Spring 5-2022

Islamic Bioethics: National Regulations and Guidelines of Human Stem Cell Research in the Muslim World

Azza Mahmoud
Chapman University, azmahmoud@chapman.edu

Islamic Bioethics: National Regulations and Guidelines of Human Stem Cell Research in the Muslim World

A Thesis by

Azza H. Mahmoud

Chapman University

Orange, CA

Wilkinson College of Arts, Humanities, and Social Sciences

Submitted in partial fulfillment of the requirements for the degree of

Master of Arts in International Studies

May 2022

Committee in charge:

Minju Kwon, Ph.D., Chair

Jared Rubin, Ph.D.

Deepa Badrinarayana, Ph.D.

CHAPMAN
UNIVERSITY

The thesis of Azza H. Mahmoud is approved.

Minju Kwon, Ph.D., Chair

Jared Rubin, Ph.D.

Deepa Badrinarayana, Ph.D.

April 2022

Islamic Bioethics: National Regulations and Guidelines of Human Stem Cell Research in the Muslim World

by Azza H. Mahmoud

ACKNOWLEDGEMENTS

Thanks, and gratitude to my Advisor, Committee Members, Professors, Fellow students, Department staff, Chapman University members, and Family.

VITA

EDUCATION

MA. In International Studies, Chapman University, California, USA.

Ph.D. Biomedical Engineering, Concentration in Biomechanics, Minor in Mechanical Engineering, North Carolina State University, North Carolina, USA.

Post-Graduate Certificate, Institutional Research in Higher Education, Florida State University, Florida, USA.

M.Sc. Systems and Biomedical Engineering, Cairo University, Cairo, Egypt.

B.Sc. Systems and Biomedical Engineering, Cairo University, Cairo, Egypt.

PROFESSIONAL EXPERIENCE

Assistant Professor and Curriculum Leader, Biomedical Engineering Department, Higher Colleges of Technology, United Arab Emirates.

Vice Dean of Academic Affairs, Effat University, Saudi Arabia.

Assistant Professor, Computer Science & Information Systems Department, Effat University, Saudi Arabia.

Research Associate, Veterinary School, North Carolina State University, USA.

Research Associate, Muller Institute of Biomechanics - University of Bern, Switzerland.

CAD/CAM Laboratory System Manager, Mechanical Engineering Department, American University in Cairo, Egypt.

IT VAX/VMS System Manager, Supreme Council of Universities in Cairo – Egypt.

LIST OF PUBLICATIONS

Mahmoud, A. H., Roe, S. C.; Biomechanical Analysis of the Pin-Bone Interface (PBI) in External Skeletal Fixation, National BMES 2001 Conference, Duke, USA, 2001.

Azza Mahmoud, Simon Roe, Frank Moutos; Stress Analysis of a Composite Femoral Stem Using Advanced Composite Technology - A Preliminary Study, National BMES 2001 Conference, Duke, USA, 2001.

M. W. Kay, S. C. Roe; L. F. Stikeleather; A. H. Mahmoud; C. F. Abrams, Jr. 1998. Axial Vibration of Threaded External Fixation Pins: Detection of Pin Loosening. Annals of Biomedical Engineering, Vol. 26 (3): 361-368.

Mahmoud, Azza. Biomechanical Analysis of the Pin-Bone Interface (PBI) in External Fixation. Ph.D. North Carolina State University, USA, 1997.

ABSTRACT

Islamic Bioethics: National Regulations and Guidelines of Human Stem Cell Research in the Muslim World

by Azza H. Mahmoud

The utilization of human stem cells emerged recently in the Muslim world as one of the essential valuable areas of medicine for their vital role in developing regenerative medicine and treating chronic and incurable diseases. Existing studies indicate that most human stem cell researchers rely on varying schools of thought in Islamic law or on an individual base to define legitimate practices. From a policy perspective, the different Islamic religious decrees do not constitute a unified legal framework to promote essential international collaborations. The existing literature exhibits a limitation in comprehensive studies on human stem cell research (HSCR) in the newly joined countries of the Muslim world regarding HSCR policy variation. This comparative research provides for the first time cross-country comparisons of the top HSCR Muslim countries pertaining to their religious sect and affiliation and HSCR national policies. A second research contribution is in surveying the legal position of the Muslim countries on legal clinical abortion to learn about its related-legal framework and inform policy consistency on HSCR. The case-based study of the influence of the religious background of the top Muslim countries on the legal position of HSCR components shows that HSCR is permissible in Islam and is independent of the sect or affiliation as a barrier to a permissive policy. However, the case-based study of abortion laws and the legal position from HSCR components show that the "restrictive" policies in the Muslim countries prohibiting embryonic stem cell research are inconsistent with Islamic abortion laws and embryo’s graduality view that rely on the same subject matter, the embryo's

moral status. These findings emphasize that the variation in HSCR policies is not embedded in the Islamic theological or philosophical reasoning but in other socio-cultural, economic, or political issues. Revisions of restrictive policies and the constructive debates among Muslim countries on the existing Islamic policy models are devised to bridge all the policy variations, clear all uncertainties, and help reach a harmonized consensus on HSCR.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ..... **IV**

VITA ..... **V**

LIST OF PUBLICATIONS ..... **VII**

ABSTRACT ..... **VIII**

LIST OF TABLES ..... **XII**

LIST OF ABBREVIATIONS ..... **XIII**

1 INTRODUCTION **1**

2 BACKGROUND **8**
2.1 Stem Cells 8
Sources of Stem Cells 8
Types of Embryonic Stem Cells 9
2.2 Ethical Issues in Human Stem Cell Research 11
2.3 HSCR Governance in the Global Perspective 14

3 LITERATURE REVIEW **18**

4 THEORETICAL FRAMEWORK **24**
4.1 HSCR Governance in the Islamic Perspective 24
4.2 Moral Status of an Embryo in the Islamic Law 28
A) Shi'ite Fatwa - Khamenei Stem Cell Fatwa 2002 30
B) Sunni Fatwa - Muslim World League (MWL) Conference 2003 32
4.3 Position of Abortion in Islamic Law 33

5 RESEARCH DESIGN **37**
5.1 Units of Analysis 38
A- HSCR Components 38
B- Configurations and Policy Levels 38
5.2 Methods 41

6 RESULTS **44**
6.1 HSCR Profile of the Top Muslim Countries 44
6.2 Non-Embryonic Stem Cell Research in the Top 17 Muslim Countries 45
6.3 Embryonic Stem Cell in the Top 17 Muslim Countries 49
A- Naturally Generated Human Embryos 49
B- Artificially Generated Human Embryos (Embryoids) 53

6.4 Abortion Laws in the Top 17 Muslim countries 59

7 DISCUSSION 61
HSCR Country Profile 61
Policy Levels of Non-Embryonic Stem Research 64
Policy Levels of Embryonic Stem Cell Research 64
Policy Levels of Embryonic Stem Research and Legal Clinical Abortion 67

8 CONCLUSION 70
Recommendations 72

9 REFERENCES 74

APPENDICES 82

LIST OF TABLES

Page

Table 4-1: Legality of Abortion by Islamic Affiliations. 35

Table 5-2: HSCR Scientific and Ethical Components. 39

Table 5-3: Policy levels of HSCR Policies and Guidelines. 40

Table 6-4: HSCR Profile of the Top 17 Muslim Countries by Affiliation. 47

Table 6-5: Legal Positions of the Top 17 Muslim Countries from Naturally Generated ESC Research by Affiliation. 51

Table 6-6: Legal Positions of the Top 17 Muslim Countries from Artificially Generated ESC Research by Affiliation. 56

Table 6-7: HSCR Policy Levels for the Top 17 Muslim Countries by Affiliation. 58

Table 6-8: Legal Positions from Abortion for the Top 17 Countries by Affiliation..... 60

Table 7-9: HSCR Scientific Output of the Top 17 Muslim Countries by Number of Stem Cell Publications…..... 62

LIST OF ABBREVIATIONS

Symbol	Meaning
CB	Cord Banks
ESC	Embryonic Stem Cell
ESCR	Embryonic Stem Cell Research
HSCT	Hematopoietic Stem Cell Transplantation
hESCs	Human Embryonic Stem Cells
HNB	Hanbali School of thought
HNF	Hanafi School of thought
HSCR	Human Stem Cell Research
ISSCR	International Society of Stem Cell Research
IVF	In vitro Fertilization
MLK	Maliki School of thought
MoH	Ministry of Health
MWL	Muslim World League
R	Research
RP	Reproductive
SHF	School of thought
SHI	Shi’ite
TH	Therapy

1 Introduction

On August 7, 2006, the Guardian newspaper published that scientists acknowledged a technological breakthrough at Tehran's Royan Institute in Iran after producing the Middle East's first cloned sheep. On May 1, 2020, a breakthrough COVID-19 treatment with promising initial results developed by United Arab Emirates (UAE) stem cell center was announced. The news delivered that the Ministry of Economy has granted a patent in Abu Dhabi of the UAE for developing an innovative and promising treatment for COVID-19 infections using stem cells. Scientifically, these breakthroughs in developing countries represent profound progress in emerging biosciences such as Human Stem Cell Research (HSCR). From the legal perspective, Iran has a clearly established HSCR policy influenced by religious guidelines (Farajkhoda, 2017). On the other hand, there is no legal framework regulating human stem cell research (HSCR) in the UAE; instead, scientists often rely on religious decrees outlining acceptable practices, as in many other Muslim countries (Bapat, 2018; Flynn & Matthews, 2010).

A survey of HSCR-related literature shows that most stem cell research activities in the Muslim World are conducted without any regulatory policies or public discussions. Differences across countries are manifested in the diversity or absence of national policies and regulations of HSCR in the Muslim World. For example, leading the way for the first time in the Middle East, Jordan has decreed 2014 the first Statute under the Law of Public Health to regulate the use of ESCs in therapy and research purposes (Al-Tabba' et al., 2020). In Malaysia, the Ministry of Health commenced 2009 by regulating and promoting stem cell research using adult stem cells; however, they prohibit the creation of human embryos by any means for research purposes

(Ministry of Health Malaysia, 2009). In contrast, there are no identified laws or guidelines in Egypt to regulate HSCR but rather recommendations from the Egyptian Medical Syndicate allowing HSCR only on adult stem cells and prohibiting the use or the creation of human embryonic stem cells (Sleem, 2012). Thus, several questions come into perspective regarding HSCR and its regulations: How do laws and ethics of Human Stem Cell Research vary across the Muslim World pertaining to its sources, research purpose, and applications? Can an informed consensus be reached, and a harmonized Islamic regulatory framework be shaped among the different religious affiliations to govern HSCR and promote its international collaborations?

With the rapid progress and developments in the stem cell field, especially in regenerative medicine, researchers must operate under agreed-upon guidelines that safeguard ethical practices and ensure transparency to gain and maintain public trust. The governance of the emerging biosciences dramatically impacts the development and discoveries of science and is a key to the country's social, economic, and political advancement. Consequently, policymakers are careful when regulating science and considerate of changes in social values to ensure that scientific activities and societal values are acceptably and accurately represented in the development of policies for controversial applications of HSCR. Currently, international organizations and bioethical committees worldwide, such as the International Society of Stem Cell Research (ISSCR) and Hinxton Group, continue to monitor concerning issues regarding the support and funding for HSCR. However, these international bodies are not recognized as universal divisions in a way that can produce global binding policy outcomes (ISSCR & Hinxton Group official websites). Since the success of the first laboratory isolation of human stem cells in 1998, this innovative biomedical HSCR continues until the present to stimulate a myriad of moral, religious, and legal debates. Unprecedented, distinct HSCR sensitivities ignited the ethical

complications for this one area of scientific governance that diversely influences the political dynamics, national regulations, and policy guidelines across countries worldwide. With the rapid pace of advanced scientific technologies, the utilization of human stem cells has become of global concern and the center of international focus (Saniei & Baharvand, 2018). This area of bioscience offers the potential for a deeper understanding of early human development and the creation of cell-based remedies that might help treat degenerative, incapacitated, and incurable disorders, such as diabetes and spinal cord injury, and Parkinson's and Alzheimer's diseases. Similarly, HSCR opens the door for creating a successful model for discovering drugs and testing their toxicity, efficacy, and safety without experimentation on human subjects (Salter, 2007).

As HSCR has ensued, its advances provoked inevitable debates about the creation and destruction of embryos in the process of human stem cell procurement. The current controversy related to HSCR is not associated with its purpose and goals but rather with the source and means of obtaining these stem cells. Nevertheless, HSCR increasingly proliferated globally with no single universal policy or official rules to govern. Instead, each country developed its regulations and procedures concerning its cultural perspectives and religious doctrine. In this regard, the religious deliberations about HSCR posit various opinions and epistemological inquiries about the moral status and respect for human dignity as opposed to its benefits and therapeutic promise for alleviating human suffering and curing disorders (Al Tabaa', et al. 2014; Fakruddin, 2012; Saniei, 2018; Shapiro, 2014). Moral status shows the inherent worth of something from a moral standpoint rather than an economic, technical, or another standpoint. With HSCR gaining ground in the Muslim World, it is essential to deliberate the surrounding ethical issues and challenges and revisit the national regulations at present and their implications

on the advancement of research and the risks of its application. In the West, ethical and legal disputes related to HSCR are substantial, and policies vary significantly from one country to another, posing a more conservative and strict position. While the challenges to harmonization are diverse and essential, so are the benefits of establishing uniformity in approaches to stem cell research worldwide (Cambell & Nycum, 2005). Likewise, the response has been fraught with moral and religious concerns and a lack of consensus throughout the Muslim world. With varying schools of thought in Islamic law, one decree may be well adopted in a country but not recognized as a legal or regulatory framework in another country (Matthew & Morali, 2020). As a result, most human stem cell researchers rely mainly on the differing religious decrees to individually define legitimate practices. From a policy perspective, the different religious decrees do not constitute a unified legal framework or structure to promote international collaborations with other countries that legislated HSCR. Despite conflicts and debates to reach a consensus on ethical policies of HSCR in many Muslim countries, researchers are still pursuing HSCR and leading in stem cell therapy, especially in diseases most prevalent in the region. Moreover, Muslim countries are increasingly investing in scientific research and development to strengthen the economy and develop knowledge-based infrastructures (Al-Tabba' et al., 2020).

Engagement in HSCR international collaborations proposes obvious scientific and clinical benefits for most institutions, especially to newer institutions in the Muslim World aiming to increase their prominence and advancement in the field. With the absence of appropriate legislation or prohibition on HSCR, researchers in these countries take advantage of the lack of specific regulations to carry on with HSCR considering that the need for its development and potential benefits outweighs the concerns of its risks and dangers to human identity. The danger lies fundamentally in the potential risk of misuse, exploitation, and obstacles in the necessary

comprehensive collaborations with other countries that have recognized legislated laws worldwide. Furthermore, religious and ethical conflicts arise from the idea that humans are on the verge of playing God by manipulating and creating life. There is generally a legalized scientific infrastructure in developed countries, and research institutions are part of the larger community. These conditions transform research results into healthcare practices that benefit society and monitor any unethical practices closely. Thus, with such legalized scientific structure, the risk of exploitation of subjects or communities is minimized. In comparison, with the absence of harmonized HSCR regulatory guidelines in developing countries, combined with the probable existence of poverty, limited healthcare services, illiteracy, cultural and linguistic differences, or limited understanding of the nature of HSCR, the risk of exploitation and possibility of knowledge misuse significantly increase under these circumstances (Emanuel et al., 2004).

Consequently, there has been an ongoing call for an international consensus or universal standards on carefully regulating pioneering scientific and medical advances to secure their ethical and safe application. Therefore, the essential identification of these arguments, an analysis of the current national regulations, and the near-term reach to an informed consensus become the crucial challenge for countries of the Muslim world that share a similar religious background and cultural views. The anticipated consensus will help reach the required balance between the need to preserve human identity, the need for a continuous improvement in the quality of human life, and the global promotion of this innovative scientific research and its applications (Cambell & Nycum, 2005; Warren, 2016). Existing studies indicate that most human stem cell researchers rely on varying schools of thought in Islamic law or on an individual base to define legitimate practices. The different religious decrees do not constitute a

unified legal framework to promote essential international collaborations from a policy perspective. The existing literature related to HSCR in the Muslim World primarily focuses on debates on the perceptions of the moral status and rights of the human embryo (the fertilized egg) in Islamic Law or the current state of stem cell-based therapies in individual countries. The stem cell-related literature exhibits a limitation in comprehensive studies on the policy variation in human stem cell research (HSCR) in the newly joined countries of the Muslim world. Only a few studies on individual countries regarding the HSCR governmental and religious guidelines are available.

