



Original scientific article

An overview of the welfare of animals used for scientific and educational purposes in Algeria

By Abdelouafi Benmouloud^{1,2,3*}, Salima Charallah^{2,3}, Nabila Seridi², Rachida Raache^{2,4}, Souhila Aouichat², Adel Ghoul², Safia Tennah⁵, Mohamed H. Benaissa⁶, Mourad Laouadi⁷, Borhane H. Fellah⁸, Farida Khammar^{2,3}

¹University of M'hamed Bougara Boumerdes (UMBB), Faculty of Sciences, Department of Biology, Boumerdes, Algeria

²University of Sciences and Technology Houari Boumediene (USTHB), Faculty of Biological Sciences, El Alia, Algiers, Algeria

³University of Algiers 1 Benyoucef Benkhedda, Algiers, Algeria

⁴Department of Immunology, Pasteur Institute of Algeria, Algiers, Algeria

⁵National Superior Veterinary School of Algiers, Algiers, Algeria

⁶Scientific and Technical Research Centre for Arid Areas (CRSTRA), Biophysical Station, Nezla, Touggourt, Algeria

⁷University Amar TELIDJI, Department of Agricultural Sciences, Laghouat, Algeria

⁸Research Center, MSD Laboratories, France

*Correspondence: Abdelouafi Benmouloud, email: a.benmouloud@univ-boumerdes.dz

Summary

This study describes the welfare and animals used for scientific and educational purposes in the field of laboratory animal sciences in Algeria. The aim of this study is to provide an overview of the status of the care and use of animals and to improve implementing plans and animal welfare measures. A literature review was performed using online databases and reference lists of the US National Library of Medicine to assess the prevalence of animal use for research in Algeria between 2013 and 2017. Also a retrospective study was conducted using the Pasteur Institute of Algeria report for 2015 to assess the prevalence of animal use in both teaching and research. The first workshop on animal experimentation was organized in 2013 in collaboration with international animal laboratory organizations (ICLAS and OIE) and involving the participation of universities, research centers, veterinary schools and the Pasteur Institute of Algeria. In addition, after accreditation of the Algerian Association of Experimental Animal Sciences, a number of training workshops and courses relating to laboratory animal sciences were organized. In Algeria the use of laboratory animals in research and education is a subject of debate regarding the need to establish regulations and to propose an appropriate ethical framework for the use of animals. Finally, some actions have been already taken in Algeria to promote the ethical use of animals but many more sustainable actions are needed and require cooperation, harmonization of policies and establishment of regional and international networks for experience exchange.

Introduction

Algeria is the largest country by area in Africa with more than 41 million people (July 2018). The climate is arid to semi-arid: mild, wet winters with hot, dry summers along the coast; drier with cold winters and hot summers on the high plateau. The literacy rate of the population for those aged 15 and above is 80%. While Arabic is the official language, students are

required to learn a second language, predominantly French or English (CIA 2019).

As in many countries, animal use has played a vital role in science and research in Algeria. Animals have been used for scientific purposes such as biomedical research, animal production research, technical and scientific training and biological produc-

tion. Most scientists and researchers who use animals are in academic institutions and government organizations. The use of animals for scientific purposes in Algeria has increased and requires the establishment of standards, policies, regulations and the implementation of various programs, *i.e.* appropriate education and training of researchers, veterinarians, laboratory animal technicians and animal care staff, as well as the establishment of animal ethics committees.

The Algerian University network has 106 institutions of higher education located in 48 prefectures, covering the entire national territory. This network is made up of 50 universities, 13 university centers, 20 national higher schools, 10 superior schools, 11 normal higher schools and 2 annexes (JORA 2003).

To set the direction of Algeria's Research and Development framework, the Directorate General for Scientific Research and Technological Development (DGRSDT) was created under the authority of the Minister of Scientific Research and the national policy of scientific research and technological development by law n° 98-11 of 22 August 1998. This Directorate is responsible for implementing all provisions of the law regarding programming, evaluation, institutional organization, human resource development, university research, technology development and engineering, scientific and technical information, scientific cooperation and evaluation of research results.

