ORIGINAL RESEARCH

Medical Professionals' Knowledge, Sensitivity, and Attitudes Towards Social and Ethical Aspects of Stem-Cell Donation, Therapy, and Research: Implications for Healthcare Risk Management

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Background: Knowledge, sensitivity, and acceptance attitudes towards social, moral and ethical aspects of stem-cell donation and treatment are important factors in preventing professional negligence and improving healthcare risk management and health justice in this specialized area of health services.

Objective: To assess knowledge, sensitivity, acceptance and rejection attitudes towards stem-cell transplantation and research and its associated factors among medical professionals in Saudi Arabia.

Methods: A quantitative and cross-sectional study was conducted in December 2022. Data were collected from 260 medical workers from various regions in Saudi Arabia. *T*-tests, ANOVA, and multiple linear regression were applied to find variations and associations of gender, age, profession, nationality, religious orientation, and work experiences of professionals with knowledge, sensitivity, acceptance and rejection attitude towards stem-cell donation, therapy, and research. A confidence interval (CI) of 95% and a significance level of $p \le 0.05$ was chosen for testing statistical models.

Results: A total of (n=260) medical professionals, among which clinicians (n=98;38%), pharmacists (n=78;30%), and nurses (n=84;32%) completed the survey questionnaire. Findings show that (n=27; 10%) participants have work experience in stem-cell donation, (n=67; 26%) in stem-cell therapy, and (n=124; 48%) in stem-cell research. Clinicians and pharmacists, in comparison to nurses, had better knowledge (p<0.01 and p<0.05); pharmacists had higher sensitivity (p<0.05) than nurses. Compared to those who do not have work experience in stem-cell research, those who had work experience had higher levels of knowledge, sensitivity, and acceptance attitudes at (p<0.01) and (p<0.01). Acceptance attitudes are considerably higher among male participants than females and similarly higher among older participants than younger participants (p<0.05). Compared to non-Saudi nationals, Saudi nationals scored higher on rejection attitudes (p<0.01). Compared to those having work experience in stem-cell donation and research, those without work experience are more likely to hold rejection attitudes (p<0.01).

Conclusion: Findings suggest female professionals, Saudi nationals and those who do not have prior work experience in stem-cell donation, therapy, or research had low levels of knowledge, less sensitivity, and less acceptance attitude and are more likely to hold rejection attitude, signifying the need to address them to improve healthcare risk management.

Keywords: awareness, belief, dilemma, perceptions, stem cells, transplantation, work exposure

Introduction

Stem cell donation, therapy, and research are becoming the focus of attention for the scientific community, healthcare organizations, and patients due to successful treatment outcomes for certain serious illnesses.¹ In Saudi Arabia, the treatment by employing stem cells started in the late 80s.² It was initially started on a limited scale to treat some diseases that included inherited immunodeficiency, leukemia, and genetic blood diseases.³

© 2023 AL-Shammary and Hassan. This work is published and licensed by Dove Medical Press Limited. The full terms of this license are available at https://www.dovepress accessing the work you hereby accept the Terms. Non-commercial uses of the work are permitted without any further permission for nowe Medical Press Limited, provided the work is properly attributed. For permission for commercial uses of this work, please see paragraphs 42 and 5 of our Terms (https://www.dovepress.com/terms.php). Although some fatal diseases, including blood cancers and some immune system diseases, have been treated using stem-cell transplantation,⁴ therapy procedures, and outcomes are still evolving. In addition, the lack of adequate knowledge about stem-cell transplantation and therapy outcomes in the various segments of the population⁵ has resulted in misperceptions and unrealistic hopes about the contributions and effectiveness of stem-cell therapy for various disease conditions⁶ 5, 6. Medical professionals involved in stem-cell treatment and research often face ethical dilemmas and social pressures due to several myths associated with these treatments.