This research aims to undertake cross-country comparisons in the field of HSCR in the Muslim world to learn from and about HSCR current policies. The comparative research will present a critical review of the existing stem cell literature to facilitate an understanding of the unique position of each sect and affiliation towards HSCR and its ethics and to what extent these regulations overlap among the different Islamic affiliations. The emphasis of this review is to introduce and examine the various Islamic perceptions surrounding HSCR ethical issues. The first contribution of this comparative research will be in conducting for the first time a cross-country comparison of the top HSCR Muslim countries pertaining to their religious sect and affiliation and the HSCR legal arrangements. The cross-country comparisons will highlight the similarities and differences between national legal contexts of the Islamic views of the human embryo as a research tool, the surrounding issues and the ethical measures ultimately influencing HSCR regulations, and the HSCR policy levels in the Muslim world. The comparison will help understand the influence of the religious sect and affiliation on HSCR policies and the permissive legal stances of some countries to inform policy learning in other restrictive countries. The second contribution of this comparative research will be a contribution to policy

learning. A survey of the legal position of the Muslim countries on a close-related issue, legal clinical abortion, is sought to learn about its related-legal framework and inform policy consistency on HSCR. Since the ethical issues for clinical abortion and utilization of human stem cells are centered on the moral status of the human embryo and the protection of life, the relationship between these issues is considered synergistic. Accordingly, the legal position on abortion will be critical in determining the unique positions of each sect and affiliation with HSCR. This comparison is important in utilizing the interlinking of abortion laws and HSCR activities to shape its guidelines. Furthermore, it gives coherent reasoning to exhibit a unified position for a harmonized policy framework in the Muslim world regarding this much-debated topic. Overall, the results of the comparative research will have an important implication in determining a common ground among the different religious affiliations and devising a harmonized HSCR regulatory framework in the Muslim world for credible and valuable collaborations.

2 Background

2.1 Stem Cells

Stem cells are the origin of all different 210 kinds of human body cells. They are a category of unspecialized cells that can differentiate into specialized cell types. Stem cells are notable from other cell types of two essential characteristics: they are unspecialized self-renewal cells through cell division, and they differentiate into more specialized cells, like skin, muscle, and blood. Human stem cells are present in adult tissues and organs in small numbers mainly to replace and renew damaged cells (Zakrzewski et al., 2019). In terms of characteristics, there are three stem cell categories: (1) totipotent are embryonic cells that can generate a complex organism, a human, or an animal; (2) pluripotent cells are the blastocyst's inner mass and can self-renew; (3) multipotent are the differentiated cells of the inner cell mass in the developing embryo and develop into specific cell types and eventually make the different body organs (Human Organ Transplant Authority, Pakistan).

Sources of Stem Cells

Stem cells exist in human adults (somatic cells) and human embryos. Adult or somatic stem cells are undifferentiated stem cells found among differentiated cells in the whole body after development. They are observed to have a restricted range of differentiation options: bone marrow, hematopoietic, brain, eye, peripheral blood, liver, skin, umbilical cord blood, and skin stem cells. Their characteristics make them promising for research and therapy, especially regenerative medicine. This type of stem cell enables the daily healing, growth, and replacement of human dead cells.

On the other hand, human embryonic stem cells (hESCs) are more notable and valuable to scientific and medical fields for their ability to differentiate into any cell type. They are found in gametes, blastocysts, fetal tissues, and fetuses. This type of cell exhibits a self-renewal and a remarkable long-term proliferative potential that can generate more than 220 cell types in the adult human body. The latter characteristic, known as pluripotent, makes them a promising candidate for therapeutic use in regenerative medicine (Liras, 2010).

Types of Embryonic Stem Cells

A- Naturally Generated Human Embryos: Human embryonic stem cells (hESCs) are mainly developed from eggs in vitro fertilization (IVF), and their genesis is observed by laboratory steps of precise controlled culturing and differentiation. First, stem cells are harvested from the cell mass called blastocysts of five- to six-day preimplantation embryos - zygotes. The outer membrane of the blastocysts is punctured, destroying the embryo; the inner cell mass with its pluripotent stem cells is transferred to various culture conditions; and eventually differentiates into every cell type in the organism (Zakrzewski et al., 2019). The main objectives of HSCR are modeling genetic disorders, employing stem cell-based human therapies, and tissue or organ transplantation. In terms of stem cell therapeutic potential, hESCs obtained from the early developed embryos have massive therapeutic potential for their ability to transform to every cell type in the human body. For this reason, researchers are focused on studying embryonic stem cells (ESCs) despite the ethical concerns regarding obtaining these multipotent stem cells by destroying the embryo (Farajkhoda, 2017).

B- Artificially Generated Human Embryos (Embryoids): To avoid the controversy of endangering the embryo's life in the process and the controversy surrounding it, the second

research advancement in genetics and developmental biology involved developing lab models of early human embryos using pluripotent stem cells. These artificial embryos or embryoids are synthetic entities with embryo-like features (pluripotent cells) not created from fertilization. Meanwhile, scientists argue that current embryoid models do not have the potential to become fully developed human beings (Matthews & Morali, 2020). The first artificial technique is the **Somatic Cell Nuclear Transfer (SCNT)**, developed explicitly for research purposes. They create a viable embryo from the nucleus transfer of a body cell to an egg cell or ovum. The stem cells are then harvested by destroying this cloned embryo for use in therapeutic cloning (regenerative medicine) or reproductive cloning by implanting the cloned embryo into a host mother for further development to its term (Hengstschlägerand & Rosner, 2021). Second is the **Induced Pluripotent Stem Cells (iPSCs)**, a recently developed technique. Another turning point in stem cell therapy has made it possible to develop multipotent stem cells from adult skin cells by genetic reprogramming, thus bypassing the need for human embryos (Takahashi, 2006). The iPSCs resemble embryonic stem cells in their ability to differentiate into a myriad of cells that constitute tissues and organs of the body. They can be developed, put back in the same individual from whom they were derived, and escape immune surveillance. However, iPSC is a long and inefficient process but can differentiate into three primary or germ layers. Another technique that is widely implemented in regenerative medicine is **Therapeutic Cloning** which involves taking a cell from a patient and joining it with a donor egg to create a blastocyst or pre-embryo. The goal is to harvest stem cells from the pre-embryo (blastocyst), which is destroyed in the process, and transplant them back into the patient to treat diseases such as Alzheimer's, Parkinson's, diabetes, and perhaps spinal cord injury.

Most scientists argue that embryoids are not human embryos and cannot become fully functional human embryos due to absent cells or tissues vital for implantation. In some countries where basic research on human embryos is prohibited by law, working with imported iPSCs is permitted. Permission is based on the fact that ESCs or an embryoid cannot develop into a complete human being and do not meet all criteria of the local legal definition of an embryo. Hengstschläger & Rosner (2021), in recent research, highlighted the effect of embryoid research on the prevailing opinion on the legal status of work with hESCs and re-evaluation of the regulations in all countries with similar embryo definitions.

2.2 Ethical Issues in Human Stem Cell Research

Since the beginning, HSCR has created a cultural dispute and tension because of its subject matter, the human embryo. The source of stem cells is one of the most provocative topics surrounding HSCR, with three fundamental and recurring issues in contention: the moral status of human embryos, the purpose line of research, and complicity. Embryonic stem cell research presents a moral problem because it focuses on two fundamental moral principles: utilitarianism and deontology. The utilitarian principle instructs to prevent or alleviate suffering, and the deontology principle instructs to respect human life's value. In this conflict situation of embryonic stem cell research, the debate goes on which principle ought to be given precedence since the two principles obviously cannot concurrently be respected. Should the destruction of embryos be permitted for its remarkable potential medical benefits? Or should it be prohibited since it violates respect for the value of the embryo as a potential human life? Both positions are undoubtedly grounded in fundamental moral values of life - human dignity, the sanctity of life, and autonomy (Fakruddin, 2008; Liras, 2010; Rispler-Chaim, 1989).

The conflict situation revolves around determining the human embryo's moral status, which is essentially linked to its legal status. In this context, HSCR regulations and practices in each country manifest the view that the human embryo holds. Considering that the in vitro embryo has a genetic constitution and is a living being with the potential to become a human being, the embryo is regarded as sui generis[1] i.e., with unique legal status. This opinion reveals three views: first, the embryo (the fertilized egg) has a moral status starting from its constitution, a view that is supported by both philosophical and religious opinions. According to the dominant opinions of French, German, and Turkish doctrines, germ cells that are departed from the body cannot be considered property, and harming these cells causes a violation of personal rights. As to the conservative Christian position, human life begins at the moment of fertilization. The embryo is an individual with a personality that should be treated and protected as a living human being. Thus, from this viewpoint, HSCR is prohibited. The strong opposition to the destruction of human embryos stresses the equality of all human beings. They argue that the frozen fertilized eggs in the laboratory are new human beings with unique human DNA and will develop those characteristics if implanted in a uterus. This position, supported by many scientists and ethicists, entails that these fertilized eggs deserve the same respect as any other human being. Destruction of embryos is placed in the same status as illegal abortion, murder, or a sacrifice of the feeblest link for the interests of others (Fadel, 2008; Kanyıs, 2019; Rispler-Chaim, 1989).

Second, the embryo (the fertilized egg) has a gradual independent moral status, a view that is overall supported by the Islamic faith. Analogous to the termination of pregnancy, it is more likely acceptable in the early stages of embryo development. However, it becomes more difficult

[1] *sui generis*, a Latin expression that translates to "of its own kind or class." In legal contexts, *sui generis* denotes an independent legal classification that refers to creating a new national law or establishing international norms that would afford protection to intellectual property.

later as the moral status of the embryo increases with the pregnancy progress. Many measures are instated to define the embryo's early development stages, including trimesters, heart beating, sentience, movement, and viability. One of the measures crucially linked to HSCR is the first 14 days of the embryo's development, known as the early embryonic stage or the preimplantation stage. Accordingly, graduality is defined by the stages of the 14-day rule, implantation into the womb, ensoulment, and the moral status is expected to be consistent with laws of abortion and assisted reproductive techniques (ART).

Third, the embryo (the fertilized egg) has no moral status and is viewed as a body part. Based on this point of view, the in vitro embryo is neither a property nor a person; instead, it is viewed as an organic material with a status no different from any other body part without any considered moral status or human dignity. For a "being" to be destroyed, it should have an interest that is defeated by destruction. This interest is manifested in beliefs, desires, expectations, aims, and purposes. In the early stages of development, the embryo has none of these interests, and as a result, HSCR is permitted. Moreover, regulations pay regard to the fact that the characteristics of the embryo's cells are changing from totipotent and pluripotent to somatic and germ cells where the embryo starts resembling a human being.

Another perspective of the moral conflict is the situations of in vitro and in vivo embryos. The transfer of the embryo into the womb can be considered another sub-measure of the early embryonic stage. The status of the in vivo and in vitro embryo does not depend on how it is constituted or fertilized; therefore, there is no difference in moral status between them. However, when it is transferred to the womb, the moral status of the in vitro and the in vivo is different, and the in vitro embryo that is not used for treatment may be a subject of HSCR.

In this account, a wide range of diverse opinions are in question on the ethical status of the human embryo since harvesting them necessitates destroying it. Hence, scientists defined preimplantation age limits to utilize human embryos in research. The five-to six-day period will represent the first embryonic age limit. Some views argue that the 5-day-old embryo is too young to attain personhood, and if developed in IVF clinics, it would go to medical waste (Matthew & Morali, 2020). Likewise, the 14-day rule related to HSCR defines when a primitive streak develops into the nervous system, before which human embryos have no pain or sentience. Based on the reasoning of "when life begins," the debate concerning the destruction of human embryos led to the implementation of a 14-day rule to enable HSCR to make use of the spare IVF embryos where sentience and brain development of the embryos begins after 14 days (Nishakanthi, 2019). Other conflicting and ethical issues arise at distinct phases of HSCR, including the regulations for the donations of biological materials, informed and voluntary consent of the donors, protecting the reproductive interests of women in infertility treatment, and commercialization and trade of biological materials (Fakruddin, 2012).

2.3 HSCR Governance in the Global Perspective

In a fast-developing scientific and economic landscape, the global politics of HSCR is driven jointly by scientific, economic, and cultural forces creating a global political dynamic that translates into a series of government policies and controversial lobbying across the international, regional, and national policy realms. Though, the subsequent unwary handling of cultural sensitivities constantly produces unforeseeable political reactions - supporting, opposing, or indifferent - that obscure the seeming potential of the novel technology. These obstacles increase the instability of the stem cells market, the lack of interest of venture capitalists, and the funding gap between science aptitude and the delivery of new treatments for chronic and

incurable diseases. As a result, the international political competition landscape pushes states, international institutions, and bioethics committees for political negotiations to reach a global ethical language capable of enabling the political debate and validating the subsequent policy decisions (Salter, 2007). Since much of the criticism in this respect results from religious beliefs and ethical views, the perspectives of the diverse cultures and faith traditions must be investigated and considered regarding the definition of a human embryo, the timing of ensoulment and personhood, and the rights of the human embryo as a potential life. However, political leaders still debate regulating and funding HSCR studies with no clear global or regional consensus essential for interdisciplinary and international collaboration (Salter and Salter, 2007). There is a stalemate between countries that support the total banning of all forms of human cloning and those calling for legislating therapeutic cloning (regenerative medicine). Notably, there is an international agreement across all countries, regions, and faiths banning reproductive cloning and restricting research on its application. However, researchers in many countries across the globe utilize the remaining embryos created through in vitro fertilization and are no longer needed for infertility for therapeutic cloning (Flynn & Matthews, 2010).

National and international bioethics committees such as UNESCO's International Bioethics Committee, the European Union's European Group on Ethics, Hinxton Group, and the International Society of Stem Cell Research (ISSCR) presumed growing importance in the global politics of HSCR. They established a model of self-regulation and other potentially controversial research areas engaging many different actors and stakeholders. These bioethics committees coordinate to provide global standard guidelines in an attempt to bring disputes to discuss and resolve cultural conflicts related to HSCR; however, they are not recognized as universal divisions in a way that can produce global binding policy outcomes. Many scientists and ethicists

develop Hinxton and ISSCR's guidelines from Asia, Europe, North America, and Australia. These organizations receive review and feedback from individuals and organizations, including regulators, funding bodies, journal editors, patient advocates, researchers, and public members. As a result, views, and conceptions differ considerably regarding aspects of the guidelines; some may consider them too permissive; others may find parts too restrictive. Moreover, some countries set well-defined legal policies that may supersede them (ISSCR & Hinxton Group official websites). These national and international Bioethics committees are mainly developed and applied in Europe as a political framework to seek answers to the cultural conflicts surrounding HSCR. Their presence is limited and is identified globally only for the benefit of their experiences, international collaborations, and political usefulness by other developing countries with distinct cultural traditions, such as in the Muslim world. Overall, the main goal of the bioethics committees with HSCR guidelines is to define core principles of scientific objectivity and research integrity, to consistently revise and update them based on current needs of scientific developments, and publish them to researchers, clinicians, organizations, and institutions around the world. Among the core binding principles defined by the bioethics committees for conducting HSCR (ISSCR, Hinxton Group, STA Law Firm, 2018):

1. The Principle of Respect considers an embryo as a human biological life that is granted sanctity and cannot be damaged or controlled without enough reason.
2. The Principle of Informed Consent requires that donors be informed of all aspects and procedures of the research before such a donation.
3. The Principle of Safety and Utility requires that research conducted with human embryonic stem cells must have been tested on animals to avoid damaging patients and donors alike.
4. The Principle of Non-commercialization prohibits the buying and selling of gametes, embryos, and fetal tissue.

