dispersed nature of this information, it is suggested to establish a unified database that consolidates information on animal strains, animal vendors, and sourcing, as well as transportation used for research purposes across the GCC region in the future.

Collaboration and Research Output

In a comparative analysis study published by Al-Marzouqi & Arabi, it was observed that most GCC universities have established international collaborations to promote a research culture (Al-Marzouqi & Arabi, 2022). Over the last 10 years (2011–2020), international collaborations have increased for all GCC countries, with Qatar leading the way. Oman and the UAE showed consistent growth

in international collaborations, whereas Saudi Arabia, the UAE, and Oman had slightly lower levels of collaboration. Bahrain and Kuwait have had lower and more limited collaboration compared to the rest of the countries.

The study by Al-Marzouqi & Arabi also examined research output in areas such as veterinary, pharmacology, toxicology, immunology, microbiology, medicine, neuroscience, and other health and biological sciences. These disciplines often require experimental animals at various stages. The research output in these areas was found to be quite low compared to other disciplines, with only Qatar showing exceptionally higher research output than other GCC counterparts. Saudi Arabia was found to have the highest overall research contributions, while Bahrain had the lowest in all subject areas. Despite the noted international collaborations, it remains unclear how much collaboration exists among GCC countries specifically concerning experimental animal units. The study suggests that enhancing research collaborations within the region could significantly improve research productivity, efficiency, and quality. This collaborative approach could help close gaps among the scientific communities within the region, particularly in Lab Animal Science.

Furthermore, fostering open communications about animal experimentation among non-scientific communities could help eliminate false mindsets and ideas. Incorporating Lab Animal Science as a topic or subject in higher education curricula could promote broad-mindedness and increased awareness about the subject. This would encourage open discussions on good science and good practices of animal care among the student population, addressing the urban and scientific disconnection about lab animal science. It would also help reduce exaggerated activism and extremism on animal experimentation through transparent scientific explanation and intervention.

Significance of the Vivarium Bench Towards Biomedical Research

The GCC region contains a total of thirteen Animal House facilities (Vivarium) which follow both unconventional and conventional facility designs. Most of the vivarium houses a variety of research animals such as mice, rats, hamsters, and rabbits (KAU-Animal house) (IAFU-Animal care) (QU-Research centers). Some have species of frogs, guinea pigs, and hyrax, and some even host larger research animals such as sheep, monkeys, dogs, camels, horses, and cattle. Chicken chicks, reptiles, and various insects are also managed by specific universities (SQU-Agricultural and Marine Sciences. Some facilities also maintain transgenic knockout, nude, scid mice varieties (QU-Research centers) (AGU-CMMS Animal facility) as well as avians and fishes (SQU-Agricultural and Marine Sciences. The primary objective of these Animal Units is to breed, raise, and maintain different research animals to provide researchers to carry out experiments, and research projects to support biomedical research, training, and teaching.

These vivarium's host and support studies in the following areas: Research on cancer, immunology and transplantation biology, neurology, gene therapy, infectious illnesses, inflammation, metabolic disorders, toxicology, drug metabolism studies, Nanomedicine and Health care Biotechnology. They also offer a wide range of imaging-based experimental approaches suitable for small animals, supporting preclinical research applications for long-term studies. Furthermore, these facilities are increasingly exploring areas like endoscopic, thoracic, and orthopaedic surgery (Festing & Wilkinson, 2007). They serve as a robust in-vivo research platform, fostering Internal research programs in national priority areas, such as cardiovascular disease, cancer, obesity, diabetes, microbiome research, and Environmental toxicology.

Accreditation and Management

Lab Animal Science imparts the knowledge of a controlled scientific experiment versus an uncontrolled vivarium experiment, where several variables such as housing, husbandry factors, noise, and environment can alter the quality of life of the test animal, which in turn would give rise to varied data. Successively, this can avoid questionable research practices and opens the gateway to non-clinical trials.