The other major challenge in stem-cell therapy is obtaining the right match for transplantation. Retrieval of stem cells and donation of stem cells has several controversies due to various psycho-social,⁷ religious and ethical aspects associated with it.⁸ In 2010, the development of the Saudi Stem Cell Donor Registry and, in 2014, the establishment of the National Centre for Stem Cell Technology (NCSCT) made stem cell donation and⁹ transplantation procedures relatively more regularized.9 Due to limited knowledge of the general population about stem cell donation and treatment outcomes and information about organizations authorized to provide such services, patients, and families are at risk of being victimized due to existing malpractices in this area. The unethical code of conduct will likely have medical, social, and psychological implications.¹⁰

Some previous research from Saudi Arabia conducted during the pre-COVID-19 pandemic has explored knowledge about stem cell donation among nurses and dental students.^{11,12} Some recent studies focus on assessing the attitudes of medical and health science students toward stem-cell transplantation for specific disease conditions.¹³ A quantitative study reported a moderate level of knowledge and positive attitude toward stem cell transplantation among healthcare providers from the Qasim region. It recommended the need for informational campaigns/programs on stem cell donation and therapy procedures to enhance the knowledge and to inculcate acceptance towards such therapies.¹⁴ In 2020, a qualitative study assessed the knowledge about stem cells and attitudes toward stem-cell transplantation and stem-cell-based treatments by conducting interviews with research staff, medical professionals, and science students at King Abdulaziz University (KAU). Findings revealed that respondents generally hold positive attitudes towards ethical and best professional practices in stem cell research and treatment. However, there is a need to implement rigorous measures to protect society from psychological, social, and economic repercussions.¹⁵ In this era, when the medical field is advancing at a fast pace, and there is easy accessibility to information from multiple channels, the levels of knowledge and attitudes of health professionals about advanced and specialized treatments are likely to experience quick shifts.¹⁶ Therefore, descriptive studies are crucial to identify the gaps in knowledge and professional attitudes that can influence ethical practice and patient care.

This study aimed to assess the perceptions, sensitivity, and attitudes toward social and ethical aspects of stem cell donation, treatment, and research among medical professionals in Saudi Arabia. The study has a broad scope as perceptions of medical professionals determine their attitudes and practices. Limited knowledge and negative attitudes are crucial factors to cause professional negligence and malpractice in healthcare settings. In the past few years, there has been a tremendous expansion in stem-cell-based therapy and research in various regions of the world, including Middle East countries. Moreover, professionals from other parts of the world deliver health care through telehealth services. In addition, medical professionals work with international health organizations and stem-cell donor agencies due to the focus on a collaborative approach to services and research. Medical professionals have a central role in maintaining best practices in healthcare and significantly contribute to advancements in medical therapies through ethical clinical research. It is, therefore, essential to assess the knowledge and attitudes of healthcare professionals and pharmacists about health and safety issues in stem-cell donation, treatment, and research because they are providing treatment and care services to clients and are also directly or indirectly involved in research work. This study will address the existing gaps in knowledge that will be useful in addressing the ethical and social issues in this specialized area of medical services and research. Moreover, this study will provide insight into establishing and implementing best practices in stem-cell transplantation and research. This study findings will have significant implications for improving health services and health justice for people seeking stem-cell-based therapies.

Materials and Methods

Study Design

This cross-sectional study was conducted in the Northern and Eastern Provinces of Saudi Arabia. Data were collected using an electronic survey questionnaire in the first two weeks of December 2022.

Target Population and Sample Size Estimation

The target population for this study was medical professionals, including clinicians, pharmacists, and nurses working in healthcare organizations in the Northern and Eastern regions of Saudi Arabia. The sample size estimation was completed by using Raosoft software. According to available estimates,¹⁷ the number of allied health professionals is around 14,000, by choosing the confidence level of 95%, 5% margin of error, and 80% response distribution, the estimated sample size was 241 respondents.

Instrument

The study questionnaire was developed by reviewing recent literature,^{6–18} and questionnaires used in previous studies.^{12–15} The first part of the survey collected information about demographic variables. These include gender, age, professional field, nationality, religious orientation, and work exposure in stem-cell donation, therapy, and research. The second part of the survey questionnaire comprises 21 questions that assessed (1) basic knowledge/awareness about stem cells with a set of five items (2) sensitivity towards social and ethical issues in stem cell donation, therapy, and research with a set of eight items, (3) acceptance attitudes with a set of four items and (4) rejection attitudes with a set of four items. All items on these sub-scales are rated on a five-point Likert Scale, with options of "strongly agree=4", "agree=3", "neutral=2", "disagree=1", and "strongly disagree=0". A higher score indicates high levels of knowledge, sensitivity, acceptance, and rejection attitude. The English and Arabic versions of the survey questionnaire were prepared and pre-tested for this study. Pre-testing was completed on ten respondents, and we completed necessary modifications in the wording and order of presentation of items before conducting the data collection in the main study. The content and face validity were assessed by field experts and found to be adequate. The internal reliability of the tool was assessed based on data obtained from 260 participants in the main study. Cronbach Alpha coefficient values for all four dimensions and total scale lie between 0.81–0.87.