5. The Principle of Transparency requires researchers to be transparent in their clinical research and endorse the prospective registration of all trials in public databases, regardless of phase.

Together, these principles constitute a universal systematic framework that stipulates core practical considerations necessary to justify HSCR and the use of human embryos ethically. Since national governments are the principal entities supporting or opposing HSCR through legislation and funding globally, the political significance of HSCR can be weighed by the number of these national and international organizations and bioethical committees that produce or are requested to produce legitimate regulatory policies for this type of scientific research.

3 Literature Review

For the current state of stem cell therapies in Muslim countries, the existing literature focuses on the advancement of many countries in hematopoietic stem cell transplantation (HSCT). Over the past three decades, HSCT has become a vital therapeutic modality in managing a variety of hematologic malignancies and inherited disorders in most Muslim countries. Matsumoto et al. (2015) reviewed and assessed CB banking policies and initiatives in the Arab world, specifically in Jordan, Saudi Arabia, Egypt, Qatar, and the United Arab Emirates. The study pointed out the importance of addressing the impact of the lack of knowledge in the stem cell field, public opinion, and awareness in the region to help reach informed decision-making.

In the context of bioethics, the most provocative topic surrounding HSCR is the destruction of human embryos as a source of stem cells. The literature identifies three fundamental and recurring issues in the debate: the moral status of human embryos, the purpose line of research, and complicity. By reviewing the discourses on the controversial ethical implications, literature shows that one way to resolve the legal consequences and determine the permissibility of HSCR is to examine the moral status of the human embryo. Thus, the moral status represents a critical consideration in concluding the ethical position of each country and the national legislative decisions for this type of scientific research (Fadel, 2007; Fakruddin, 2012; Prentice, 2004; Saniei & Baharvand, 2018). Fadel (2007) reviewed the prospects and ethics of stem cell research from an Islamic perspective and theorized three positions for the human embryo's moral status, including the Islamic graduality position based on the embryo's developmental stages. Kanyıs (2019) compared the embryo's moral status views and HSCR regulations in two Muslim

countries – Turkey and Iran. The study pointed to the contradictory logic in the Turkish system legalizing the destruction of surplus embryos and prohibiting them for therapeutic purposes, thus neither protecting human embryos nor helping patients seeking treatment. Nishakanthi (2019) critically reviewed the inquiries of moral philosophy in the context of emerging technologies and its implications on the unique position and ethics of Malaysian stem cell technology. Similarly, Fakruddin (2012) discussed the HSCR ethical and political controversies and raised questions about the complicity of researchers in the destruction of an embryo and the moral distinction between creating embryos for research or reproductive purposes.

In another dimension, several stem cell studies highlighted the key arguments and concerns of the human embryonic debate in Muslim countries. They emphasized the need for Muslim jurisprudence conferences and organizations to discuss all the possibilities and uncertainties and consider the potential benefit of HSCR on human health. Researchers reviewed the Islamic ethical standpoint regarding using human embryos, the permissibility of human cloning to harvest stem cells, and ways of its improvement in several countries such as the Eastern Mediterranean Region, Iran, Turkey, Pakistan, and Bangladesh. The findings indicated the need to formulate HSCR regulations, the ethical and legal status of the human embryo from a common sociological perspective, the differences and similarities in regulations, and the incompatibility between regulations on the practice (Abdur Rab & Khayat, 2006; Fakruddin 2012; Kanyıs, 2019; Shamsi, 2008). Also, the findings revealed the differences in investments and clinical research output between developed and developing countries and the importance of government regulation and support in strengthening. Abdur Rab & Khayat (2006) emphasized the urgent need for Muslim scholars to rationally examine the issue of HSCR and cloning, considering the

scientific advantages and the ethical and legal implications, especially the importance of reaching a consensus on this vital issue in the Muslim countries.

Regarding the HSCR legal status, several studies analyzed the conceptual bioethical basis for the co-production of science, policy, and stem cell legal status in several Muslim countries. The studies identify the common principles in the Muslim tradition on which the laws and guidelines apply to identify the permitted and the prohibited techniques in modern technologies. However, the findings show no binding view on the prohibition or the permissibility of any scientific research, including modern biotechnology, as long as it benefits human life and well-being (Abdur Rab & Khayat, 2006; Aksoy, 2005). Despite the field topic's cultural and religious sensitivities, the literature recognizes a dominant favorable Islamic position for HSCR. Generally, the literature shows no restrictions from the Islamic viewpoint regarding biomedical sciences and technologies, unless expressly prohibited, as long as they are employed to improve human life. However, the ethical assessment of HSCR using human embryos is still widely diverse due to several factors such as the lack of a central religious authority like the Roman Catholic church in Europe, the diversity of viewpoints in Islamic law, and the characteristics of political regimes or social conditions. This diversity produces a different position in the ethical assessment of HSCR for each country in the Muslim World and subsequently in its national regulations and policy governance (Turkmen & Arda, 2008).

Recently, many countries in the Muslim world are fast developing their scientific infrastructure for R&D as well as financing well-developed research and academic facilities to collaborate in the novel scientific technology of HSCR. The present state of HSCR activity within these countries will have a higher impact and will enhance international collaborations if their national

governments strive for policy interoperability (Flynn & Mathews, 2010). Alahmad et al. (2020) identified four research themes based on the ethical challenges related to the use of stem cells and the essential need to promote the knowledge, education, and awareness of stem cell research and treatment in Saudi Arabia. For the first of its kind in the Middle East, Al-Tabba' et al. (2020) reviewed the stem cells Statute in Jordan (JSCS), the comprehension and consistency of its content, the gaps, and the recommendations for the substantive requirements, procedural safeguards, and the requirements for research governance. In Malaysia, Nishakanthi (2019) critically reviewed the ethics of Malaysian stem cell technology based on written literature to understand its unique position towards stem cells and the impact and influence of contemporary stem cells on Western ethics. Similarly, Saniei (2013) analyzed Iran's hESC policy in Iran described as a 'more flexible approach based on the viewpoints of stem cells scientists, embryologists, and ethics committee members on hESC research policy in the Shia Muslim country.

The ethical disputes surrounding these emerging technologies throughout the Muslim world have been substantial, with moral and religious concerns and a lack of consensus. Despite the ethical issues surrounding HSCR, as discussed above, the literature indicates that the present state of HSCR activity within several Muslim countries shows a substantial scientific contribution on the national and international level in a few decades. Engagement in HSCR international collaborations of these countries proposes the existence of national policies and guidelines for most institutions to exchange information with other countries and increase their prominence and advancement in the field, as opposed to countries with limited facilities for cell-based therapy and advanced technologies.

Worldwide, the governing bodies positioned themselves from HSCR regulatory policies in different multitudes: the UN Sixth Committee focused on legal issues and agreed to delay consideration of the banning proposal of HSCR globally. The World Health Organization (WHO) opposed the ban on HSCR techniques. The 1997 UNESCO Universal Declaration on the Human Genome and Human Rights state that " practices contrary to human dignities, such as reproductive cloning of human beings, shall not be permitted". The Council of Europe's Convention on Human Rights and Biomedicine bans the creation of embryos entirely for research purposes. Researchers, ethicists, and various spokespersons from 14 different countries 'Hinxton Group' issued a set of legal and ethical guidelines relating to HSCR to address inconsistent international laws in this area. In the United States, no federal funding is available for HSCR. Only eleven states support research to improve scientific exchange, coordination, and collaboration. The rest of the states restrict research in this field based on ethical standards. In Asia, there is a vast diversity of principles and religions with no consensus on HSCR, and the region projects a fragmented legislative landscape like Europe. Even though the spiritual and cultural codes in many Asian countries consider the economic incentives resulting from technological advances, it emphasizes the fear of knowledge misuse and commercial exploitations. Correspondingly, many African countries support the total banning of HSCR out of concerns about women's exploitation as sources of human eggs and problems from cultural norms that value a broad definition of human life (Dhar & Hsi-en Ho, 2009).

By surveying the laws and guidelines of the 22-top research-intensive countries, Matthew and Morali (2020) examined and highlighted the existing barriers and obstacles related to the expansion of research using human embryos and embryoids. The study emphasized the importance of collaboration with policymakers and stakeholders to set clear laws, reach a global

ethical language, and develop the appropriate regulations and guidelines within each national context to promote this type of research. Similarly, Rispler-Chaim (1998) stressed the distinct dynamic nature of ethics and argued that basic ethics in society or religion must be evaluated regarding their period and place. For example, the study underscored how Islamic bioethics demonstrates a progressive and consistent relationship with medical advances and legally aligns with recent discoveries. Cambell & Nycum (2005) suggested a model for harmonizing the regulation of HSCR by concentrating efforts on universal norms and principles rather than specific rules. Harmonization is recommended to be commenced and established by an independent international agency of diverse cultural identities, perspectives, and interdisciplinary expertise.

Since HSCR is a newly pursued scientific discipline in the developing Muslim World, the contribution of this research is in conducting for the first time an HSCR cross-country comparison and comprehensive case-based studies of the state and the national guidelines of this novel type of scientific research. The case-based studies will highlight each policy window's existing barriers and restrictions concerning each country’s religious affiliation and its position on close-related issues such as legal clinical abortion. The comparative research anticipates identifying common policy aspects for harmonizing an HSCR regulatory framework and helping reach a policy consensus in the Muslim world. The agreed-upon regulatory framework opens the way to promote legal coordination and scientific collaborations nationally among Muslim countries and internationally with countries of regulated HSCR. Muslim countries in prospect will span the Middle East region, Asia, and Africa geographically.

4 Theoretical Framework

The ethical disputes surrounding these emerging technologies throughout the Muslim world have been substantial, with moral and religious concerns and a lack of consensus. Despite the ethical issues surrounding HSCR, as discussed above, the literature indicates that the present state of HSCR activity within several Muslim countries shows a substantial scientific contribution on the national and international level in a few decades. Engagement in HSCR international collaborations of these countries proposes the existence of national policies and guidelines for most institutions to exchange information with other countries and increase their prominence and advancement in the field, as opposed to countries with limited facilities for cell-based therapy and advanced technologies.

4.1 HSCR Governance in the Islamic Perspective

The legislation and principles in the Islamic tradition (Shari'a) are constructed collectively from five primary sources: the Holy Quran, the Prophetic traditions (Sunnah), Consensus (Ijmaa), Analogy (Qiyas), and Intellect and reasoning (Ijtihad). Most Muslim-majority countries integrate Shari'a into their legal framework, where constitutions commonly refer to Shari'a as the primary source of law. There are two main sects within Islam: Sunni Muslims and Shi'ia Muslims. Different schools of thought - the most prominent of which are Hanafi, Maliki, Shafi'i, Hanbali, and Ja'afari - established methodologies and practices for interpreting and extracting rules from the primary scriptural sources (Al-Tabba' et al., 2020). The schools of thought show a large amount of tolerance between schools' legal rulings and overlap in about 75% of the legal inferences and conclusions. Variances among schools in jurisprudence exist due to

methodological differences in reasoning or authentication of the principal scriptural evidence. Different jurisprudential viewpoints may exist among the orthodox and progressive scholars of the same school or viewpoints on newly emerged issues may be revised and updated by its contemporary scholars. Islam does not have a central authoritative structure, and no single school or theology dominates Islamic thought. Instead, there is a diverse understanding of how to practice Islam and a large amount of tolerance between schools' legal rulings. Various areas of Shari'a intersect with the Western perception of law – such as equality and respect for human sanctity - while others link more specifically to living life by the scripture (Esposito, 2014). For example, the Islamic scripture, in accord with Human rights codes, instructs universal equality and respect for human life as interpreted from the text:

1. "And if anyone saved a life, it would be as if he saved the life of the whole people" – the moral message of this verse means that this life-saving mission is universal without any space, time, and faith partitions.
2. "And make not your own hands contribute to (your) destruction" - Through an analogical understanding, this verse can be inferred as bringing from a medical perspective a note that anyone can neither carry (actively) nor allow (passively) oneself to destruction.

Among ways of making regulations and drawing up laws in Islamic tradition, Muslim Scholars and intellectuals apply case-based arguments and reasoning for judgment on newly emerging ethical issues. Theoretically, they employ several Islamic principles and methodologies in interpreting and extracting rules that have been introduced by Islamic scholars, jurists, and legal experts in related disciplines, including: (1) the principle of "the Public Interest"; (2) the principle of "Necessity"; (3) the principle of "No Awkwardness"; (4) the principle of "Do No Harm" is to be neither harming nor reciprocating harm, another harm, or a similitude should not ward off harm; and (5) the principle of "A severe harm shall be removed by a lesser harm", i.e.,

in the presence of two harms the commission of the lesser one shall ward off the greater one (Farajkhoda, 2017; Nur, 2020; Rispler-Chaim, 1989). Similarly, Muslim Scholars and intellectuals apply the concept of Intellect and reasoning (Ijtihad) and the principle of "the Public Interest." In the juristic sense, the principle of Intellect and reasoning (Ijtihad) is a method of exercising personal conclusions to avert any inflexibility or injustice that may be deduced from the literal textual implementation of the law. The concept of Ijtihad plays a prominent role in the reworking of Islamic law to the shifting needs of societies. It authorizes retreat from an instituted precedent in support of a different ruling for a stronger reason (Aksoy, 2005; Saniei & Baharvand, 2018). Institution of the above-mentioned Islamic principles helps present laws for newly emerged ethical concerns and solve clinical bioethics problems and research in question. Based on these principles, it can be concluded that any effort to heal an ailment of any kind, for any reason, and even on any ground, must relentlessly be pursued.

In the case of HSCR, medical knowledge and clarity are needed to decide the necessity, level of harm, and degree of life-threatening situations based on which the ruling of a "heavier harm" should take precedence. Meanwhile, countries that share similar socio-religious beliefs and scientific interests approach new knowledge and technologies in diverse ways due to the direct influence of historical, cultural, and sociological perspectives. Similarly, the institutional framework and the mobilization of stakeholders are among the factors that may explain the variation in rulings on the same issues (Nur & Tulungagung, 2020; Saniei, 2018). The bioethics of HSCR is inseparable and essentially linked to Islamic jurisprudence and social principles. The basis for the regulation of HSCR relies fundamentally on the source of the stem cell, the purpose of research, and the symbolic moral right of the embryo. From the Islamic perspective, the debate on HSCR builds on three main arguments: (1) At what developmental stage is the human

embryo considered a living human being, and (2) How does HSCR conflict with Islamic beliefs? (3) What are the collective outcomes and advances that it would add to the quality of human life? Consequently, the religious examination of HSCR ethics and the embryo's moral status becomes essential and maintains precedence in the Islamic Shariah from the ethical relativism perspective, a fundamental disposition of the Muslim population (Devolder, 2005; Nur & Tulungagung, 2020).

An important aspect of consideration regarding the variation in the Islamic stance from HSCR is the absence of a central authoritative structure and orthodox prominent legal schools (affiliations) of diverse viewpoints regarding gestational stages of development. According to Saniei (2013) “Fatwas on these modern debates vary among the different Islamic schools of thought; these Islamic rulings actually reflect local customs, cultures and moral sentiments”. The author added, “Countries with similar religious backgrounds and, perhaps, scientific interests may therefore approach new knowledge in different ways” (p. 349). It is claimed throughout the stem cell-related literature that the Islamic stance from the modern debates on the embryo's moral status varies among the sects and Islamic affiliations. Fatwas and Muslim scholars' rulings on these modern debates are not legally binding and differ among the prominent Islamic schools of thought, reflecting local customs, cultures, and moral sentiments. Accordingly, a case-based study of the religious background of the Muslim countries and its influence on the legal position of HSCR moral issues and rulings for its components helps understand the variation in HSCR national policies in the Muslim world.

4.2 Moral Status of an Embryo in the Islamic Law

Muslim scientists and scholars undertake all biomedical technologies that may result in beneficial therapies for currently incurable debilitating diseases. To this end, Islamic viewpoints on HSCR revolve around the notion of human life sanctity, which is considered to begin later when the ensoulment occurs, and the embryo becomes subject to the ethics of human dignity. The fundamental question that all debates revolve around and generate variation in policies is: whether we allow destroying one life (destruction of the embryo) to save another one or we should close our eyes to the potential of life-saving therapies out of respect for the potential life of the embryo as a human?