In 2002 the Arab League Educational, Cultural and Scientific Organization (ALESCO) established an advisory committee entitled "Arab committee for ethics of science and technology (Beloucif and Benammar 2016); this was followed by the Arab Charter of Ethics of Science and Technology prepared by the UNESCO Regional Bureau for Science in the Arab States (Tunis, July 2018, see ACEST 2018). According to the recommendation of ALESCO, and under the authority of the Ministry of higher education, the Algerian council on ethics and university deontology was formed at the end of 2005. Accordingly in Algeria, bioethics became a mandatory matter for students in biological schools and there are courses at Master's level.

This study provides an overview of the status of the care and use of animals for scientific and educational purposes in Algeria, including details of the use of animals in Algeria between 2013 and 2017 for laboratory studies and experiments. We present some of the most notable and readily identifiable examples of strengths and weaknesses of laboratory animal use in our country to serve as a baseline and

guide for future programs and to help plan work on animal ethics regulations.

Materials and Methods

A meta-analysis search was performed using PubMed (MEDLINE 2017), an electronic database of the US National Library of Medicine's MEDLINE* to assess the prevalence of animal use in research by Algerian institutions between 1st January 2013 and 1st September 2017. A second source for our analysis was the Pasteur Institute of Algeria (PIA) which is the official and major source of laboratory animals for all institutions in Algeria. A retrospective study was conducted using the PIA annual report for 2015 to assess the prevalence of animal use in both education activities and research by different Algerian institutions (PIA report 2015).

Results

Prevalence of animal species used in education and research in Algeria

In 2015, the PIA report indicates that 27% of the Algerian institutions used animals in research and/or education. The animals used were mostly mammals. According to the annual report, we estimated that an annual total of 37 958 animals was used. The frequency of species used was 84%, 15%, 0.7%, 0.2% and 0.1%, respectively, for mice, rats, rabbits, ovines and horses (Figure 1).

Prevalence of laboratory animal use for different purposes in Algeria

The prevalence of laboratory animal use for different purposes in Algeria (PIA report 2015) is presented in Figure 2. The percentage of animals used in teaching activities was 41%. Most of the animals used were small rodents (mice and rats). Only a small percentage of animals were used for fundamental biological research (5.0%) and breeding purposes. Animals were also used for quality control (34%) and screening for drugs, in bioassays and for preclinical testing including general and specific toxicity studies. The preclinical safety and efficacy data are needed for submission to drug regulatory authorities before permission for further studies in humans is granted. Rabbits and horses were also frequently used for therapeutic sera production (19%).

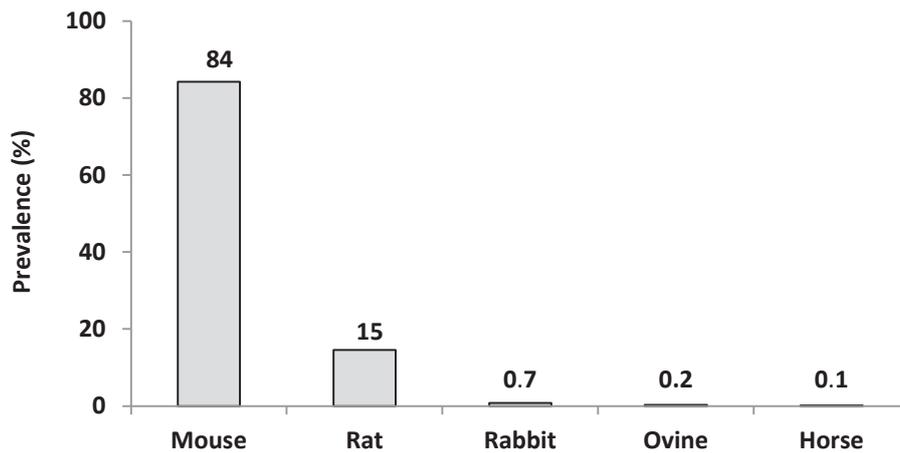


Figure 1. Prevalence of animal species used in education and research in Algeria (PIA report, 2015).