Data Collection

To recruit participants from tertiary healthcare organizations and research institutes located in these two provinces of Saudi Arabia, we approached the higher-level management of the organizations involved at some level in stem-cell donation, therapy, or research. We explained to them the purpose of the survey and obtained permission and support. The organizations that agreed to support data collection distributed the electronic link to the survey questionnaire through their online portals. Participation in the study was voluntary, informed consent was presented at the beginning of the survey questionnaire, and anonymity of organizations and participants was maintained during data collection. The inclusion criteria for the study were (1) the participant must be either clinician, nurse, or pharmacist, (2) at least two years of professional experience (3) and living in Saudi Arabia.

Ethical Approval and Considerations

The University of Ha'il Ethics Committee approved this study after reviewing the methodology and study questionnaires (Approval No: H-2022-354) dated 31/10/2022. All study procedures complied with the research guidelines per the Declaration of Helsinki. Participation in the study was voluntary, informed consent was obtained from all participants before data collection, and no personal data or identifying information was collected. Data analysis was completed on collective data stored in secure files.

Data Analysis

Data were analyzed using SPSS version 25.0 software. Descriptive statistics (frequency and percentage) were used to present the demographic characteristics of respondents. Other descriptive statistics (mean, standard deviation, and 95%

CI for means scores) were reported to describe the levels of knowledge, sensitivity, and attitudes toward stem-cell donation, therapy, and research. The chi-square test was applied to determine the association between categorical variables, and *t*-test and ANOVA were applied to determine the significance of mean differences on knowledge, sensitivity, and attitudes scores across gender, age group, professional field, nationality, religious orientation, and work experiences in the area of stem-cell donation, therapy and research. The dataset was checked to meet the assumptions for multiple linear regression. The next level of analysis was conducted to determine predictors of knowledge, sensitivity, acceptance, and rejection attitudes of medical professionals towards stem cell donation, treatment, and research. A confidence interval (CI) of 95% and a significance level of $p \le 0.05$ was chosen for testing statistical models.

Results

Background Characteristics

The demographic profile of the participants is presented in Table 1. A total of (n=260) medical professionals, including clinicians, pharmacists, and nurses, completed the survey questionnaires. In this sample, just over one-third were clinicians (n=98;38%), around one-third were nurses (n=84; 32%), and slightly below one-third were pharmacists (n=78; 30%); thus, there is about an equal representation of professionals from these three disciplines of medicine. The male participants were (n=158; 61%) and females (n=102; 39%). Over fifty percent (n=141; 54%) were in the age group of 20–39 years, and the remaining (n=119; 46%) were 40–59 years old. In addition, a large section of respondents was Saudi (n=234; 90%), and over ninety percent were Muslims (n=234; 94%) (Table 1).

The analysis shows that (n=4; 1.5%) of medical professionals reported a complete lack of awareness about stem cells, among which three are pharmacists and one is from nursing. Findings show that (n=27; 10%) participants have experience in stem-cell donation, (n=67; 26%) have experience in stem-cell therapy, and (n=124; 48%) have experience in stem-cell research (Table 2).

Table 2 shows that a significantly higher proportion of clinicians and pharmacists had work experience in stem cell donation and therapy (p<0.001). Though statistically a higher proportion of medical doctors (n=65; 52%; p<0.001) are involved in stem cell research, however, there are some participants from the pharmaceutical industry (n=34; 28%) and nursing field (n=25; 20%) who have work experience in stem-cell research.