Islam does not place a judgment on an embryo that is not fully developed, whether within or outside the womb. According to Shari'a or Islamic law, there is a distinction between "actual" life and "potential" life. In this context, there is an apparent distinction between the fertilized ovum in the dish or a test tube and the fertilized ovum in the body of a human being. In the case of IVF embryos, they are produced in the laboratory merely for infertility treatment and reproduction. Due to the scientific limitations of the in vitro fertilization technique, they are produced in surplus of what is needed, which will be frozen for a certain period, 5 to 10 years in most countries, then discarded. It has been part of the argument that if these embryos were initially treated like fully developed human beings, it would have been prohibited to produce them in excess and destroy them afterward. Apparently, the destruction of the IVF supernumerary embryos is not considered in any context as abortion since no one considers human beings. From this standpoint, proponents believe that it is morally permissive to use surplus embryos for life-saving research purposes (Turkmen & Arda, 2008).

Second, Shari'a views the destruction of human embryos in research as ultimately linked to the "developmental view" of human embryos less than 14 days old. The embryo has a gradual independent moral status, a view overall supported by most Muslim scholars. Graduality[2] is provided by the stages of the 14-day rule, implantation into the womb, and ensoulment. The graduality status is undoubtedly witnessed in the abortion and assisted reproductive techniques regulations in Muslim countries and most Muslim scholars (Kanyıs, 2019). Arguments build on the fact that these embryos are rudimentary in development to be considered individual organisms. Given the consequentiality approach, the embryo has none of the vital characteristics of personhood, such as uniqueness, sentience, the cognitive capabilities of consciousness, and reasoning and self-awareness - to determine the morality of actions (Agbedia & Godwin, 2013; Devolder, 2005). Thus, it is believed that these embryos should not be granted protection at the expense of legitimate vital scientific research for collective health benefits. However, it is agreed that embryos have a status greater than other tissue, and their rights increase as it transforms from one stage to another. These embryos should have particular respect that would require legitimate reasons to use, create, discard, and experiment on them (Fadel, 2008). Accordingly, Muslim scholars define the following gestational stages:

1. Fertilization to implantation (7-day rule),
2. From implantation to the appearance of the primitive neural streak at the end of the second week (14-day rule),
3. Ensoulment and beginning of personhood (120-day rule), and
4. Viability, which has traditionally been set at 24 weeks.

[2] In Islam, it is believed that a soul is introduced into the embryo when it is four months old. This view of most jurists is based on the Tradition (Hadith) narrated, which means :
"Verily, the creation of each one of you is brought together in his mother's belly for forty days in the form of seed; then he is a clot of blood for a like period, then a morsel of flesh for a like period, then there is sent to him the angel who blows the breath of life into him and who has commanded about four matters: to write down his means of livelihood, his life span, his actions, and whether happy or unhappy…." Related by Bukhari and Muslim.

A third Islamic perspective on hESCs is based on the concept of ensoulment, which has been thoroughly debated and widely documented. An embryo is only considered a human life after four months with the existence of a soul. The debates concluded in distinct variations in Islamic jurisprudence on when ensoulment occurs, when human life starts, and the sanctity of the embryo prior to this phase. Most Muslim scholars agree that human life begins between 40 or 120 days after conception and unanimously agree that human life after ensoulment must not be transgressed against (Nishakanthi, 2019). Also, most Muslim scholars agree with therapeutic cloning using IVF supernumerary early pre-embryos. The early pre-embryos are considered worthy of respect but not granted the complete sanctity of the embryo after implantation in the womb and specifically after ensoulment (Farajkhoda, 2017). Thus, differences in opinion among Islamic schools in this regard define two-time points of ensoulment (40- and 120-days) and two-time points for processing (7- and 14-day rules). These time limits are consistent as well with the international standards of HSCR. However, Fatwas and Muslim scholars' rulings on these modern debates are not legally binding and differ among the prominent Islamic schools of thought, reflecting local customs, cultures, and moral sentiments. Among the most prominent Fatwas regarding stem cells that are taken as a groundwork for HSCR national policies in the Muslim World (Shi'ia and Sunni) are the Khamenei Stem Cell Fatwa of 2002 and the Muslim World League (MWL) Conference of 2003.

A) Shi’ite Fatwa - Khamenei Stem Cell Fatwa 2002

Iran's Supreme Leader Ayatollah Khamenei issued a Fatwa on HSCR in 2002. In the Fatwa, he declared that hESC research is not conflicting with Shi'ia tradition and acknowledged the work of the HSCR scientists encouraging them to advance the technology to save lives. This Fatwa has enabled new Fatwas, practices, and legislation that allow HSCR. Iran's regulations and practices

reflect the view of graduality - that the human embryo has a gradual independent moral status. Policymaking Council of MOHME completed HSCR guidelines under "Ethical Guide to Gamete and Embryo Research in the Islamic Republic of Iran" and "Ethical Guide to Stem Cell Research" (Kanyıs, 2019) with the following articles:

Article 1: human gametes and embryos can be used for therapeutic research only when it aims to cure human diseases.

Article 2: strictly forbids the purchase and sale of human gametes and embryos.

Article 3: prohibits the production of human embryos for research purposes. Research on embryos is acceptable in surplus embryos only when they are not certainly be used for IVF in the future.

Article 4: regulates that research on human embryos is permitted until the 14th day, starting from fertilization. In the pre-ensoulment stage, it is possible to perform HSCR with both spare/surplus embryos and embryos created for therapeutic research.

Article 5: The production of an embryo is allowed if there is no surplus human embryo with the necessary stem cell for such therapeutic research, and research on a human embryo is essential. However, reproductive cloning is prohibited for research purposes.

Article 6: it is regulated that the number of embryos used for research should be as few as possible to provide protection for embryos.

Article 7: provides protection for human embryos and specifies other restrictions for HSCR, such as the prohibition of producing chimeras and changing the genetic content of

the gametes or embryos for transfer to the uterus, except for the purpose of preventing a specific illness.

Article 8: prohibits the use of a human embryo in research without donors 'consent.

Article 9: also regulates that any research on human embryos requires the consent of embryo owners and the permission of the Ethics Committee.

Articles 10, 11, and 12 regulate how informed consent should be taken. (p. 5)

B) Sunni Fatwa - Muslim World League (MWL) Conference 2003

The General Islamic Conference is the highest policy-making body and the source of the League's legitimacy and capacity as the spokesperson of Muslims worldwide, expressing the attitudes and aspirations of Muslims around the world. Within the Muslim World League, the Islamic Fiqh Council comprises a select group of Muslim jurists and scholars who discuss severe issues concerning the Muslim World (Muslim World League official website). Fadel (2008) stated passages of the HSCR issued Fatwa (religious opinion) by the MWL's Islamic Jurisprudence Council conference in December 2003, held in Mecca, Saudi Arabia which are translated below:

It is permissible to acquire, grow and use stem cells for therapy or scientific research as long as the cells' sources are permissible. Examples of permissible sources are adults who consent as long as it does not inflict harm on them, children whose guardians consent for a legal benefit without inflicting harm on the children, placenta or umbilical cord blood with the permission of the parents, spontaneously aborted embryos or those aborted for a legally sufficient cause and with the permission of the parents, and excess fertilized eggs produced

> during the course of IVF and donated by the parents with the assurance that they are not to be used to produce an illegal pregnancy. It is forbidden to obtain or use stem cells if their source is forbidden. Examples include fetuses intentionally aborted without a legal, or medical reason, intentional fertilization between a donated ovum and sperm, and therapeutic cloning. (p. 80)

As stated, it is permissible under the MWL Fatwa 2003 to obtain, grow and use stem cells for therapeutic or scientific research purposes only if they are obtained from permissible sources:

1. Adults, if consent is obtained and no harm comes to them due to collection.
2. Children, if parental consent is obtained and no harm comes to the child as a result of the collection.
3. Placenta or umbilical cord if parental consent is obtained.
4. Embryos or fetuses that have been miscarried on their own accord or aborted for therapeutic reasons allowed by Shari'a law, and parental consent is obtained.
5. Leftover fertilized embryos from in vitro fertilization that is donated by the parents.

However, under the 2003 fatwa, it is prohibited to procure and use stem cells from the following sources: (1) willfully aborted fetuses and fetuses aborted without a medical reason permitted by Shari'a law; (2) willfully fertilized donated ovum and sperm; and (3) therapeutic cloning (Fadel, 2008; Shapiro, 2014).

4.3 Position of Abortion in Islamic Law

The Quran, as the primary source of legislation, does not directly address induced abortion, giving great discretion to the scholars' jurisprudential perspective and the laws of individual countries. Islamic positions on abortion are shaped by the Prophetic tradition and are significantly different among Muslim-majority countries depending on the pregnancy conditions

and stage of gestational development. The significant variation is related primarily to affiliations and which grounds are legally accepted reasons for abortion (Saniei & Baharv, 2018). Within the Muslim-majority countries, a largely conservative approach was observed where abortion is legally permitted only in a life-threatening condition for the mother or before 120 days after conception. Concerning other grounds and later gestational development of the fetus, abortion is greatly disputed among the different affiliations and prohibited for fear of a "misuse" on religious grounds rather than on theological or philosophical reasoning. Muslim scholars mostly agree that the slightest blameworthy ground for abortion is in the life-threatening condition for the pregnant woman and before the 120-days rule when ensoulment occurs. Muslim scholars view the embryo's age when ensoulment occurs, whether within or outside the womb, as a living being undergoing the growth process but not yet a human life until the existence of a soul (Shapiro, 2014). However, regarding other grounds and later gestational development of the fetus, it varies among the Muslim countries based on their Islamic affiliation and national Fatwas given by renowned Muslim scholars who identified seven dimensions as legal grounds for abortion:

- Abortion is permitted to save the life of the pregnant woman (L)
- Abortion is permitted to preserve a woman’s physical health (PH)
- Abortion is permitted to preserve a woman’s mental health (MH)
- Abortion is permitted in cases of fetal impairment (F)
- Abortion is permitted in cases of incest or rape (I/R)
- Abortion is permitted for social or economic reasons (SE)

Table 4-1 exemplifies the substantial diversity of Islamic laws across the prominent schools of thought regarding the different gestational stages of development (Shapiro, 2014; Saniei & Baharv, 2018; United Nations, 2014).

Table 4-1: Legality of Abortion by Islamic Affiliations.

Muslim Sects	Affiliations	Embryonic Development Stages			
		1 Conception to 40 days	**2** 40–80 days	**3** 80–120 days	**4** 120 days to birth
Sunni	Hanafi	permitted	permitted	permitted	prohibited
	Shafi'i	majority permit	some permit	some permit	prohibited
	Hanbali	some permit	some permit	some permit	prohibited
	Maliki	prohibited	prohibited	prohibited	prohibited
Shi'ite	Ja'afari	permitted	permitted	permitted	prohibited

Quranic description - Stage 1: Fertilized ovum; Stage 2: Develops into a clinging blood-like clot; Stage 3: Clot forms into a clump of flesh; Stage 4: Ensoulment occurs.

It must be noted that the permission for abortion for all affiliations is constrained by the recognized legal ground of the religious authority and national laws. Based on a particular affiliation, the permission of some scholars, as in table 4-1, indicates different jurisprudential opinions among its scholars (orthodox and progressive) or that the opinion has been reviewed and updated later by contemporary scholars.

Such moral decision regarding the embryo's status is not limited to the realm of HSCR but also other close-related issues involving the gestational stages of development, such as clinical abortion, which have been already regulated in all Muslim countries, as demonstrated above. Since this relationship is interlinking and the ethical issues for both abortion and HSCR revolve around the moral status of the human embryo and the protection of life, the legal position on abortion will be critical in determining the unique positions of each sect and affiliation toward HSCR components. Since both cases assume the protection of life and the respect for human

dignity and sanctity, it can be argued that these Islamic rulings regarding the moral status of the embryo are consistent with those ruled upon abortion. Based on the above discussion, a case-based study is sought to examine the consistency of the signifying synergistic relationship between clinical abortion and utilizing the IVF supernumerary embryos and embryoids for HSCR.

5 Research Design

This research employs descriptive cross-country comparisons for two case-based studies to understand the variations in HSCR national policies and help determine a unified position for an HSCR policy framework in the Muslim world.

The first case-based approach undertakes a comparative study of the top Muslim countries grouped by sect and affiliation, selected for their significant HSCR international collaborations, and HSCR legal arrangements. The cross-country comparison highlights the similarities and differences between national legal contexts in the Muslim world focusing mainly on the Islamic views of the human embryo as a research tool. Each country is considered an entire macro-social unit, carried out analytically as a whole. The country's HSCR scientific profile is identified as the R&D as a percentage of GDP, the number of stem cell publications, the number of international registries of stem cell clinical trials, and the number of cord blood banks (CB). These identifiers help guide the selection of data, justification for countries to be included, and approach to analysis. Contextual variation in the country's HSCR legal arrangements is accounted for by the country's religious sect and affiliation and HSCR policies in place for each type of HSCR.

The second case-based approach undertakes a comparative study of abortion legal positions in the selected Muslim countries grouped by sect and affiliation and the national policies for each HSCR type in place. The cross-country comparison will examine the consistency of the signifying interlinking between clinical abortion and the country's HSCR legal arrangements.

5.1 Units of Analysis

The units of analysis for the case-based studies include the selected Muslim countries grouped by sect and affiliation and the legal positions on abortion as units of comparison versus national policies of the defined components for each HSCR type.

A- HSCR Components

The international formal bioethical HSCR discourse defined a common terminology with a limited set of components that constitute the building blocks of HSCR. These components represent the basis for ethical conflict and variation among national policies in the Muslim World. HSCR regulation relies fundamentally on these components and their indicators: the source of the stem cell, the embryo's age or developmental limit, and research line purpose (Table 5-2). The policy levels for these measures will rely fundamentally on the symbolic moral status of the embryo. The use of particular or combinations of these measures creates configurations or hierarchies of choices that indicate the chosen legal paths of HSCR (Salter & Salter, 2007; Salter, 2007).

B- Configurations and Policy Levels

Given the scientific and socio-economic factors in play in stem cell technology, a government or an authorized religious agency may support or oppose a particular or a combination of components to achieve an acceptable political compromise. Hence, different possible constructed configurations of HSCR components result in prominent ethical positions for research line purposes. The research will survey the policy levels for the resulting constructed configurations

for analysis, as illustrated in Table5-3. In cultural terms, the bioethical levels move from prohibition (the moral status of the human embryo and its sanctity are preserved from the time of fertilization) to permission (the moral status of the human embryo diminishes, and the status is attached to its scientific, economic, and social utility).

Table 5-2: HSCR Scientific and Ethical Components.

HSCR Components	**Type of Research**	**Indicators**	**Measures**
Sources of Human Stem Cells (How?)	Non-Embryonic	Adult Stem Cells (Brain, Skin, Bone Marrow, Liver, etc.)	Y/N
		non-IVF donated (Umbilical cord, placenta, skin, deciduous teeth, fetal tissues, aborted fetuses, etc.)	Y/N
	Embryonic Naturally Generated	IVF supernumerary, creation lines	Y/N
	Embryonic Artificially Generated (Embryoids)	Cloning (Human, Human parts) Somatic Cell Nuclear Transfer (SCNT) Induced Pluripotent Stem Cells (iPSCs)	Y/N Y/N Y/N
Embryo Age or Developmental limit (When?)	Embryonic	5-, 14-, 40-, or 120-days past fertilization	value
Research Line Purpose (What for?)	All types	Therapeutic (Th) Research (R) Reproductive (Rp)	value
The value "- "indicates nonspecific policy or no record at present.			

In political terms, the regulatory policy follows the same continuum from "restrictive" (protection of the early human embryo) to "permissive" or liberal (no moral status of the embryo but simply an instrument in the application of HSCR). The political impact of these configurations is translated into policy levels legitimated by ethics, where states adopt individual positions and policies according to social and religious guidelines.