Prevalence of animal use in education and research by institution

The prevalence of animal use by institution in Algeria (PIA report 2015) is presented in Table 1. Twenty seven institutions using animals in research and/or education were surveyed. The University of Sétif and the University of Science and Technology Houari Boumediene (USTHB) used the largest number of animals, 13% and 11% respectively of the total number of animals used by the twenty seven institutions.

Prevalence of animal use particularly in research in Algeria

From the PubMed database (between 1st January 2013 and 1st September 2017) we found that 62% of the 27

Algerian institutions used animals in research. Most animals used were mammalian species. According to the US National Library of Medicine search results, we estimated that a total of 4006 animals were used over 5 years. Of the total animals used, mice accounted for 1511 (38%), rats 1437 (36%), rabbits 349 (8.7%) and hamsters 80 (2.0%). Wild captured animals, like Sand Rat accounted for 507 (13%), *Gerbilus* 71 (1.8%), *Meriones* 22 (0.5%) and *Uromastyx* 10 (0.2%). Livestock like goat accounted for 16 (0.4%) and camel 3 (0.1%) (Figure 3). The wild captured animals are commonly used as models for human diseases, in cell physiopathology and metabolism, endocrinology, nutrition and neurological research (Benmouloud et al. 2014; Gouaref et al. 2017).

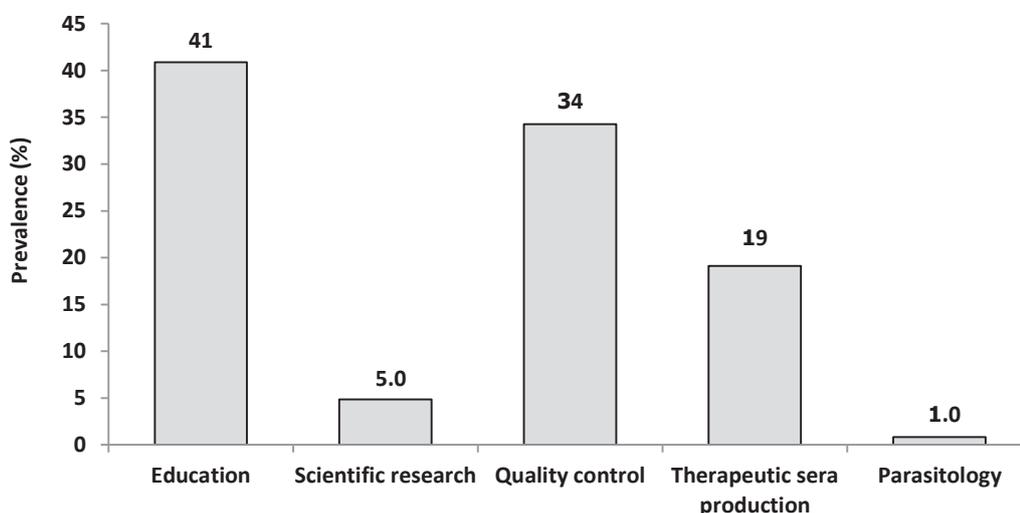


Figure 2. Prevalence of laboratory animal use for different purposes in Algeria (PIA report, 2015).

Table 1. Prevalence of animal use in education and research by institution in Algeria (PIA report, 2015).