A non-clinical or preclinical trial is conducted before human trials. These studies involve specific tests to study aspects of a compound, enabling the determination of an initial safe dose for testing on humans to get the desired outcome without toxicities. "Lab animal trials" are the essential means to characterize, identify, and predict the biological outcome and effects (Mukherjee et al., 2022). Studies done on relevant animal models will also help determine intervention effects. Realization of these tests must be done in Vivarium Laboratories that are complying with global set standards to ensure the reliability and reproducibility of data which leads to highlighting the importance of Accreditation. Although not all, the presence of a few accredited Vivarium facilities is a ray of Hope in the region. Accreditation of Animal Houses and Animal Laboratories by OIE and AAALAC standards; OECD (Organization for Economic Cooperation and Development) and GLP (Good Laboratory Practices) is of crucial importance in the region (Newcomer & Cloutier, 2017).

The Monitoring of the use of research animals in experimentation is overseen by each institution's Animal Care and Ethics Committee. This is an internal committee comprising of scientific, health, research, and administrative professionals. The committee plays a major role in monitoring the Research plan, scientific justification of appro-

priate Animal model selection, determining the number of animals for experimentation, and adhering to the 3R principle - Replacement, Reduction, and Refinement (Kiani et al., 2022). They also oversee precautionary and biosecurity measures, biomaterials, and tools used. They are also responsible for attaining Accreditations, Licenses, and Veterinarian supervision from competent authorities for the vivarium.

The Management of the vivarium involves the General Management; Institute Animal Care and Use Committee and scientific management which includes attending veterinarians, Lab Animal science coordinators, Facility managers, Animal Technicians or Para vet staff, Animal care Aides, or support staff. The role of an attending veterinarian is of prime importance to any facility which houses research animals. The Veterinarian should be certified by either of the following authority boards such as ICLAM, ACLAM, or ECLAM alongside their Doctoral degree. The Veterinarian's responsibility is designated either as Full-time, part-time, or Adjunct /Ad hoc capacities (National Research Council, 1996). Another Crucial factor in Vivarium Management is the Implementation of regulations, falling under the Cooperation Council for Arab States' member states which possess a framework called the Unified Animal Welfare Act.

Laws and Regulations

To protect animal welfare and for the good conduct of animal experimentation, the regulatory bodies have devised certain regulations. The regulations are unified for the Animal Welfare Act for the Arab states of the Gulf Cooperation Council. The system of animal welfare comprises 9 chapters and 17 articles (MoEWA-Saudi animal welfare law).

Articles 2, 4, 5 and 6 have effective voices regarding animal rights encompassing the right to food, shelter, and the avoidance of pain and suffering. It also embodies the five freedoms outlined in the Brambell report, where the Article emphasizes the provision of living hygienic conditions, favourable space, and the climate of animal shelters and animal houses according to the size, gender, age, and needs of the species. The regulations mandate sufficient ad libitum feeding according to the species' need and age, alongside directives on health monitoring of the animals. They also underscore the importance of professional competence skills among animal husbandry staff in handling animals requiring the presence of a permanent veterinarian as compulsory for health stats checks. Article 3 grants authorized personnel the right to access animal facilities for examination, testing, and sample collection.

Articles 7, 8, and 9 enforce strict regulations on trafficking, competitions, exhibitions, and neglect of any animal, imposing fines and payments on any violations of the Animal Welfare Act practices. Articles 11 to 16 focus on implementing regulations, and compliance with practical procedure standards. Article 10 allows the use of animals in scientific experiments with licensing from competent authorities. Furthermore, Article 13 (Chapter 7), outlines the licensing requirements for conducting the scientific experiments from the competent authority. It elaborates that the scientific experiment must contain a research plan, scientific justification for the animals subjected to the experiment, precautionary and biosecurity measures, and veterinary supervision for imported animals. The law incorporates the 3 R principle- Reduce, Refine, Replace- advocating for minimizing the use of animals in research, improving techniques employed in research as few as possible, and encouraging substitutes of animals as feasible. The Article informs the disposal of carcasses of dead animals and their wastes following environmental laws and hygiene. It cautions employees and institutions in complying, implementing, and informing of policies. According to Article 6 of this implementing regulation, research institutions that use animals in scientific experiments are required to establish an internal committee to oversee the use of these animals and ensure that they receive health and medical care from veterinarian specialists and other staff members who possess the same qualifications