Table 5-3: Policy levels of HSCR Policies and Guidelines.

Policy Level	**Policies**	
	Permission	**Prohibition**
Restrictive	Procurement of adult stem cells (from brain, skin, bone marrow, liver, etc.).	Research using embryos or cell lines derived from embryos.
Restrictive Compromise	Procurement of non-IVF stem cells (from the umbilical cord, placenta, fetal tissues, aborted fetuses, etc.)	Research using embryos or cell lines derived from embryos.
Permissive Compromise	Procurement of hESCs from IVF-supernumerary embryos. Restricted by an age limit or a creation date.	Research using embryos or cell lines derived from embryos beyond an age limit or a creation date.
Permissive or Liberal	Creation and procurement of hESCs, including SCNT, iPCS, and cloning. Restricted by an age limit and application.	

For example, under Australia's Research Involving Human Embryos Act 2002, IVF supernumerary embryos (What?) are qualified as "excess "for use in research only if the creation date is before April 5, 2002 (when?), and only for therapeutic purposes (what for?). So, the configuration is defined by the ethical criteria "How?" "When?" and "What for?" resulting in a "permissive compromise" policy with the creation line date limit of April 2002 and therapeutic

line purpose only. Otherwise, IVF supernumerary is prohibited, and the "restrictive compromise "policy level is effective (Salter & Salter, 2007). Regarding the sui generis status of the in vitro embryo (the fertilized egg) discussed before, policy level 1 reflects the conservative view of the human life beginning just past fertilization, policy levels 2 and 3 reflect the status of graduality, and policy level 4 reflects no moral status for the in vitro embryo.

5.2 Methods

To understand the surrounding issues and the ethical measures of HSCR in the Muslim world, this comparative research examines the HSCR profile of the Muslim countries, surveys the existing bioethical policies and guidelines concerning the perceptions of the human embryo's moral status (the fertilized egg), and the legal position from HSCR and abortion in Islamic Law. First, a cross-country examination of the HSCR profile is conducted. The examination includes: (1) the country's R&D investment profile in R&D which is conventionally depicted in research intensity (GERD as a percentage of its gross domestic product GDP). The GERD will provide an insight into the prominence of R&D and the priority in the country's budget; (2) the existence of bioethics committees (or equivalences), expert and public debates, and (3) the country's collaborations with international HSCR bodies such as the number of stem cell-related research publications, stem cell-related clinical trials, and the number of registered Cord blood (CB) banks. These indicators are used to guide the selection of the Muslim countries for the case-based studies.

Second, the examination surveys the profile of the top contributors of Muslim countries in HSCR regarding their Islamic affiliation, the legal position of the various HSCR constructed configurations regarding non-embryonic stem cell research, followed by the legal position of

each country concerning both types of embryonic stem cell research. Based on examining the constructed configurations or paths of the HSCR components, the research investigates the influence of the country's sect and affiliation on the policy level of the HSCR components; and the consistency of HSCR legal positions with the country's religious position on clinical abortion. Eventually, the case-based studies facilitate comparing and contrasting the current legal status of HSCR and the potential pathway in the Islamic tradition to reach a harmonized regulatory platform and a policy consensus for HSCR activities in the Muslim World.

Muslim countries reside in several sub-regions of Europe, Asia, Africa, and the Middle East. These sub-regions comprise about 50 Muslim countries, primarily located in the Middle East region – Appendices Table1. A wide range of international open-access statistical databases is employed in the cross-country examination such as UN data, UNESCO, World Bank Open Data (WB), and UNCTAD to provide data on the socio-economic profile of the Muslim countries. HSCR data associated with the research components and policy levels for the top Muslim countries are provided from scholarly publications and datasets of stem cell organizations. These stem cell datasets include the International Society for Stem Research (ISSCR), Hinxton Group, Arab Scientific Community Organization, the Muslim World League, and other datasets presenting the most recent and reliable data on global and national HSCR regulatory policies (Appendices Table 2).

To evaluate the state of HSCR in the top Muslim countries, the number of stem cell research-related citations are identified from the Web of Science - Science Citation Indexing – using search queries with keyword strings (“TI = stem cell” AND “COUNTRY= respective country”). Data on the number of privately and publicly funded clinical studies conducted worldwide are

retrieved from the open-access database “ClinicalTrials.gov". The number of registered Cord blood (CB) banks are available on the Parent's Guide to Cord Blood organization's official website. Search queries (“Country = respective Country”) are used for each country (Appendices Table3).

6 Results

HSCR data linked to the country's profile and bioethics national policies are surveyed to analyze the existing HSCR regulations and guidelines as well as abortion laws. The data includes the profile indicators of the Muslim countries, countries' sect and affiliations, the national policies of the defined components for each type of HSCR, and the countries' legal positions on abortion. To understand the variations in the HSCR national policies and the influence of the different sects and affiliations, cross-country comparisons of the national policies of HSCR primary areas (non-embryonic and embryonic) and legal positions on abortion are conducted.

6.1 HSCR Profile of the Top Muslim Countries

The Muslim World views science and biomedical technology as a mechanism for improving their well-being and the economy. Countries that prioritize R&D and invest in HSCR are significant contributors to HSCR outputs or determinants in terms of publications, clinical trials, and the number of Cord blood (CB) banks (Appendices tables 3 and 4). These research intensity indicators select the top 17 countries in HSCR, as demonstrated in Table 6-4. The top 17 Muslim countries span Asia, Africa, and the Middle East. Due to their relatively solid scientific outputs, the top 17 Muslim countries are considered the ideal selection for examining their national guidelines and regulations policies of HSCR practices (Appendices Table4). Among the top 17 Muslim countries, the data show that only Iran and Jordan have HSCR societies or public debates. For HSCR regulation, the data identify that 10 out of 17 countries have HSCR national policies and guidelines. Bioethics of HSCR in these countries is governed by government ministries or joined to religious jurisprudence. Table 6-4 demonstrates the national agencies and

authorities that define HSCR policies for these countries. For the top 17 countries, R&D investments as a percentage of GDP range from 1.44 to 0.12, with Malaysia on the top (worldwide value is about 2.81 for the USA). Related stem cell publications count from 2025 for Turkey to 24 for Kazakhstan. Similarly, Turkey tops the number of stem cell clinical trials with 98. As shown in Table 6-4, the growing numbers indicate that all the top 17 countries witness significant investments in new public, private, and hybrid Cord blood (CB) banks.

To examine the link between the legal position of the top 17 Muslim countries from HSCR components, the review of laws and guidelines centered on two areas: non-embryonic and embryonic stem cell research.

6.2 Non-Embryonic Stem Cell Research in the Top 17 Muslim Countries

In the account of non-embryonic stem cell research, the policy level of the top 17 Muslim countries using adult and non-IVF stem cells is identified as "restrictive compromise" (policy level 2), as demonstrated in Table 5-3. All countries of all affiliations legally permit the use of both components of non-embryonic stem cells in research and therapy, demonstrating a progressive stance in this area of stem cell technology (Appendices Table 5).

Data shows that the legal position for all the top 17 countries of all affiliations to the HSCR components of non-embryonic stem cell research (adult and non-IVF stem cells) permit the procurement of adult stem cells derived from brain, skin, bone marrow, liver, etc.; and non-IVF derived from the umbilical cord, placenta, fetal tissues, aborted fetuses, etc.) for therapeutic purposes. Hematopoietic and umbilical cord transplantations are the most established form of stem cell therapy in these countries (Gopalan & Mohamed, 2020). Embryonic Stem Cell (ESC) Research in the Top 17 Muslim Countries.

HSCR guidelines in Muslim countries align in general with the universal moral rules defined by the Guidelines for stem cell Research and Clinical Translation (2016) of the International Society for stem cell Research (ISSCR). The focus in this HSCR area - Embryonic Stem Cells (ESCs) - is on the in vitro culturing or processing of naturally and artificially generated human pre-embryos. All the top 17 Muslim countries prohibit using cultured ESCs in research related to human germline gene therapy or for reproductive purposes at all stages of development (Table 6-5).

Table 6-4: HSCR Profile of the Top 17 Muslim Countries by Affiliation.

Country	Religious Affiliation	HSCR Societies / Public Debate	HSCR National Policies	HSCR Authority	R&D as % of GDP	Publications (TI="Stem Cells")	Clinical Trials (TI="Stem Cells")	Cord blood (CB) banks
Qatar	HNB, MLK	N	Y	by Law; National Fatwa	0.82	45	0	3
Saudi Arabia	HNB	N	Y	SFDA; 2003 MWL Fatwa	0.58	607	24	3
Bangladesh	HNF	N	N	Ministry of Health and Welfare	#N/A	27	1	1
Egypt	HNF	N	N	Egyptian Fatwa Council 2007, Ban by MOHP 2009 of ESC Therapy	0.72	430	63	5
Jordan	HNF	Y	Y	2003 MWL Fatwa, Statute 2014; Law number 47 on Public Health (Article 6)	0.71	113	25	2
Kazakhstan	HNF	N	N	by Law - Article (99); Covenant Article 15 (1, 12, 15)	0.12	24	2	1
Pakistan	HNF	Y	Y	Pakistan Medical Research Council (PMRC)	0.24	125	15	3
Turkey	HNF	N	Y	by Law; MoH	0.96	2025	98	6
Oman	IBD**	N	N	-	0.22	37	1	3

Country	Religious Affiliation	HSCR Societies / Public Debate	HSCR National Policies	HSCR Authority	R&D as % of GDP	Publications (TI="Stem Cells")	Clinical Trials (TI="Stem Cells")	Cord blood (CB) banks
Algeria	MLK	N	N	MoH	0.54	108	2	0
Morocco	MLK	N	N	-	0.71	29	0	1
Nigeria	MLK	N	N	-	0.13	38	0	1
Tunisia	MLK	N	Y	by Law	0.6	75	3	0
UAE	MLK	N	Y	by Law; Dubai Healthcare City Authority - Regulatory (DHCR)	1.3	47	6	7
Indonesia	SHF	N	Y	by Law - MoH Decree & Regulation - Indonesian Patent Act No. 36 2009	0.23	134	31	3
Malaysia	SHF	N	Y	by Law; Guideline for Stem Cell Research and Therapy (2009)	1.44	256	22	4
Iran	SHI	Y	Y	Khamenei Stem Cell Fatwa 2002; Ministry of Health and Medical Education	0.83	1206	77	1

Religious Sects and Affiliations: Religious Sects and Affiliations: S=Sunni; HNF=Hanafi; SHF=Shafi'i; MLK=Maliki; HNB=Hanbali; SHI=Shi'ia; IBD **=Ibadi is not identified as one of the prominent Sunni affiliations; MWL= Muslim World League; MoH= Ministry of Health.

Table 6-4: Continued

6.3 Embryonic Stem Cell in the Top 17 Muslim Countries

A- Naturally Generated Human Embryos

As demonstrated in Table 6-5, basic research on human embryos generated from IVF supernumerary is prohibited by 6 out of the 17 top countries: Turkey, Algeria, Morocco, Nigeria, Tunisia, and Indonesia. Prohibition is issued by law, either by the constitution or governmental ministries. In this context, cultural and traditional beliefs are assumed to hinder embryonic stem cell research in these countries with no reference to a regional or national religious decree or Fatwa. Due to limited resources and lack of field knowledge, Bangladesh and Oman have no record of ESC research (Devolder, 2005; Ismail, 2020). In Egypt, ESC therapy was banned by MOHP in 2009 and by a National Egyptian Fatwa Council issued in 2007. Despite the ban, ESC research exists. Furthermore, the creation of stem cells by cloning (such as HSCT) that is not done for reproductive purposes is generally accepted among scientists in private research centers (Sleem, 2012). For Oman, there is no published record of ESC research. Only HSCT using adult stem cells from bone marrow, peripheral blood, and cord blood has been carried out for three decades (Dennison et al., 2008; Ismail, 2015). In contrast, eight countries institutionalized ESC research allowing the use of the IVF supernumerary embryos and the establishment of new human cell lines from discarded embryos from fetal or adult stem cell lines before two different time points (5- and 14-day rules) for research and therapeutic purposes. Jordan and the UAE set a 5-day rule limit, while six countries set an alternative universal limit, the 14-day rule. Based on this data, these countries adopt a "permissive compromise" HSCR policy (policy level 3).

From the Islamic jurisprudential perspective, all countries of the Hanbali and Shi’ia affiliation allow ESC research by law and religious decree. In contrast, countries of Maliki affiliation,

except for the UAE, prohibit ESC research. The UAE does not have a national legal framework or governing rules for ESC research, yet ESC research and applications exist on an individual base (Castillo-Aleman, 2021). For the Hanafi group, three countries (Jordan, Pakistan, and Kazakhstan) allow the use of the IVF supernumerary embryos by law and national religious decrees (Fatwas). These Fatwas outline acceptable practices within the Islamic philosophy context that encourages scientific research directed toward finding cures for human diseases. For the Shafi'i affiliation, Indonesia prohibits using the IVF supernumerary under the Indonesian Patent Act. The Ministry of Health views that only adult stem cells are suitable for conditions in Indonesia and would be acceptable from a moral and religious perspective (Utomo, 2012). On the other hand, the newly revised Malaysian stem cell guideline allows research on ESCs derived from IVF supernumerary embryos. It follows the 120-day limit based on its Islamic practice that justifies human embryonic stem cell research and stem cell technology based on the 14-day rule adopted globally (Gopalan et al., 2020).

Table 6-5: Legal Positions of the Top 17 Muslim Countries from Naturally Generated ESC Research by Affiliation.

Policy Level 3						
Country	**Religious Affiliation**	**National Policies / Guidelines**	**IVF Super-numerary**	**Embryo Creation Lines**	**HSCR Line Purpose**	**Authority**
Qatar	HNB, MLK	Y	Y	<6 days	Th	by Law, Qatar Supreme Council of Health (SCH), National Fatwa
Saudi Arabia	HNB	Y	Y	<14 days	R, Th	SFDA, MWL Fatwa (2003) IVF Act #2870/1/12
Bangladesh	HNF	N	-	-	-	Ministry of Health and Welfare
Egypt	HNF	N	-	-	R, Th	Ban of ESC Therapy by MOHP (2009) National Egyptian Fatwa Council (2007)
Jordan	HNF	Y	Y	<5 days	R	Statute 2014, MWL Fatwa (2003)
Kazakhstan	HNF	N	Y	-	R, Th	by Law - Article (99); Covenant Article 15(1, 12, 15)
Pakistan	HNF	Y	Y	<14 days	R, Th	Pakistan Medical Research Council (PMRC)
Turkey	HNF	Y	N			by Law, MoH
Oman	IBD**	N	-	-	-	-

Policy Level 3						
Country	**Religious Affiliation**	**National Policies / Guidelines**	**IVF Super-numerary**	**Embryo Creation Lines**	**HSCR Line Purpose**	**Authority**
Algeria	MLK	N	N	N	-	MoH
Morocco	MLK	N	N	N	-	-
Nigeria	MLK	N	N	-	-	-
Tunisia	MLK	Y	N	N	-	by law
UAE	MLK	N	Y	<5 days	-	by Law; Dubai Healthcare City Authority - Regulatory (DHCR)
Indonesia	SHF	Y	N	N	-	by Law - MoH Decree & Regulation - The Indonesian Patent Act No. 36 (2009)
Malaysia	SHF	Y	Y	<14 days	R, Th	by Law – Malaysian Guideline for Stem Cell Research and Therapy (2009)
Iran	SHI	Y	Y	<14 days	R, Th	Khamenei Stem Cell Fatwa 2002; Ministry of Health and Medical Education

Religious Sects and Affiliations: Religious Sects and Affiliations: S=Sunni; HNF=Hanafi; SHF=Shafi'i; MLK=Maliki; HNB=Hanbali; SHI=Shi'ia; IBD **=Ibadi is not identified as one of the prominent Sunni affiliations; MWL= Muslim World League; MoH= Ministry of Health; R=research; Th=therapeutic; "-"indicates nonspecific policy or no record at present.