Name	University/ high School	Animal use in education and research (%)
Sétif	University	13
University of Science and Technology Houari Boumediene (USTHB), Algiers	University	11
Oran	University	9.3
Annaba	University	8.4
Jijel	University	7.0
Béjaia	University	6.4
Mostaganem	University	4.1
High Normal School Kouba, Algiers	High School	4.0
Faculty of Medicine Algiers	University	3.8
Biskra	University	3.3
Veterinary School Algiers	High School	3.2
Blida, Tebessa, M'Sila, Constantine, Chlef, Khenchla	University	[2.6-2.2]
Annaba, Boumerdes, El Oued	University	[1.9-1.3]
Tlemcen, Guelma, Djelfa, Khemis-Meliana, Tizi-Ouzou, Tiaret, Bechar	University	[0.9-0.1]

In Table 2 we present the prevalence of animal use for research by institution in Algeria (Pub Med database, 1 January 2013- 1 September 2017). 15 institutions surveyed used animals in research. Most of the animals were used in research at the University of Science and Technology University Houari Boumediene (USTHB) and University of Annaba, 46% and 17% respectively.

Sources of animals

Most animals used in education and research were provided by PIA which has an animal breeding program. Wild animals like Sand Rat, *Gerbillus*, *Meriones* and *Uromastix* were captured in their natural habitat especially in desert environments (Beni Abbes, El Meniaa, Biskra, Ouargla and Djelfa region).

Alternatives to animal experimentation

Alternative approaches to animal experimentation are defined as complete or partial replacement of live animals in biomedical research and experimentation. William Russell and Rex Burch in “The principles of humane experimental technique” proposed that if animals were to be used in experiments, every effort should be made to replace them with non-sentient alternatives (Russell and Burch 1959). This document also emphasized that researchers need to reduce, replace and refine the use of animals “the 3Rs” so as to minimize the pain and stress to animals. There are a few non-animal methods that have been used in teaching, and their use may be hindered by the limited resources available to the Algerian academic institutions. Films, videos, plastic models, physiological

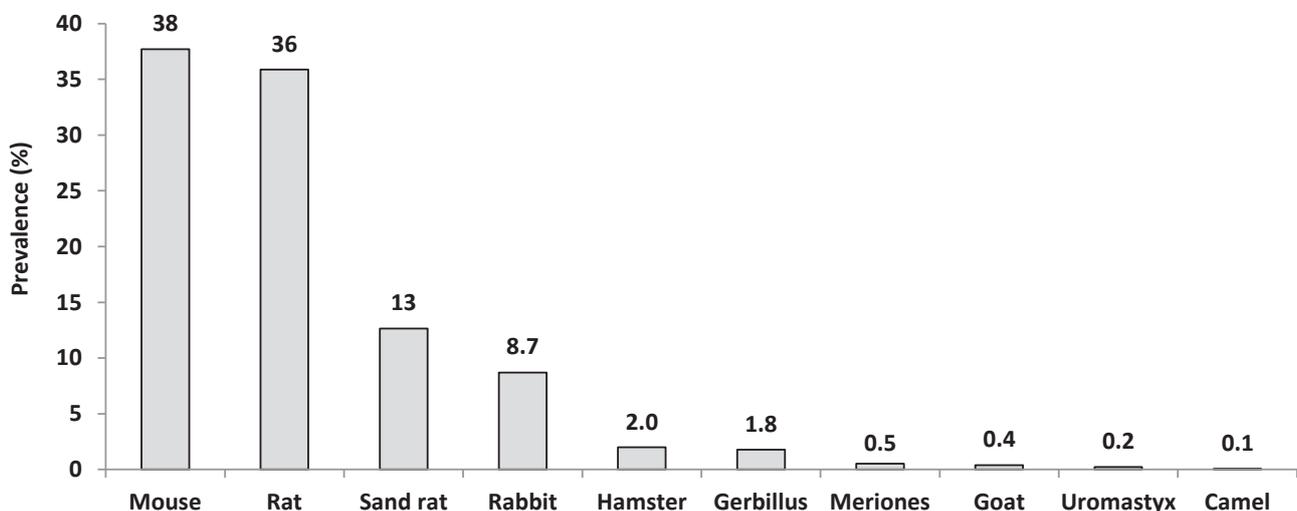
**Figure 3.** Prevalence of animal species used specifically for scientific research in Algeria (PubMed 2013-2017).