Table 3 presents the mean scores and standard deviation values on scales and items assessing knowledge, sensitivity towards social and ethical aspects, and acceptance and rejection attitudes towards stem-cell donation, transplantation, and research. The average scores on scales demonstrate that healthcare professionals possess moderate levels of knowledge

Variable		Frequency	Percentage
Gender	Female	102	39%
	Male	158	61%
Age	20–39 years	141	54%
	40–59 years	119	46%
Profession	Clinician	98	38%
	Pharmacist	78	30%
	Nurse	84	32%
Nationality	Saudi	234	90%
	Non-Saudi	26	10%
Religious Orientation	Islam	243	94%
	Others	17	6%

Table I Background Characteristics of Respondents (N= 260)

Profession	Are You Aware What are Stem Cells?		Work Experience in Stem Cell Donation		Work Experience in Stem Cell Therapy		Work Experience in Stem Cell Research	
	Yes (n=256; 98.5%)	No (n=4; 1.5%)	Yes (n=27; 10%)	No (n=233; 90%)	Yes (n=67; 26%)	No (n=193; 74%)	Yes (n=124; 48%)	No (n=136; 52%)
	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
Clinician	98 (38%)	0 (0%)	20 (74%)	78 (34%)	46 (70%)	52 (27%)	65 (52%)	33 (24%)
Pharmacist	81 (32%)	3 (75%)	6 (22%)	78 (33%)	(17%)	73 (38%)	34 (28%)	50 (37%)
Nurse	77 (30%)	I (25%)	I (4%)	77 (33%)	9 (14%)	69 (36%)	25 (20%)	53 (39%)
χ^2 (p-value)	$\chi^2 = 3.85(ns)$		$\chi^2 = 18.4^{***}$		$\chi^2 = 38.6^{***}$		$\chi^2 = 23.1 ***$	

Table 2 Work Experience of Medical Professionals in Stem Cells Donation, Therapy, and Research (N= 260)

Notes: p-value significance: ***p<0.001. **Abbreviation:** χ^2 , Chi-square.

Scales	altems	^ь М (S.D)
Knowledge about stem-cell donation, therapy and research	Know diseases that are currently being treated in reliable ways by using stem cells including umbilical cord stem cells, embryonic and adult stem cells	3.60 (0.64)
(M= 15.27; S.D.=2.84) (95% CI = 14.92–15.61)	Know the potential benefits of stem-cell donation	3.73 (0.53)
	Know the potential risks of stem-cell research	3.51 (0.63)
	Know about the Saudi Stem Cell Donor Registry	2.89 (1.14)
	Know about other organizations which collect stem cells from donors in Saudi Arabia	1.50 (1.28)
Sensitivity towards social and ethical aspects of stem cell donation, treatment, and research (M= 22.29; S.D.=2.54) (95% CI = 21.98-22.60)	Embryonic stem cell research that involves fetal destruction is immoral, illegal, and unnecessary	3.88 (0.57)
	Witnessed several irregularities in stem cell research and treatment	2.27 (1.15)
	Action is needed to regularize stem cell therapy in Saudi Arabia	3.80 (0.59)
	Patient's consent is necessary for both stem cell donation and transplantation	3.94 (0.38)
	Healthcare practitioners can apply stem-cell-based treatments that are proven effective with testing on animals and human cells in laboratories	2.68 (1.05)
	Healthcare practitioners can apply stem-cell-based treatments that are proven effective in the laboratory in absolute terms	1.60 (0.92)
	Negative competitive environment in pharmaceutical industry is hindering progress in stem cell research	0.15 (0.63)
	Ethical approval from an ethics committee is necessary before conducting research	3.96 (0.33)

Table 3 Mean Scores on Knowledge, Sensitivity Towards Social and Ethical Aspects, Acceptance and Rejection Attitudes Towards Stem Cells Donation, Therapy and Research (N= 260)

(Continued)

Scales	altems	^ь M (S.D)
Acceptance Attitudes (M= 15.65; S.D.=1.06) (95% Cl = 15.52–15.78)	Stem-cell donation is necessary for better prospects in transplantation and interventions	3.86 (0.42)
	Pregnant mothers should be allowed to store cord blood stem cells for future purposes	3.93 (0.36)
	Donation of stem cells is necessary to advance research in this area	3.93 (0.38)
	Stem cell transplantation should be implemented on a large scale	3.90 (0.422)
Rejection Attitudes (M= 4.86; S.D.=1.95) (95% CI = 4.62–5.10)	Stem-cell transplantation is valuing certain lives over others and should not be practiced	1.12 (0.826)
	Stem-cell transplantation may open the door to the destruction of innocent human life	0.18 (0.73)
	Government must prevent all research on embryonic stem cells from embryos or aborted fetuses	3.34 (1.12)
	Studies on stem cells are unnecessary and a waste of time and resources	0.22 (0.71)

Table 3 (Continued).