Table 6-5: Continued

B- Artificially Generated Human Embryos (Embryoids)

Most national laws and guidelines in the top 17 Muslim countries do not explicitly state whether this type of research is permitted or restricted but may be indirectly inferred or interpreted from the ESC regulations in place. Embryoids require permission to create embryos, reprogramming, and re-engineering their DNA in laboratories, especially for research and therapy (Al Tabba', 2020; Matthew & Morali, 2020). Data from the related literature show that only 5 out of 17 countries (Qatar, Saudi Arabia, Jordan, Pakistan, and Iran) allow the use of IVF supernumerary to create embryoids or any other method employed to derive ESC lines for research and therapy as demonstrated in Table 6-6. The ESC technology (iPSC and SCNT) is permitted, provided that it is not implanted into a woman's uterus or used for reproductive purposes. Jordan, Pakistan, and Iran have clear regulations on the use of ESCs formulated by the Ministry of Health, the National Biosafety Committee in Islamabad; the Ministry of Health and Medical Education in Iran; and the Jordanian Stem Cell Statute (JSCS), respectively. These countries present a "permissive" HSCR policy where the embryoid is viewed as an organic material or an instrument in HSCR with no independent moral status or sanctity. The rest of the countries prohibit the creation of embryos explicitly for research due to traditional perspectives, fear of misuse and exploitation, or lack of knowledge and practice rather than theological or philosophical reasoning.

From the Islamic jurisprudential perspective, countries of the Shi'ia and Hanbali affiliations approved the in vitro processing of ESCs (iPSCs, SCNT, and cloning) from any permissible source of human tissue since the current embryoids models do not scientifically have the potential to become a human being. As a Shi'i country, Iran employs the new ESC technology based on the Khamenei Fatwa in 2003. In the Hanbali group, Saudi Arabia and Qatar follow

Islamic decrees of MWL 2003 and a national fatwa, respectively – that allow "to acquire, grow, and use stem cells for therapy or scientific research as long as the cells' sources are permissible". The Fatwa does not explicitly address the innovative technology in particular, but it can be indirectly inferred to allow the creation of embryoids for research and therapeutic purposes. For the Maliki affiliation, 3 out of 6 countries prohibit embryo creation from any human tissue for any purpose. The UAE has a vague policy for the permissibility of innovative technology, and the other two countries have no record of its practice (Castillo-Aleman, 2021). For the Hanafi affiliation, only two countries of the group, Pakistan, and Kazakhstan, have guidelines on the processing of ESCs. Both countries have no regulation or law that dictates the status of the embryo, or at which point human life begins. The regulations are based on the approach of risk management of ESC research. In Pakistan, the use and manipulation of ESCs in research or clinical work are considered permissible if there are no reports in the literature of any adverse effect or undesirable concern concerning the origin, potency, level of in vitro processing, or the manner in which these are used (NGO Parallel Report on the Republic of Kazakhstan's 2018, Law and Justice Commission of Pakistan, 2019). For Egypt and Bangladesh, there is no clear policy instituted to create embryoids, and only Turkey prohibits the technology by law (Arda & Aciduman, 2009). Similarly, Oman has no mention of the innovative technology in their national guidelines, which may be due to no hold yet on it. Lastly, for the Shafi'i affiliation, both countries – Indonesia and Malaysia – prohibit the creation of embryoids by law (Ministry of Health Malaysia, 2009; Utomo, 2012).

The policy level for all the top 17 countries for the HSCR components by religious affiliation is summarized in Table 6-7. Albeit the substantial diversity, the cross-country examination of HSCR guidelines in the top 17 Muslim countries concludes a "restrictive compromise" policy for

four countries, a “ permissive compromise” policy for eight countries, and a “permissive” policy for five countries. However, the #N/A value (nonspecific policy or no record) for the use of ESCs suggests possible permissibility for five countries that can be added and change their HSCR policy level to “permissive compromise” and “permissive” (policy levels 3 and 4) if regulated.

Table 6-6: Legal Positions of the Top 17 Muslim Countries from Artificially Generated ESC Research by Affiliation.

Policy Level 4							
Country	**Religious Affiliation**	**Embryo Creation**	**Embryo Creation Purpose**	**iPSCs**	**SCNT**	**Cloning**	**Notes**
Qatar	HNB, MLK	Y	Th	-	-	Th	Qatar Biomedical Research Institute in 2007, Policies in 2012
Saudi Arabia	HNB	Y	-	Y	N	Th	
Bangladesh	HNF	-	-	-	-	-	Limited resources of ESC research.
Egypt	HNF	-	-	-	-	Th	Experimental cloning is acceptable; Conflict of regulations regarding (ESC); Lack of funds.
Jordan	HNF	Y	-	Y	Y	R	
Kazakhstan	HNF	N	-	N	N	-	ESCs are imported from organizations or clinics abroad for transplantation, diagnostic studies, and joint scientific research.
Pakistan	HNF	Y	R, Th	Y	Y	Th	Biosafety Guidelines
Turkey	HNF	N	-	N	N	Th	IVF supernumerary embryos are discarded after 5 yrs.
Oman	IBD**	-	-	-	-	Th	

Policy Level 4							
Country	**Religious Affiliation**	**Embryo Creation**	**Embryo Creation Purpose**	**iPSCs**	**SCNT**	**Cloning**	**Notes**
Algeria	MLK	N	-	N	N	N	
Morocco	MLK	N	-	N	N	N	
Nigeria	MLK	-	-	-	-	-	Limited resources Bone Marrow Registry in 2012
Tunisia	MLK	N	-	N	N	N	NO experimental work on embryos
UAE	MLK	-	-	-	-	-	SC research and applications are on an individual base
Indonesia	SHF	N	-	N	N	-	
Malaysia	SHF	N	-	-	N	-	Embryo creation is only experimental.
Iran	SHI	Y	Th	Y	Y	Th	Producing human embryos only for research purposes is illegal.

Religious Sects and Affiliations: Religious Sects and Affiliations: S=Sunni; HNF=Hanafi; SHF=Shafi'i; MLK=Maliki; HNB=Hanbali; SHI=Shi'ia; IBD **=Ibadi is not identified as one of the prominent Sunni affiliations; MWL= Muslim World League; R=research; Th=therapeutic; "-"indicates nonspecific policy or no record at present.

Table 6-6: Continued

Table 6-7: HSCR Policy Levels for the Top 17 Muslim Countries by Affiliation.

Country	Religious Affiliation	Policy Level 1 "Restrictive"	Policy Level 2 "Restrictive Compromise"	Policy Level 3 "Permissive Compromise"	Policy Level 4 "Permissive"
Qatar	HNB, MLK	X	X	X	X
Saudi Arabia	HNB	X	X	X	X
Bangladesh	HNF	X	X	#N/A	#N/A
Egypt	HNF	X	X	#N/A	#N/A
Jordan	HNF	X	X	X	X
Kazakhstan	HNF	X	X	X	
Pakistan	HNF	X	X	X	X
Turkey	HNF	X	X		
Oman	IBD**	X	X	#N/A	#N/A
Algeria	MLK	X	X		
Morocco	MLK	X	X		
Nigeria	MLK	X	X		#N/A
Tunisia	MLK	X	X		
UAE	MLK	X	X	X	#N/A
Indonesia	SHF	X	X	#N/A	
Malaysia	SHF	X	X	X	
Iran	SHI	X	X	X	X
Total					
17	6	17	17	8+4	5+5

#N/A indicates possible permissibility for nonspecific policy or no record at present; religious Affiliations: HNF=Hanafi; SHF=Shafi'i; MLK=Maliki; HNB=Hanbali; SHI=Shi'ia; IBD **=Ibadi is not identified as one of the prominent Sunni affiliations; MWL= Muslim World League, R=research; Th=therapeutic

6.4 Abortion Laws in the Top 17 Muslim countries

Diversity in the Islamic positions on abortion is related primarily to which grounds are legally accepted reasons for abortion in terms of the pregnancy conditions and stage of gestational development. Data of the top 17 Muslim countries by legal grounds for abortion are retrieved from the open-access database of the United Nations (Department of Economic and Social Affairs, Population Division, 2019). Basically, abortion is forbidden across the Muslim world unless it is medically believed that the embryo's existence threatens the mother's life. In comparison, the destruction of an embryo for stem cell research and therapy stands on the same ground as abortion. Based on the Islamic legislation principles of "Do No Harm," "A severe harm shall be removed by a lesser harm," and "Public interest," at the bare minimum, it can be concluded that any effort to heal the disease of any kind, for any purpose, or in any field, must relentlessly be pursued.

Table 6-8 demonstrates the legal position on abortion and the legal grounds for the top 17 countries grouped by religious affiliation. The cross-country examination of the abortion position illustrates that clinical abortion is permitted for all affiliations on the ground of saving the life of the pregnant woman (L). When comparing countries of the same affiliation on other grounds, variation in legislation is significant, only three out of the 17 countries allow abortion for women on all grounds. On the other hand, the embryo age or developmental limit varies across countries between the 40-day rule (when the primitive streak develops into the nervous system and sentience begins) and the 120-day rule (when ensoulment occurs, and the embryo develops a complete moral status and rights of human life). However, within the Maliki school, which prohibits abortion from the day of conception (Table 4-1), UAE and Tunisia presented distinct positions for the embryo developmental limit.

Table 6-8: Legal Positions from Abortion for the Top 17 Countries by Affiliation.

Country	Religious Affiliation	Legal Clinical Abortion	Abortion Legal Grounds	Embryo Age Developmental Limit	IVF Super-numerary
Qatar	HNB, MLK	Y	L, PH, MH, F	120 days	Y
Saudi Arabia	HNB	Y	L, F, MH, PH	120 days	Y
Bangladesh	HNF	Y	L	10 weeks	-
Egypt	HNF	Y	L, F, MH, PH	-	-
Jordan	HNF	Y	L, MP, MH	-	Y
Kazakhstan	HNF	Y	ALL	12 weeks	Y
Pakistan	HNF	Y	L, PH, MH	120 days	Y
Turkey	HNF	Y	ALL	10 weeks	N
Oman**	IBD	Y	L, MH, MP, F	120 days	-
Algeria	MLK	Y	L, MH, PH, R	-	N
Morocco	MLK	Y	L, MH, MP	-	N
Nigeria	MLK	Y	L	-	N
Tunisia	MLK	Y	ALL	12 weeks	N
UAE	MLK	Y	L	120 days	Y
Indonesia	SHF	Y	L, F, R	6 weeks	N
Malaysia	SHF	Y	L, PH, MH	120 days	Y
Iran	SHI	Y	L, PH, MH, F	120 days	Y

Abortion is permitted: L- to save the life of the pregnant woman; PH- to preserve a woman's physical health; MH- to preserve a woman's mental health; F- in cases of fetal impairment; I/R- in cases of incest or rape; SE– for social or economic reasons; REQ- upon request; "-" indicates nonspecific policy or no record at present.

(40-day rule: primitive streak develops into the nervous system; 120-day rule: ensoulment occurs)

7 Discussion

It is fundamental in the Muslim world that the ethics of stem cell technology represent the basis of its regulation and policymaking, which essentially link to the Islamic jurisprudence and social principles. The cross-country comparison of the HSCR legislation and guidelines is limited to the top 17 Muslim countries based on their R&D investments and scientific outputs in this area. The comparison highlights the similarities and differences between national contexts focusing mainly on the Islamic views of the human embryo and embryoids as research tools. Overall, the cross-country comparison of the top 17 Muslim countries shows that the strict regulations of stem cell technology are based only on some countries' traditions and social perspectives. In contrast, the permissive or liberal approach to new knowledge and technologies relies on religious grounds and jurisprudential decrees, particularly the Khamenei Fatwa 2002 and MWL Fatwa 2003.

HSCR Country Profile

Regarding the HSCR profile, Table 7-9 demonstrates the scientific determinants of the top 17 Muslim countries related to human stem cells and the status of their research policies. Among the top 17 Muslim countries, it is noted that most HSCR activities in the Muslim World are conducted in the absence of any public discussions. Decisions concerning applying this knowledge are ultimately influenced by and debated among religious scholars, medical physicians, and advanced research enterprises. A fundamental element in the HSCR profile is the Cord blood (CB) banks which play a key role in stem cell transplants, including handling and storing CB units. The therapeutic potential of these banks raised the same ethical and regulatory concerns for the emerging stem cell technology in the Muslim world. The growing numbers of

CB can be explained due to low fertility rates and growth rates of degenerative diseases and genetic disorders in these countries. The international Biobanks and Biopreservation standards define the criteria for biospecimen procurement, processing, preservation and banking, distribution, and use for the banking centers in these countries (Al-Tabba' et al., 2020).

Table 7-9: HSCR Scientific Output of the Top 17 Muslim Countries by Number of Stem Cell Publications.

Country	HSCR Policies	# Publications in HSCR	# Clinical Trials in HSCR	# Cord Blood (CB) Banks	R&D as % GDP
Turkey	Y	2025	98	6	0.96
Iran	Y	1206	77	1	0.83
Saudi Arabia	Y	607	24	3	0.58
Egypt	N	430	63	5	0.72
Malaysia	Y	256	22	4	1.44
Indonesia	Y	134	31	3	0.23
Pakistan	Y	125	15	3	0.24
Jordan	Y	113	25	2	0.71
Algeria	N	108	2	0	0.54
Tunisia	Y	75	3	0	0.60
UAE	N	47	6	7	1.30
Qatar	N	45	0	3	0.82
Nigeria	N	38	0	1	0.13
Oman	N	37	1	3	0.22
Morocco	N	29	0	1	0.71
Bangladesh	N	27	1	1	#N/A
Kazakhstan	N	24	2	1	0.12

The results show that among the top 17 Muslim countries, seven countries with relatively scientific solid output in stem cell publications, clinical trials, and the number of CB banks do not have any national legal framework or guidelines governing ESC research. The UAE, Qatar, and Egypt are among these countries that invest a relatively high percentage of their GDP in R&D (1.3, 0.82, and 0.72, respectively), developed internationally registered CB, and are among the top contributors to publications and clinical trials. In contrast, countries such as Iran, Saudi Arabia, Pakistan, and Jordan, with relatively substantial contributions in the field, have clear supportive HSCR policies. The absence of national HSCR policies in these countries raises many concerning questions regarding their unregulated HSCR practices and international collaborations, thus opening possible malpractices or unethical conduct. Similarly, the presence of legal gaps or delayed legal regulations of the recent developments in HSCR practices leaves open the possibility of violation of rights and values for human health. Furthermore, the absence of clear regulatory guidelines in these countries embeds a negative picture in which human health is left in the hands of market dynamics. Inevitably, this situation will create a negative attitude and a point of insecurity toward medical society and medical practices nationally and internationally. Resolving ethical, legal, and jurisprudence concerns and challenges will help stem cell researchers and scientists in these countries produce and publish valuable and credible findings and introduce new products and drugs for severe diseases. Based on these results, only 52% of the Muslim countries with the largest R&D investments and HSCR collaborations have long-established research policies and regulatory guidelines, while the rest of the countries collaborate with no policies individually-base. In this context, this research recommends introducing and enforcing detailed legal regulations to offer health services appropriate for human dignity, blocking any commercialization attempts, and ensuring the dominance of science

and ethics in HSCR practices. In addition, a comprehensive revision of the current stem cell guidelines in similar countries of the same affiliation and cultural backgrounds, such as Iran, Jordan, Pakistan, and Saudi Arabia, as well as any adequate international provisions that can help regulate the explicit practices of the HSCR sectors and reinforce accountability.

Policy Levels of Non-Embryonic Stem Research

Results of the cross-country comparison indicate that non-embryonic stem cell research and therapy (adult and non-IVF stem cells) are not entangled in serious ethical controversies across all affiliations. Nevertheless, this stem cell area requires serious watchfulness in the countries without national policies and limited resources, such as the case of Egypt and Nigeria. Analysis of the existing literature shows that over the past three decades, HSCT is becoming a tangible reality and a vital therapeutic modality in the management of a variety of hematologic malignancies and hereditary disorders in the countries of the Muslim world (Ismail, 2015; Matsumoto et al., 2015; Selim, 2015).