Table 2. Prevalence of animal use by institution specifically for scientific purposes in Algeria (PubMed 2013-2017).

Name	University/ High School	Animal use in research (%)
University of Science and Technology Houari Boumediene (USTHB), Algiers	University	46
Annaba	University	17
Tlemcen	University	9.9
Béjaia	University	5.6
Boumerdes	University	4.8
Jijel	University	3.5
Djelfa	University	2.6
Blida	University	2.1
High Normal School of Agronomy, Algiers	High School	1.7
Batna	University	1.5
Sétif	University	1.4
Constantine	University	1.3
El Tarf	University	1.1
High Normal School Kouba, Algiers	High School	1.1
Tebessa	University	0.8

systems modeling and observational field study, were used as educational tools in place of live animals in some institutions.

Moreover, in basic research, a few Algerian institutions (USTHB, Algiers and University of Tlemcen) used animal cell culture as alternatives, particularly in cell physiopathological research (Berdja et al. 2016).

Anesthesia and euthanasia

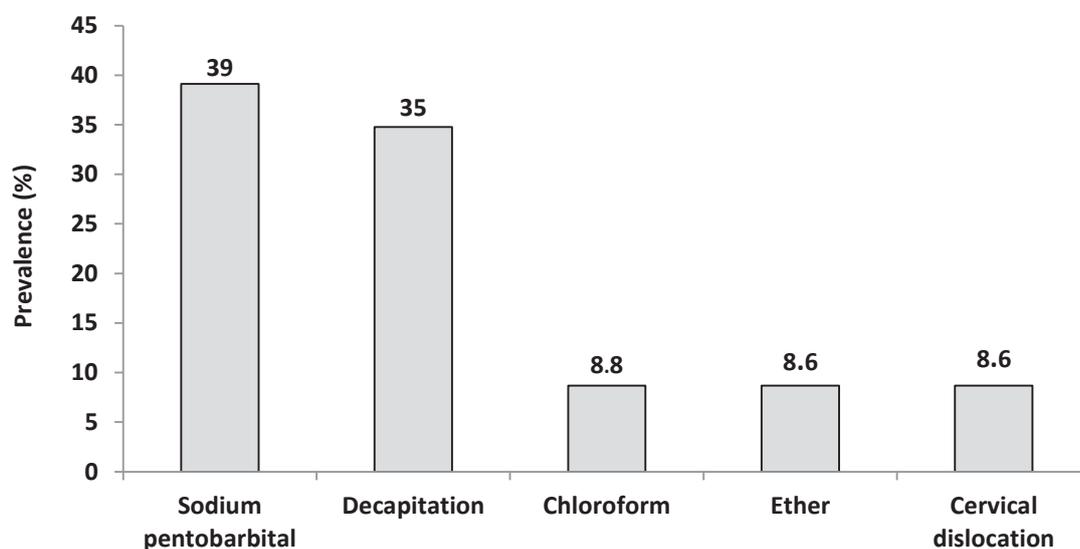
In the research field, 10 of the 15 institutions (67%) used routinely anesthesia and euthanasia (PubMed database analysis). Sixteen different methods of anesthesia were used: sodium pentobarbital, urethane

and ketamine were most commonly used at 50%, 38% and 12%, respectively. A total of 5 methods of euthanasia were reported (Figure 4). Sodium pentobarbital and decapitation were most commonly used for euthanasia at 39% and 35% respectively, followed by cervical dislocation, diethylether and chloroform.

Discussion

Patterns of animal use

Animals used for educational and scientific purposes in Algerian Universities and high schools, supplied by the registered breeder PIA, were principally mice, 84% and rats, 14%. Direct comparison with

**Figure 4.** Prevalence of euthanasia methods used specifically for scientific purposes in Algeria (PubMed 2013-2017).

the European Union (EU) statistics is possible based on a report on the use of animals for scientific and education purposes in the EU in 2015-2017. This report shows that the most used species of laboratory animals were mice, 61%, fish, 13%, rats, 12% and birds, 6% that together represented 92% of the total number of animals used (EU 2020). In terms of commonly-used species of laboratory animals, namely mice and rats, Algeria was similar to the EU.