Regional commission

The OIE Regional Commission for the Middle East is one of the five commissions of the World Organization for Animal Health decided and created based on the OIE Organic Rules decided by The international committee on 24 May 1973. Countries like Bahrain, Kuwait, Qatar, and Saudi Arabia, Oman, and UAE are eminent members of the WOAH. The delegates are duty bound in bringing WOAH standards and guidelines to the attention of Their governments and all related public and private stakeholders. All WOAH activities in the Countries are channelled or implemented through the consent information of the national delegate.

Article 16 of the section of internal rules - of the resolution no xviii terms of reference of the Regional commissions of the World Organization for Animal Health (OIE) in Paris in May 2006 has articulated that the representatives of national, regional, or international organizations and Members of OIE Collaborating Centers and Reference Laboratories, designated by the Director General, may participate in the Conferences of the Regional Commissions, and speak on topics Within their field of competence. These representatives do not have the right to vote. Although it is unknown in the region if Laboratory

Animal facilities/centers in the region have a Participatory role OR if Lab Animal Science Field experts have a platform to communicate Issues, advances, and innovations in the field of Lab Animal Science and on animals used in research.

Compliance with the Regional Public Health laws and International guidelines

Environment Protection, Health and Hygiene, Animal waste disposal, Quarantine, Vermin

Control is mandatory. Vivarium in the regions are obliged to follow regulations defined by their Kingdom's Regional Ministry of Public Health laws and requirements. However, every Institutional committee lays policies following regulations stated by AAALAC International; ARENA (American Research Ethics National Association.); NACLAR (National Advisory Committee for Laboratory Animal Research, Singapore); OLAW (Office of Laboratory Animal Welfare); FELASA (Federation of European Laboratory Animal Science Association); AVME (American Veterinary Medical Panel on Euthanasia); Guide for the Care and Use of Laboratory Animals, 8th edition National Research Council (US) Committee for the Update of the Guide for the Care and Use of Laboratory Animals; PHS - the Public Health Service Policy on Humane Care and Use of Laboratory Animals (Policy).

Futuristic scope in the GCC region

Lab animal science in the GCC region has the potential to further expand its scope in a polymorphic manner. One avenue for growth is through a strong emphasis on training and education. Several internationally certified training courses and workshops can be hosted in the region to facilitate the exchange of skill sets, knowledge, scientific insights, and current developments and practices in the field. Currently, it is known that most institutions in the regions conduct their institutional training for students and researchers which focuses on basic animal handling skills, 3R (Replace, Reduce, Refine), Animal husbandry practices, animal anatomy, etc some training courses are tailored to the institutional research needs.

Furthermore, Expos and Exhibitions can be organized and displayed to raise awareness about the latest animal house equipment, diets, bedding, cages, enrichment devices, changing stations, IVC rack systems, in vivo imaging equipment, and more. This not only highlights the availability of equipment but also provides information on logistics and pricing. This knowledge also brings to light various kinds of instrumentation available for research purposes and Animal care.

Research collaborations can be the next big thing in the region, opening doors for sharing of research expertise, and increased research productivity, efficiency, and quality. This collaborative approach would eventually close gaps among the scientific communities within the region, particularly in Lab Animal Science. This would also lead to open communications about experimenting using animals among non-scientific communities thereby eliminating false mindsets and ideas. Incorporating Lab Animal Science as a topic or subject in higher education school and college curricula promotes broad-mindedness and increased awareness about the subject. It encourages open discussions on good science and good practices of animal care among the student population. This approach would help in addressing the urban and scientific disconnection about lab animal science and would also bring down exaggerated activism and extremism on animal experimentation with transparent scientific explanation and intervention.