Policy Levels of Embryonic Stem Cell Research

The HSCR-related literature claims that one of the fundamental reasons behind the lack of consensus in the Muslim world is the absence of central authority and the existence of different schools of thought in the Islamic faith. Comparing the legal position in the top 17 countries from non-embryonic and embryonic stem cells, the results of both Shi'ia and Sunni sects point to how the government legislation regarding what is permitted or prohibited is independent of the influence of the country's religious affiliation. Data clearly indicates that a different religious affiliation is not a barrier and individual countries adopt different policies based primarily on what is suitable to their socio-cultural, political, and economic backgrounds. For embryoids case,

which are explicitly created to be used in scientific research they seem to be the most problematic source of stem cells with no or nonspecific policies. Some scientists argue that the use of spare embryos is less controversial than those explicitly created for research purposes. This type of stem cell research is a recently developed technique that is not regularly practiced in developing countries, especially those with limited resources and technology. On the other hand, the prohibition of using IVF supernumerary embryos and creating embryoids for research and therapy is issued without mentioning an Islamic jurisprudence or decree reference (tables 5 and 6). In other words, the law prohibits what the progressive Islamic jurisprudence deems permissible under regulatory and supervisory conditions in these countries. The indicated justification for the prohibition is the concern and risk of knowledge misuse and commercial exploitations of the less privileged in the society, including women, children, the disabled, and prisoners, on religious grounds. It may also be explained that the prohibition is out of the country's desire to be a champion of ethics by avoiding the worldwide controversial topic and the possible unethical conducted work associated with it.

In contrast, countries that allow ESC research and therapy have different affiliations, yet they rely on a common Islamic jurisprudence in their legislation, particularly the Khamenei Fatwa 2002 and MWL Fatwa 2003. These countries present varying levels of flexibility as to when life begins (40- or 120-days); however, they restrict the use and culturing of the embryoids to two different time limits (7- and 14-day) for serious ESC research and the benefit of humankind. Overall, their national stem cell guidelines strictly adhere to the general principles of Islamic teaching about human dignity, human rights, equality, and justice and are consistent with the revised international guidelines of ISSCR. These findings do not support the claim that the variation in the HSCR guidelines in the top 17 countries is due to different religious schools of

thought (affiliations) or religious perspectives. It is very well suggested that the prohibiting countries cooperate and align with the HSCR guidelines of the pioneering countries of both Muslim sects. The newly revised HSCR policies in Iran, Pakistan, Saudi Arabia, Malaysia, and the stem cell Statute of Jordan are well suited as directives and models for other Muslim countries strictly regulating HSCR or have nonspecific policies. The HSCR policies in these pioneering countries are based on Islamic religious grounds decreed by a collection of influential Muslim scholars of both sects. Their jurisprudential reasoning considers, above all, the respect, dignity, and sanctity of human life well as universal moral rules. In addition, their Islamic ruling on ESC research is not contradictory with their Islamic policies and legal positions on abortion for all affiliations. As discussed above, the graduality view of the embryo in Islamic faith and principles applies in both cases. This case-based reasoning would free up the spare frozen embryos for research and from being discarded. Reasonably, we can argue that if ESC research aims to alleviate human suffering, permitting such research would not be controversial; then, leaving the surplus frozen embryos to die without utilizing them to save human lives can be viewed in itself as immoral.

With this reasoning in place, the discussion mentioned above concludes that ESC research is permissible in Islam and is independent of the sect or affiliation as a barrier to legislation and source of variation. The permissibility is constrained by the permissible sources, research purpose and applications, and the necessary supervisory precautions to respect human life. Attempts to do so can bridge all the policy disagreements and variations among Muslim countries and encourage consensus on a "permissive" policy that will promote HSCR to reach international standards and generate more valuable collaborations.

Policy Levels of Embryonic Stem Research and Legal Clinical Abortion

Muslim scholars and intellectuals apply case-based arguments and reasoning for judgment on newly emerging ethical issues based on the Islamic principles discussed. The case-based argument, in this case, links the moral status of the embryo in both clinical abortion and the fate of the IVF supernumerary pre-embryos. All affiliations unanimously allow abortion or, in other words, the destruction of a human embryo, and that it should not be protected at the cost of a legitimate and fundamental reason which is the woman's life and wellbeing. Based on the developmental view in the Islamic faith, the moral status of the early-stage embryo is acknowledged. However, it does not rise to the level of the moral status of fully human life and can be sacrificed to save the woman's life. One of the definitive justifications for all affiliations to this legislation is the principle of "A severe harm shall be removed by a lesser harm." The same reasoning would apply to the central question of the spare IVF pre-embryos; whether we allow discarding or destroying a potential life (to extract the stem cells) as the lesser harm to save other full human lives suffering debilitating diseases from the severe harm.

The cross-country comparison of embryonic stem cell areas (the naturally and artificially generated embryos) reflects substantial diversity between and within affiliation groups. Analysis of this HSCR area - Embryonic Stem Cells (ESCs) – is linked to three key issues: the fate of the IVF supernumerary pre-embryos, the in vitro culturing, or processing time limit of these pre-embryos, and the artificial creation of human pre-embryos (embryoids) for scientific research. The cross-country comparison shows that the use of human pre-embryos generated from IVF supernumerary is prohibited independently of the affiliation group. For instance, 6 out of the top

17 countries (35%) - Turkey, Algeria, Morocco, Nigeria, Tunisia, and Indonesia - explicitly prohibit ESC research by law (Table 6-5). These countries belong to different affiliation groups, and prohibition is issued by law (constitution or governmental ministries) without reliance on a particular religious decree (Fatwa) or affiliation setting. Furthermore, reviewing the position of these countries on clinical abortion (Table 6-7), a contradiction to the Islamic graduality view of the embryo's moral status clearly exists. This issue is very evident in the case of Turkey (HNF) and Tunisia (MLK). Both countries legally allow abortion on all grounds, and both prohibit ESC research and the use of IVF supernumerary pre-embryos by law. Apparently, the view of a gradual independent moral status is seen in the regulations on abortion and other assisted reproductive techniques; however, it is seen as inconsistent with their regulations concerning the use of IVF supernumerary pre-embryos. Despite the prohibition, there are no illegal charges in both countries that count spare pre-embryos lately discarded by law as humans or abortion or even equivalent to infanticide.

Conversely, 8 out of 17 countries (47%) – Qatar, Saudi Arabia, Jordan, Kazakhstan, Pakistan, UAE, Malaysia, and Iran - allow the use of the IVF supernumerary embryos and the establishment of new human cell lines from the discarded embryos before two different time points (5- and 14-days limit) for research and therapeutic purposes based on religious decrees (Fatwa) and joint debates between scientists and Muslim scholars. In these eight countries, the permissibility of using the spare pre-embryos is primarily based on the two Fatwas (Khamenei Fatwa 2002 & MWL Fatwa 2003), considering the Islamic graduality view and the reasoning principles. Both Fatwas pay regard to the fact that the pe-embryo having the "potential" to become a developed human life does not make it an "actual" human life by default with full rights and sanctity. In addition, they pay regard to the scientific fact that human pre-embryos,

which are less than 14 days old, feel no pain or sentience since no primitive neural streak appears and develops before this time point. Hence, HSCR regulations in these countries are founded on the above principles and account for the potential beneficial outcomes of ESC life-saving therapies.

8 Conclusion

Ethical issues concerning stem cell research are debated among medical physicians and religious scholars worldwide. Recent studies indicate that HSCR policies are influenced by the religious, cultural, and social positions concerning the moral status of the human embryo and when human life is begun. In this regard, by analyzing the legal positions of the top 17 Muslim countries in HSCR, we can argue that the fundamental basis for the variation in HSCR policies in the Muslim world is not embedded in the different Islamic perspectives or affiliations but in other socio-cultural, economic, or political issues especially the lack of stem cell knowledge, fear of knowledge misuse, and commercial exploitations of less privileged subjects and communities. Hence, there is a crucial need to enforce education and basic understanding among the public of HSCR functions and therapeutic potentials to bridge the differences in HSCR legal positions and resolve its ethical issues and uncertainties.

The literature review emphasized the paramount importance of saving lives in Islam. Islamic jurisprudence regarding HSCR ethical issues demonstrates a prevalent pragmatism and aims to seek a balance between Islamic culture and the innovations of modern medicine without violation of the fundamental Islamic doctrine. Judgments of Islamic jurisprudence on the embryo's moral status are based on the graduality view, where the early pre-embryos are regarded as worthy of respect but do not have the complete sanctity offered to the embryo after implantation in the uterus or after ensoulment. The cross-country comparison indicates that the HSCR “permissive” policy adopted by 52% of the selected countries is concluded by implementing the Islamic graduality view of the human embryo, the jurisprudential principles of

reasoning, and the case-based approach implemented to abortion. According to the two religious decrees or Fatwas (Khamenei stem cell Fatwa 2002 & Sunni MWL Fatwa 2003), influential Muslim scholars representing Muslim attitudes and aspirations agreed that acquiring, growing, and using stem is permissible cells for therapy or scientific research. Based on these Islamic decrees, permissive policies in Muslim countries outline national guidelines on HSCR but they are not legally binding. This permissibility is constrained by the use of legal stem cell sources, research purpose and applications, and the necessary supervisory precautions to respect human life. Permissible sources are mainly linked to legal marriage, legal clinical abortion, informed consent of parents, confidentiality, no commercialization, and other management criteria.

Based on the countries' HSCR profile, the cross-country comparison of the top 17 Muslim countries indicates that about 41% of the selected countries with relatively scientific solid output in stem cell publications, clinical trials, number of CB banks, and fundings work on an individual basis without any national legal framework or guidelines governing ESC research. This finding is alarming for the credibility and accountability of ESC practices and ethics in these countries.

Regarding HSCR policies for the different components, all Muslim countries allow non-embryonic stem cell research, where the use of adult and non-IVF stem cells are the least problematic sources and are regulated with clear supportive policies. In contrast, the cross-country comparison projects substantial variation for both types of ESC research (natural and artificial generated embryos) among the top selected countries independent of their sect or affiliation. Almost half of the top 17 countries institutionalized ESC research with "permissive compromise" policies allowing the use of the IV supernumerary embryos for research and therapeutic purposes. In the case of embryoids, only one-third of the top 17 countries adopted a

"permissive" policy allowing to create embryos and simulate embryonic models. Other countries adopted a ”restrictive” prohibiting ESC research, which is inconsistent with their policies and legal positions on abortion that rely on the same embryo's moral status.

Based on these findings, it is evident that ESC research is permissible in Islam and is independent of the sect or affiliation as a barrier to a permissive stance as long as it utilizes the permissible sources, research purpose, and applications, and the necessary supervisory precautions to respect human life. Revisions of restrictive policies and the constructive debates among Muslim countries on the existing policy models can bridge all the policy variations and help reach a consensus on a unified permissive legal framework that will promote HSCR to reach international standards, clear all uncertainties, and generate more valuable collaborations.

Recommendations

In order to succeed in promoting and regulating HSCR in the Muslim world, it is imperative that authorities drafting guidelines for ESC research must be a task force of scientists, religious scholars, stakeholders, and professionals with an adequate understanding of scientific, ethical, legal, and social aspects of these significant advances in biomedical technologies. The findings of this research analysis recommend the revision of the current HSCR policies for all the Muslim countries prohibiting ESC research and the consideration of the "therapeutic promise" offered by the ESC innovative technologies. Based on the results, countries of common sect and affiliation can unify their policies to be consistent with the already set rules for abortion and related issued Fatwas. The research advises the HSCR permissive national policies in effect in the top countries as a suitable regulatory framework that can help resolve all uncertainties and reach a consensus in the Muslim world. Attempts to achieve these goals will lessen the feeling of national and

international insecurity toward the stem cell scientific community in the Muslim world and contribute to establishing healthcare policies that respect human rights and sanctity.

Second, there is a need to enforce public discussions and education to understand what stem cells are and how they function. In developing countries where traditional and socio-cultural norms dominate, it becomes essential and crucial to work on the awareness and education of the public to correct the deficit in knowledge related to this issue. Furthermore, domestic stem cell therapy and regenerative medicine are low-cost solutions for the growing number of patients with chronic diseases, including diabetes, heart diseases, hepatitis, and blood diseases such as thalassemia, which are relatively prevalent in these countries (Saniei, 2013). The combination of high demand, surging science, clear supportive policies, and standard ethical norms will all contribute to advancing biomedical technologies and particularly HSCR in the Muslim world.

9 References

Abdur Rab, M., & Khayat, M.H. (2006). Human cloning: Eastern Mediterranean Region perspective. Eastern Mediterranean Health Journal, Vol. 12 (Supplement 2).

Agbedia, C., & Godwin, O. (2013). The challenges of stem cell research in Nigeria International Journal of Advanced Nursing Studies, 2 (2) (2013) 52-57.

Aksoy, S. (2005). Making Regulations and Drawing Up Legislation in Islamic Countries Under Conditions of Uncertainty, With Special Reference to Embryonic Stem Cell Research. Med Ethics, 31:399–403.

Alahmad, G., Aljohani, S., & Najjar, M.F. (2020). Ethical Challenges Regarding the Use of Stem Cells: Interviews with Researchers from Saudi Arabia. BMC Med Ethics, 21, 35.

Al-Tabba', A., Dajani, R., & Al-Hussaini, M., (2020). Stem Cell Statute in Jordan: Leading the Way. Policy and Practice Reviews, Frontiers in Genetics, vol. 11, article 657.

Arab Scientific Community Organization Official Website.

https://arsco.org/aboutus-English

Arda, B., & Aciduman, A. (2009). An Evaluation Regarding the Current Situation of Stem Cell Studies in Turkey. Stem Cell Rev Rep, 5(2):130-4.

Bapat, A. (2018). Regenerative medicine in the Middle East. The Middle East Medical Portal (MEMP). General Medicine, Regenerative Medicine.

Cambell, A., & Nycum, G. (2005). Harmonizing The International Regulation of Embryonic Stem Cell Research: Possibilities, Promises, and Potential Pitfalls. Med Law Int., 7(2):113-48.

Castillo-Aleman, Y.M., et al. (2021). Regulatory Prospects of Clinical Trials with Stem Cells in the United Arab Emirates. Int J Stem Cell Res Ther International Journal of Stem Cell Research & Therapy, 8:073, Volume 8, Issue 1.

ClinicalTrials.gov database.

https://clinicaltrials.gov/

Dennison, D., et al. (2008). Hematopoietic Stem Cell Transplantation in Oman. Bone Marrow Transplantation, 42 Suppl 1(S1): S109-S113.

Devolder, K. (2005). Creating and Sacrificing Embryos for Stem Cells. J Med Ethics, 31: 366-/70.

Dhar, D., & Hsi-en Ho, J. (2009). Stem Cell Research Policies around the World. Yale Journal of Biology and Medicine, (82), pp.113-11.

Emanuel, E.J., Wendler, D., Killen, J., & Grady, C. (2004). What Makes Clinical Research in Developing Countries Ethical? The Benchmarks of Ethical Research. J Infect Dis.,189(5):930-7.

Esposito, J. L. (2014). “Islamic Law”. The Oxford Dictionary of Islam. Oxford: Oxford University Press. Archived from the original on 31 March 2019. Retrieved 22 January 2019.

Ezekiel, J., et al. (2004). What Makes Clinical Research in Developing Countries Ethical? The Benchmarks of Ethical Research. Department of Clinical Bioethics, Warren G. Magnuson Clinical Center, National Institutes of Health, Bethesda, Maryland: 189.

Fadel, H. (2007). Prospects and Ethics of Stem Cell Research: An Islamic Perspective. JIMA: Journal of Islamic Medical Association, Volume 39, page 73.

Fakruddin, M.D. (2012). Ethics In Stem Cell Research. Bangladesh Journal of Bioethics, 3(1):13-18.

Farajkhoda, T. (2017). An Overview on Ethical Considerations in Stem Cell Research in Iran and Ethical Recommendations: A Review. Int J Reprod BioMed, Vol. 15. No. 2. pp: 67-74.

Flynn, J.M., & Matthews, K.R. (2010). Stem Cell Research in The Greater Middle East: The Importance of Establishing Policy and Ethics Interoperability to Foster International Collaborations. Stem Cell Rev Re, 6(2):143-50.