In Algeria, the wild-captured rodents used in research were in particular Sand Rat, *Gerbillus* and *Meriones*. These animals are mainly used in fundamental research relating to biology and species behaviour, research on animal welfare, nervous system, reproductive system, human related diseases and disorders and the conservation of the species in nature. They account for 18% of all rodent species in this study which is considerably higher than that reported by EU. Thus in the latest EU report, wild species of rodents were included in the 'other rodents' category and were used in higher education or training for the acquisition, maintenance or improvement of vocational skills; they represented less than 1% of the total number of animals used in research (EU 2020). European Directive 2010/63/EU states that it is necessary to ensure that the use of animals in scientific procedures does not pose a threat to biodiversity. Therefore, the use of endangered species in procedures should be limited to a strict minimum (EU 2010). In this study of Algerian usage, the wild animals were within the IUCN categories of LEAST CONCERN, ie are not critically endangered, vulnerable or near threatened (IUCN 2008).

Education, Training and Awareness

One of the objectives of educational uses of animals is to help students learn and understand scientific and biological concepts when alternative methods are unavailable (Balcombe 2000). Our retrospective study showed that the majority of animals were used for education, with quality control and therapeutic sera production being the next two large areas where animals were used in Algeria. Indeed, educational purposes accounted for 41% of animals which was much higher than reported for EU states (EU 2020). The European Directive 2010/63/EU states that animals can be used for higher education, or training for the acquisition, maintenance or improvement of vocational skills, but that the use of animals for scientific or educational purposes should only be considered where a non-animal alternative is unavailable (EU 2010). However, this study revealed that a large proportion of the total animals used were for

teaching and educational purposes mainly due to a lack of alternative methods. The high animal usage for educational purposes may be related also to the high teaching activity and practical sessions involving animals for undergraduate and graduate biology and veterinary students. Moreover, non-animal alternative methods are still not given serious consideration in most Algerian universities and high schools.

International organizations, such as the International Council for Laboratory Animal Science (ICLAS) and the World Organization for Animal Health (OIE), have arranged workshops to increase awareness in Algeria of developments in the field of laboratory animal science. Theoretico-practical training has encompassed technical skills relating to laboratory animal use, in conformity with the principles of ethics and good practice for scientific animal experimentation. The first workshop entitled "animal experimentation" was organized by ICLAS and OIE at University of Sciences and Technology Houari Boumediene (USTHB) on 21-22 May 2013. In addition, the Algerian Association of Experimental Animal Sciences (AASEA), accredited in 2014, has initiatives to improve care and use of animals for scientific and educational purposes, and develops training programs for this. In terms of training within AASEA activities, two workshops on good practices for laboratory animals, following the recommendations of the Federation of European Laboratory Animal Science Associations (FELASA) category C, adapted to the specific needs of the region were conducted. The first one was held at USTHB in November 2015 and the second one at the University of M'sila in April 2017. Applying strategies to training for research, teaching and testing at the Algerian institutions will enhance research quality, wellbeing of experimental animals and improve competencies of persons involved in the care and use of the animals.

Animal use for scientific purposes

Basic research was the minor area for which animals were used, with less than 5% compared to 45% in the EU in 2017 (EU 2020). As Algeria in 2017 invested less than 0.1% of gross domestic product (GDP) in research and development much more needs to be done (Simpkin et al. 2019). This includes increasing investment in scientific research and supporting capacities for research and development.