Notes: ^aItems on scales are rated on a 5-point Likert Scale with 0=Strongly Disagree to 4=Strongly Agree; ^bMean Scores. **Abbreviation**: S.D., Standard Deviation.

(M= 15.27; S.D.=2.84; 95% CI = 14.92–15.61) and demonstrate moderate levels of sensitivity towards social and ethical aspects of stem-cell donation, therapy, and research (M= 22.29; S.D.=2.54; 95% CI = 21.98–22.60). The mean scores on acceptance attitudes are higher (M= 15.65; S.D.=1.06; 95% CI = 15.52–15.78) as compared to rejection attitudes (M= 4.86; S.D.=1.95; 95% CI = 4.62–5.10).

Table 4 presents the analysis of mean differences in knowledge, sensitivity, acceptance and rejection attitudes toward stem-cell donation, transplantation, and research as assessed among medical professionals working in Saudi Arabia. Findings show that male respondents have higher mean scores on knowledge (p<0.05) and acceptance attitude (p<0.05)

Variable	Categories	Knowledge	Sensitivity Towards Social and Ethical Aspects	Acceptance Attitudes	Rejection Attitudes
		M (S.D)	M (S.D)	M (S.D)	M (S.D)
Gender	Female	14.75 (3.09)	22.55 (2.89)	15.40 (1.42)	5.20 (2.56)
	Male	15.60 (2.62)	22.12 (2.27)	15.82 (0.71)	4.65 (1.40)
t-test (p-value significance)		t=2.30*	t=1.33 (ns)	t=2.72*	t=1.98*
Age	20–39 years	14.59 (2.67)	22.16 (2.85)	15.49 (1.32)	4.88 (2.40)
	40–59 years	16.07 (2.84)	22.44 (2.11)	15.85 (0.59)	4.84 (1.24)
t-test (p-value significance)		t=4.29***	t=0.86 (ns)	t=2.88*	t=0.16 (ns)
Profession	Clinician	17.40 (2.33)	22.99 (2.25)	15.79 (0.67)	5.20 (1.82)
	Pharmacist	14.48 (2.14)	22.18 (2.13)	15.47 (1.06)	4.69 (1.96)
	Nurse	13.44 (2.36)	21.57 (2.98)	15.35 (1.37)	4.62 (2.07)
F-test (p-value significance)		F=72.81***	F=7.51***	F=4.76**	F=2.46 (ns)

Table 4 Mean Differences in Knowledge, Sensitivity, Acceptance and Rejection Attitudes of Healthcare Professionals Towards Stem-Cell Donation, Treatment and Research in Saudi Arabia (N= 260)

(Continued)

Variable	Categories	Knowledge	Sensitivity Towards Social and Ethical Aspects	Acceptance Attitudes	Rejection Attitudes	
		M (S.D)	M (S.D)	M (S.D)	M (S.D)	
Nationality	Saudi	15.24 (2.96)	22.14 (2.54)	15.63 (1.09)	5.01 (1.89)	
	Non-Saudi	15.46 (1.42)	23.62 (2.09)	15.85 (0.78)	3.54 (2.04)	
t-test (p-value significance)		t=0.64 (p=ns)	t=2.84*	t=0.96; (p=ns)	t=3.72***	
Religious Orientation	Islam	15.28 (2.90)	22.24 (2.51)	15.63 (1.11)	4.95 (1.91)	
	Others	15.00 (1.93)	22.94 (2.92)	16.00 (0.00)	3.59 (2.21)	
t-test (p-value significance)		t=0.39 (p=ns)	t=1.09 (p=ns)	t=5.25***	t=2.81*	
Work experience in stem-cell donation	Yes	16.89 (2.25)	24.78 (2.59)	15.74 (0.76)	5.48 (4.08)	
	No	15.08 (2.85)	22.01 (2.37)	15.64 (1.09)	4.79 (1.53)	
t-test (p-value significance)		t=3.18**	t=5.69***	t=0.44 (ns)	t=0.87 (ns)	
Work experience in stem-cell therapy	Yes	17.46 (2.17)	23.52 (2.93)	15.85 (0.61)	4.79 (2.56)	
	No	14.50 (2.65)	21.86 (2.24)	15.59 (1.17)	4.89 (1.71)	
<i>t</i> -test (<i>p</i> -value significance)		t=8.23***	t=4.81***	t=2.35*	t=0.34; (ns)	
Work experience in stem-cell research	Yes	16.90 (2.22)	23.44 (2.17)	15.87 (0.57)	4.71 (2.28)	
	No	13.77 (2.51)	21.24 (2.39)	15.46 (1.34)	5.00 (1.59)	
<i>t</i> -test (<i>p</i> -value significance)		t=10.59***	t=7.76***	t=3.29*	t=1.17 (ns)	

Table 4 (Continued).