Gopalan, N., Nor, S.N.M., & Mohamed, M.S. (2020). Regulation of Stem Cell Technology in Malaysia: Current Status and Recommendations. Sci Eng Ethics, 26(1):1-25.

Hengstschläger, M., & Rosner, M. (2021). Embryoid Research Calls for Reassessment of Legal Stem Cell Research & Therapy, 12:356.

Ismail, A. (2015). Stem Cell Research and Ethics: An Update. Oman Medical Journal, Vol. 30, No. 1: 1–2.

Kanyıs, T. S. (2019). Human Embryonic Stem Cell Research: A Comparison Between Turkey and Iran. Skin Stem Cell, 6(2): e101509.

Liras, A. (2010). Future Research and Therapeutic Applications of Human Stem Cells: General, Regulatory, and Bioethical Aspects. Journal of Translational Medicine, 8:131

Matsumoto, M.M., Dajani, R., & Matthews, K.R. (2015). Cord Blood Banking in the Arab World: Current Status and Future Developments. Biol Blood Marrow Transplant, 21(7):1188-94.

Matthew, K.R.W., & Morali, D. (2020). National Human Embryo and Embryoid Research Policies: 22 Top Research-Intensive Countries Survey. Regen. Med, 15(7), 1905–1917 ISSN 1746.

Ministry of Health Malaysia (2009). The Guidelines for Stem Cell Research and Therapy, Medical Development Division.

Muslim World League. Islamic Jurisprudence Council Conference, (2003, Dec 13-17), Makkah, Saudi Arabia. Fatwa number 3. Regarding stem cells. http://www.themwl.org/Fatwa/default.aspx?d=1&ci di=152&l=AR&cid=12

National Biosafety Guidelines for Research, Development, and Production of Human Stem Cells (2019). Law and Justice Commission of Pakistan, Islamabad, Ministry of Health, and National Biosafety Committee. https://www.vertic.org/media/National%20Legislation/Pakistan/PK_Biosafety_Guidelines_2005.pdf

NGO Parallel Report on the Republic of Kazakhstan's 2nd Report on the Implementation of the International Covenant on Economic, Social and Cultural Rights, UN Committee on Economic, Social and Cultural Rights for consideration in the formulation of the List of Issues during the 62nd Pre-Sessional Working Group (2018, 3–6 April).

Nishakanthi, G. (2019). The Shortage of Malaysian SC Ethics in Mainstream Database: A Preliminary Study. Asian Bioethics Review, 11(4), 437–460.

Nur, I., & Tulungagung, I. (2020). Stem Cell Therapy: Its Legality in The Perspectives of Indonesian Law and Progressive Islamic Jurisprudence, International Journal of Advanced Research, 8(02):202-212, East Java, Indonesia.

Prentice, D. A. (2004). Cloning and Culture: Legislation at Home and Abroad. Georgetown Journal of International Affairs, Vol. 5, No. 2, pp. 65-72.

Protocol/Guidelines for Stem Cell Research/Regulation in Pakistan. The National Bioethics Committee, Pakistan. Adopted by the Human Organ Transplant Authority. http://nbcpakistan.org.pk/assets/guidelines_for_stem_cells.pdf

Rispler-Chaim, V. (1989). Islamic Medical Ethics in the 20th Century. Journal Of Medical Ethics, 15, 203-208.

Salter, B., & Salter, C. (2007). Bioethics, and the Global Moral Economy: The Cultural Politics of Human Embryonic Stem Cell Science. Science, Technology, & Human Values, Vol. 32, No. 5, pp. 554-581.

Salter, B. (2007). The Global Politics of Human Embryonic Stem Cell Science. Global Governance, Vol. 13, No. 2, pp. 277-298.

Saniei, M., & Baharvand, H. (2018). Human Embryonic Stem Cell Science in Muslim Context: "Ethics of Human Dignity" and "Ethics of Healing. Advances in Medical Ethics, 4:1.

Saniei, M. (2013). Human Embryonic Stem Cell Science and Policy: The Case of Iran. Social Science & Medicine, 98, 345-350.

Shamsi, T.S., et al. (2008). Review: The Stem Cell Transplant Program in Pakistan - The First Decade. Bone Marrow Transplantation, 42, S114–S117.

Shapiro, G.K. (2014). Abortion Law in Muslim-Majority Countries: An Overview of The Islamic Discourse with Policy Implications. Health Policy And Planning, 29:483–494.

Sleem, H. (2012). Ethical and practice Issues in stem cell Research and Therapy - Egyptian situation. The 3rd Regional Conference Salim El-Hoss Bioethics and Professionalism Program (SHBPP) American University of Beirut Faculty of Medicine.

Takahashi, K., & Yamanaka, S. (2006). Induction Of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors. Cell, 126 (4): 663–76.

The Hinxton Group: An International Consortium on Stem Cells, Ethics & Law. Official website http://hinxtongroup.org/

The International Society for Stem Cell Research (ISSCR). Official website. https://www.isscr.org/

The Ministry of Health and Medical Education, Iran. Available at: http://hbi.ir/part6/Default.aspx?hbsId= 377&category=6&templateid=2&hdlld=0.

The Muslim World League (MWL). https://www.themwl.org/en

Turkmen, O.H., & Arda, B. (2008). Ethical and legal aspects of SC practices in Turkey: where are we? J Med Ethics, 34(12):833-7.

UN-Data database. https://data.un.org/

UNESCO. Ethics and Law in Biomedicine and Genetics: An Overview of National Regulation in the Arab States. UNESCO Cairo Office, 2011:19.

United Nations, Department of Economic and Social Affairs, Population Division (2014). Abortion Policies and Reproductive Health around the World (United Nations publication, Sales No. E.14.XIII.11).

Utomo, T. S. (2012). Stem Cell Research Development and Its Protection in Indonesia Mimbar Hukum, Volume 24, Nomor 3, Halaman 377 – 569.

Warren, H. (2016). Embryonic Stem Cell Research: A Policy Analysis. Plast Surgn Nurs., 36(4):157-161.

World Population Review.

https://worldpopulationreview.com/country-rankings/muslim-majority-countries

Zakrzewski., Dobrzyński, M., Szymonowicz, M., & Rybak Z. (2019). Stem Cells: Past, Present, and Future. Stem Cell Research & Therapy, 10:68.

Appendices

Table 1 - Countries of Muslim Majority

Country	Total Population	Muslim % Of Total Population	Country	Total Population	Muslim % of Total Population
Afghanistan	37,135,000	99.7	Iran	83,000,000	99.4
Albania	3,057,220	58.8	Iraq	40,194,216	95.7
Algeria	41,657,488	99.7	Jordan	10,458,413	97.2
Azerbaijan	10,046,516	96.9	Kazakhstan	18,744,548	70.2
Bahrain	1,442,659	73.7	Kosovo	1,907,592	95.6
Bangladesh	170,000,000	90.4	Kuwait	2,916,467	74.6
Bosnia and Herzegovina	3,849,891	50.7	Kyrgyzstan	6,500,000	80-90
Brunei	450,565	80.9	Lebanon	6,100,075	57.7
Burkina Faso	21,382,659	63.2	Libya	6,754,507	97
Chad	15,833,116	58	Malaysia	32,730,000	61.3
Djibouti	884,017	97	Maldives	374,775	100
Egypt	95,000,000	90–94.7	Mali	18,429,893	95
The Gambia	2,092,731	95.7	Mauritania	3,845,430	99.9
Guinea	11,855,411	89.1	Mayotte	256,518	97
Indonesia	266,500,000	86.7	Morocco	38,314,130	99
Palestine	4,780,978	97.5	Tajikistan	9,540,000	97.9
Qatar	2,450,285	77.5	Tunisia	11,446,300	99.8

Country	Total Population	Muslim % Of Total Population	Country	Total Population	Muslim % of Total Population
Saudi Arabia	34,220,000	98.2	Turkey	83,155,000	89.5
Senegal	15,726,037	96.1	Turkmenistan	6,031,187	93.7
Sierra Leone	7,719,729	78.6	United Arab Emirates	9,541,615	76
Somalia	11,000,000	99.8	Uzbekistan	34,036,800	88.7
Sudan	40,825,770	97	Western Sahara	603,253	99.4
Syria	18,000,000	87	Yemen	28,036,829	99.2
Tajikistan	9,540,000	97.9			

Table 2 – HSCR Profile of Muslim Countries

Country	Year	R&D as % GDP	#Publications (TI="Stem Cells")	Oldest year of Publication	#Clinical Trials (Stem Cell)	# Cord blood (CB) banks
Malaysia	2016	1.44	256	2002	22	4
UAE	2018	1.30	47	2002	6	7
Turkey	2017	0.96	2025	1976	98	6
Iran	2017	0.83	1206	2004	77	1
Qatar	2018	0.82	45	2013	0	3
Egypt	2018	0.72	430	1998	63	5
Jordan	2016	0.71	113	2004	25	2
Morocco	2010	0.71	29	2008	0	1
Burkina Faso	2017	0.70	0	-	0	0
Tunisia	2018	0.60	75	2004	3	0
Saudi Arabia	2013	0.58	607	1995	24	3
Algeria	2017	0.54	108	2002	2	0
Palestine	2013	0.51	0	-	0	1
Somalia	-	0.49	0	-	0	0
Sudan	2005	0.30	2	2016	0	0
Chad	2016	0.30	0	-	0	0
Mali	2017	0.29	0	-	0	0
Brunei	2018	0.28	2	2013	0	1
Pakistan	2017	0.24	125	2005	15	3
Indonesia	2018	0.23	134	2007	31	3
Oman	2018	0.22	37	2008	1	3
Bosnia and Herzegovina	2018	0.20	3	2016	0	3

Country	Year	R&D as % GDP	#Publications (TI="Stem Cells")	Oldest year of Publication	#Clinical Trials (Stem Cell)	# Cord blood (CB) banks
Azerbaijan	2017	0.18	16	2015	0	0
Albania	2008	0.15	2	2016	0	2
Nigeria	2007	0.13	38	2006	0	1
Uzbekistan	2018	0.13	0	-	0	0
Kazakhstan	2018	0.12	24	2013	2	1
Kyrgyzstan	2017	0.11	1	2014	0	0
Bahrain	2014	0.10	7	2011	0	6
Tajikistan	2018	0.10	0	-	0	0
The Gambia	2018	0.07	0	-	0	0
Kuwait	2018	0.06	19	2007	0	5
Iraq	2018	0.04	27	2007	0	0
Lebanon	-	#N/A	203	1998	11	7
Bangladesh	-	#N/A	27	2010	1	1
Syria	-	#N/A	14	2009	0	0
Afghanistan	-	#N/A	1	2019	0	0
Libya	-	#N/A	1	2022	0	0
Niger	-	#N/A	1	2016	0	0
Turkmenistan	-	#N/A	1	2018	0	0
Yemen	-	#N/A	1	2019	0	0
Djibouti	-	#N/A	0	-	0	0
Guinea	-	#N/A	0	-	0	0
Kosovo	-	#N/A	0	-	0	0
Maldives	-	#N/A	0	-	0	0
Mauritania	-	#N/A	0	-	0	0

Country	Year	R&D as % GDP	#Publications (TI="Stem Cells")	Oldest year of Publication	#Clinical Trials (Stem Cell)	# Cord blood (CB) banks
Mayotte	-	#N/A	0	-	0	0
Senegal	2015	#N/A	0	-	0	0
Sierra Leone	-	#N/A	0	-	0	0
Western Sahara	-	#N/A	0	-	0	0

Table 3 – List of Top Muslim Countries by HSCR Scientific outputs

Country (Filter: Largest R&D as % GDP)	Country (Filter: Largest #Publications in Stem cells)	Country (Filter: Largest #Clinical Trials)	Country (Filter: Largest #Cord blood (CB) banks)
Malaysia	Turkey	Turkey	Lebanon
UAE	Iran	Iran	UAE
Turkey	Saudi Arabia	Egypt	Turkey
Iran	Egypt	Indonesia	Bahrain
Qatar	Malaysia	Jordan	Egypt
Egypt	Lebanon	Saudi Arabia	Kuwait
Jordan	Indonesia	Malaysia	Malaysia
Morocco	Pakistan	Pakistan	Qatar
Burkina Faso	Jordan	Lebanon	Saudi Arabia
Tunisia	Algeria	UAE	Pakistan
Saudi Arabia	Tunisia	Tunisia	Indonesia
Algeria	UAE	Kazakhstan	Oman
Palestine	Qatar	Algeria	Bosnia and Herzegovina
Somalia	Nigeria	Oman	Jordan
Chad	Oman	Bangladesh	Albania
Sudan	Morocco		Bangladesh
Mali	Bangladesh		Iran
Brunei	Iraq		Morocco
Pakistan	Kazakhstan		Palestine
Indonesia	Kuwait		Brunei
Oman	Azerbaijan		Nigeria
Bosnia and Herzegovina	Syria		Kazakhstan
Azerbaijan			
Albania			

Country (Filter: Largest R&D as % GDP)	**Country (Filter: Largest #Publications in Stem cells)**	**Country (Filter: Largest #Clinical Trials)**	**Country (Filter: Largest #Cord blood (CB) banks)**
Nigeria			
Uzbekistan			
Kazakhstan			
Kyrgyzstan			
Bahrain			
Tajikistan			
Gambia			
Kuwait			
Iraq			

Table 4 – List of Top 17 Muslim Countries by HSCR Publications

Country	Religious Affiliation	HSCR Policies	#Publications (TI="Stem Cells")	# Cord Blood Banks (CB)	R&D as % GDP	#Clinical Trials in (Stem Cell)
Turkey	HNF	Y	2025	6	0.96	98
Iran	SHI	Y	1206	1	0.83	77
Saudi Arabia	HNB	Y	607	3	0.58	24
Egypt	HNF	N	430	5	0.72	63
Malaysia	SHF	Y	256	4	1.44	22
Indonesia	SHF	Y	134	3	0.23	31
Pakistan	HNF	Y	125	3	0.24	15
Jordan	HNF	Y	113	2	0.71	25
Algeria	MLK	N	108	0	0.54	2
Tunisia	MLK	N	75	0	0.60	3
UAE	MLK	N	47	7	1.30	6
Qatar	HNB, MLK	N	45	3	0.82	0
Nigeria	MLK	N	38	1	0.13	0
Oman	IBD	N	37	3	0.22	1
Morocco	MLK	N	29	1	0.71	0
Bangladesh	HNF	N	27	1	#N/A	1
Kazakhstan	HNF	Y	24	1	0.12	2

Table 5 - Legal Positions of Non-Embryonic Stem Cell Research for the Top 17 Muslim Countries by Affiliation

		Policy Level 1	Policy Level 2	
Country	**Religious Affiliation**	**Adult Stem Cells (Bone Marrow, Peripheral Blood, Skin, Liver, etc.)**	**Non-IVF (Umbilical Cord, Placenta, Aborted Fetuses)**	**Purpose**
Qatar	HNB, MLK	Y	Y	TH
Saudi Arabia	HNB	Y	Y	TH
Bangladesh	HNF	Y	Y	TH
Egypt	HNF	Y	Y	TH
Jordan	HNF	Y	Y	TH
Kazakhstan	HNF	Y	Y	TH
Pakistan	HNF	Y	Y	TH
Turkey	HNF	Y	Y	TH
Oman	IBD**	Y	Y	TH
Algeria	MLK	Y	Y	TH
Morocco	MLK	Y	Y	TH
Nigeria	MLK	Y	Y	TH
Tunisia	MLK	Y	Y	TH
UAE	MLK	Y	Y	TH
Indonesia	SHF	Y	Y	TH
Malaysia	SHF	Y	Y	TH
Iran	SHI	Y	Y	TH

Religious Sects and Affiliations: Religious Sects and Affiliations: S=Sunni; HNF=Hanafi; SHF=Shafi'i; MLK=Maliki; HNB=Hanbali; SHI=Shi'ia; IBD **=Ibadi is not identified as one of the prominent Sunni affiliations; TH=Therapeutic; R=Research