From the PIA 2015 report, it appears that the University of Sétif and USTHB were the largest users of animals for scientific and educational purposes; they are considered among the biggest universities

with world university rankings for higher education in Algeria. Moreover, when focusing specifically on scientific activity, based on a PubMed search involving animal usage, USTHB was the predominant institute. Reported common methods of euthanasia in Algeria showed a major use of sodium pentobarbital and decapitation which are acceptable methods (AVMA 2020). Although the use of animals cannot yet be completely replaced, it is important that researchers support the wellbeing of the animals, avoid or minimize pain and distress and maximize refinement in scientific research (Festing and Wilkinson 2007).

Ethical review and oversight

Despite the common use of animals for research, testing and education, there is an absence of specific laws governing animal care and use for scientific and educational purposes in Algeria. However, some regulations and guidelines dealing with ethical issues in research and the Algerian National Council of Ethics for Health Sciences were established in 1990 (Law 90-17 of 31 July 1990) under the authority of Minister of Health. Unfortunately, the remit of this council does not include the care and use of animals for scientific and educational purposes. Indeed, it was necessary to establish programs for the safe and secure use of animals in Algeria and to implement appropriate practices and procedures to ensure animal welfare and to respect their well-being. There has been an initiative aimed to implement Algerian legislation: in 2017, a draft law entitled “Draft of the national charter for ethical use and welfare of animals in experimentation” was prepared by a working group of researchers, scientists and council members of AASEA. To consolidate this approach AASEA established a focused charter covering elements of bioethical consideration, biosafety and biosecurity policies for animal research experiments in collaboration with Tulane University, Louisiana (USA), in partnership with Sandia National Labs (USA). Regarding wild animals legislation, it is included under the laws of the wildlife protection in Algeria [(1) Decree N° 83-509 of 20 August 1983 on protected non-domestic animal species, (2) Order of 17 January 1995 supplementing the list of protected non-domestic animal species, JORA N° 19 of 12 April 1995, (3) Decree N° 06-05 of 15 July 2006 on the protection and preservation of animals threatened with extinction].

It is clear that Algeria does not have specific national legislation addressing the care, use and wel-

fare of laboratory animals. A cross-sectional strategy, involving government agencies, scientists, veterinarians and professional societies, is needed to improve the quality of research through structures and programs that support the humane care and use of animals for scientific purposes.

Certainly, international networks will play a crucial role in ensuring improvements in animal care and use for scientific and educational purposes by an increasing focus on animal welfare. A need has been identified for a coordinated initiative to provide education and training in laboratory animal sciences in the African continent (Mohr et al. 2016). The establishment of regional and pan-African networks of laboratory animal science may be the most efficient way to reach the regions involved. It seems likely that ICLAS may play a key role in supporting the connection of Algerian and regional laboratory animal science associations and organizations in Africa.

In conclusion, the present study demonstrates that animals are commonly used for educational purposes in Algerian institutions. The use of alternatives to animal experimentation in research and education has been rarely employed. Furthermore, most institutions did not have ethical committees established to undertake a review of experimental protocols. Our findings highlight the need to establish and enforce strict policies and guidelines regarding the use of animals for educational and scientific purposes in Algeria and perhaps elsewhere in Africa.

Acknowledgements

The authors would like to thank Prof. Ouajdi Souilem and the Pasteur Institute of Algeria for their full support of AASEA activities. This paper has been revised based on the kind input of the editorial and review team, for which the authors are very grateful.

Declaration of conflicting interests

The authors have declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article