Participating in and hosting Lab Animal Science conferences would serve to be a dynamic platform to bring together animal scientists, veterinarians, animal welfare scientists, entrepreneurs, researchers, animal lab technicians, animal specialists, and medical doctors. This allows for meaningful discussions on various issues, concerns, advancements, and implementation of regulations in the field.

Funding stability in the region for Lab Animal Science

Another important aspect is the funding stability for lab animal science in the region. To maintain the resources and supporting infrastructures, a long-term sustain-able intramural and extramural framework of funding is required. This will enable the application of effective multidisciplinary approaches for the handling and management of different kinds of animal resources. Besides, it would eventually help in adapting to the changing regulations in cost for the standard of upkeep, welfare, and health of the animal resources. Inevitably, the goal of lab animal science is to facilitate research, increase scientific productivity, and avoid misconceptions that Lab animal science is of little value.

CONCLUSIONS

The Gulf Cooperation Council (GCC) region hosts a robust and diverse array of research institutions dedicated to laboratory animal sciences, which play a pivotal role in advancing biomedical research. Despite this strong foundation, there are notable gaps in publicly available information regarding specific infrastructure, the species of animals held, and training details within many universities and research institutes. This lack of transparency makes it

challenging to form a comprehensive understanding of the status and capabilities of animal research facilities in the region.

A key observation is the presence of only four AAALAC-accredited institutions within the GCC, highlighting significant room for improvement in attaining international standards of animal care and research. The existing facilities, such as those at Qatar University and Weill Cornell Medicine-Qatar, set a benchmark for others to follow in achieving and maintaining high standards of accreditation and ethical practices. The region has established well-structured Institutional Review Boards (IRBs) to oversee and ensure adherence to laws and regulations governing animal research. These IRBs are integral in maintaining ethical standards and ensuring the welfare of laboratory animals, reflecting a commitment to responsible research practices. One area identified for enhancement is the regular conduct of international-level training in laboratory animal science. Such initiatives would facilitate the exchange of innovative ideas, foster collaboration, and promote the adoption of best practices across institutions.

In summary, the GCC region demonstrates a commendable commitment to advancing laboratory animal sciences through its diverse research infrastructure and adherence to regulatory frameworks. However, increased transparency, accreditation, and enhanced training oppor-tunities are essential to further elevate the standards and efficacy of animal research in the region. This paper aims to serve as a valuable resource for scientists, policymak-ers, and stakeholders, guiding future developments and promoting ethical and effective laboratory animal research practices in the GCC countries.

List of Abbreviations

WOAH/OIE - World Organization for Animal Health
GCC- Gulf Cooperation Council
AAALAC- AAALAC International
OECD- Organization for Economic Cooperation and Development
HSC- Health Science Centre
LARC- Laboratory Animal Research Centre
KSA- Kingdom of Saudi Arabia
RIMHS- Research Institute of Medical and Health Sciences
AALAS- American Association for Laboratory Science
ICLAS- International Council for Laboratory Animal Science
UAE- United Arab Emirates
ARC- Animal Resources Centre
ICLAM- Indian College of Laboratory Animal Medicine
ACLAM- American College of Laboratory Animal Medicine
ECLAM- European College of Laboratory Animal Medicine
GLP- Good Laboratory Practices
IVC- Individually Ventilated Cage

Availability of data and material

The data can be accessed from the website of the particular institution.

Competing interests

There were no conflicts of interest among the authors

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Author's contributions

Nanitha Rachel wrote the initial draft, Bilal Ur Rehman did the writing review of the article, and Vijay Pal Singh laid down the basic idea of the review article.

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