References

- American Veterinary Medical Association (AVMA), (2020). The AVMA guidelines for the euthanasia of animals. Version 2020.0.1, 121p. [Accessed 14 May 2020]. Available from: <https://www.avma.org/sites/default/files/2020-01/2020-Euthanasia-Final-1-17-20.pdf>.
- Annual Report Activity of Pasteur Institute of Algeria (PIA report), (2015). 277p. [Accessed 01 September 2017]. Available from: <http://pasteur.dz/images/docs/Rapport-2015.pdf>.
- Arab Charter of Ethics of Science and Technology (ACEST), (2018). Region-wide consultations. [Accessed 01 September 2018]. Available from: http://www.unesco.org/new/en/cairo/about-this-office/single-view/news/region_wide_consultations_on_the_arab_charter_of_ethics_of_s/.
- Balcombe, J., (2000). *The use of animals in higher education: Problems, alternatives and recommendations*. 1st Edition Humane Society Press. 104p.
- Beloucif, S., Benammar, M.S., (2016). Bioethics in Arab Region and the Impact of the UNESCO International Bioethics Committee. Global Bioethics: The Impact of the UNESCO International Bioethics Committee. *Advancing Global Bioethics Book Series*. 5, 151-161.
- Benmouloud, A., Amirat, Z., Khammar, F., Patchev, A.V., Exbrayat, J.M., Almeida, O.F.X., (2014). Androgen receptor-mediated regulation of adrenocortical activity in the sand rat, *Psammomys obesus*. *Journal of Comparative Physiology B*. **184**, 1055-1063. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25179180>.
- Berdja, S., Smail, L., Saka, B., Neggazi, S., Haffaf, EL-M., Benazzoug, Y., Kacimi, G., Boudarene, L., Aouichat-Bouguerra, S., (2016). Glucotoxicity induced oxidative stress and inflammation in vivo and in vitro in *Psammomys obesus* : Involvement of aqueous extract of *Brassica rapa rapifera*. *Evidence Based Complement Alternative Medicine*. **2016**, 3689208. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/27047569>.
- CIA World Factbook "Country Comparison Area", (2019). [Accessed 18 August 2019]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/print_ag.html.
- European Union, (2010). Directive 2010/63/EU of the European Parliament and of the council of 22 September 2010 on the protection of animals used for scientific purposes. [Accessed 28 March 2020]. Available from: <https://eur-lex.europa.eu/legal-content/FR/TXT/?uri=celex%3A32010L0063>.
- European Union, (2020). 2019 report on the statistics on the use of animals for scientific purposes in the Member States of the European Union in 2015-2017. COM (2020) 16. [Accessed 14 May 2020]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0016&from=EN>.
- Festing, S., Wilkinson, R., (2007). The ethics of animal research: Talking point on the use of animals in scientific research. *EMBO Reports*. **8(6)**, 526-530. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2002542/pdf/7400993.pdf>.
- Gouaref, I., Detaille, D., Wiernsperger, N., Khan, N.A., Leverage, X., Kocair, E.A., (2017). The desert gerbil *Psammomys obesus* as a model for metformin-sensitive nutritional type 2 diabetes to protect hepatocellular metabolic damage: Impact of mitochondrial redox state. *PLoS One*. **12(2)**, e0172053. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/28222147>.
- International Union for the Conservation of Nature (IUCN), (2008). [Accessed 2 August 2018]. Available from: <https://www.iucn.org/>.
- JORA - Official Journal of the People's Democratic Republic of Algeria (JORA, 2003, n° 51, modified by executive decree n° 06-343 of 27/09/2007 (J.O.R.A.D.P, 2006, n°61). [Accessed 2 August 2018]. Available from: <https://www.mesrs.dz/universites>.
- Mohr, B.J., Fakoya, F.A., Hau, J., Souilem, O., Anestidou, L., (2016). The governance of animal care and use for scientific purposes in Africa and the Middle East. *ILAR Journal*. **57(3)**, 333-346. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29117404>.
- National Library of Medicine's Medline (PubMed). [Accessed 01 September 2017]. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/>.
- Russell, W.M.S., Burch, R.L., (1959). *The principles of humane experimental technique*. London: Methuen & Co. Special edition. 238p.
- Simpkin, V., Namubiru-Mwaura, E., Clarke, L., Mossialos, E., (2019). Investing in health R&D: where are, what limits us, and how to make progress in Africa. *BMJ Global Health*. **4(2)**, e001047. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6407556/pdf/bmjgh-2018-001047.pdf>.