Notes: p-value significance: ****p<0.001; **p<0.01; *p<0.05. Values in Italics represent non-significant values. Abbreviations: M, Mean; S.D., Standard Deviation.

as compared to females. In contrast, females had significantly higher mean scores on rejection attitude (p<0.05). The difference was non-significant in the case of sensitivity. Findings show that older respondents (40–59 years) had higher mean scores on knowledge and acceptance attitudes at (p<0.001), whereas the difference was non-significant on sensitivity and negative attitudes. Clinicians had higher mean scores on knowledge (p<0.001), sensitivity (p<0.001), and acceptance attitudes (p<0.01) as compared to pharmacists and nurses, whereas the differences were non-significant on rejection attitudes. There were non-significant differences across nationalities in knowledge and acceptance attitudes. However, non-Saudi nationals had higher mean scores on sensitivity (p<0.05) and lower mean scores on rejection attitudes (p<0.001). Non-Muslim participants had higher mean scores on acceptance attitudes (p<0.001) and lower mean scores on rejection attitudes (p<0.05) about stem cell donation, therapy, and research. However, the analysis shows these differences were only significant when data was needed to meet the assumption of equal variance.

Those who had an experience of work in stem cell donation had significantly higher mean scores on knowledge (p<0.01) and sensitivity (p<0.001). In contrast, the differences were non-significant in both types of attitudes. Those who had work experience in stem cell therapy had higher scores on knowledge (p<0.001), sensitivity (p<0.001), and acceptance attitudes (p<0.05), and the difference was non-significant in rejection attitudes, and the pattern was similar for those who had work experience in stem cell research.

Table 5 shows findings from the multiple regression analysis to determine whether demographic variables and the nature of work experience determine the knowledge of medical professionals about stem-cell donation, transplant, and research. In multiple linear regression analysis, clinicians (β =0.507; t=7.98; p<0.001) and pharmacists (β =0.12; t=2.26; p<0.05) likely to have more knowledge as well as work experience in stem-cell research (β =0.32; t=4.21; p<0.001) significantly predict having higher levels of knowledge related to stem-cell donation, therapy and research as compared to their reference categories. The adjusted R-square value is 0.51, illustrating that 51% of the variation in awareness about ethical issues can be explained by variation in the work experience in stem-cell donation and research. The analysis

	Knowledge as Outcome Variable			Sensitivity as Outcome Variable			
	B (95% Cls)	Std. Error	β	B (95% Cls)	Std. Error	β	
(Constant)	11.48 (10.31–12.65)	0.595		21.43 (20.1–22.7)	0.669		
Gender (Male)	0.27 (-0.26-0.81)	0.271	0.047	-0.29 (-0.89-0.30)	0.305	-0.057	
Age (Older group)	0.002 (-0.55-0.56)	0.284	0.000	0.054 (-0.68-0.57)	0.319	0.011	
Profession (Clinician)	2.97 (2.23–3.71)	0.372	0.507***	0.039 (-0.86-0.78)	0.418	0.007	
Profession (Pharmacist)	0.75 (0.09–1.41)	0.332	0.124*	0.77 (-1.15-0.78)	0.373	0.144*	
Nationality (Non-Saudi)	0.89 (-0.26-2.04)	0.587	0.094	-0.71 (-2.06-0.59)	0.660	-0.084	
Religion (Non-Muslim)	0.26 (-1.12-1.64)	0.705	0.023	0.99 (-0.56-2.55)	0.792	0.097	
Work experience in stem-cell donation	-0.57 (-1.47-0.31)	0.455	-0.062	1.74 (0.74–2.75)	0.512	0.210**	
Work experience in stem-cell therapy	0.59 (-0.15-1.33)	0.379	0.091	0.085 (-0.92-0.75)	0.426	0.015	
Work experience in stem-cell research	2.34 (1.71–2.96)	0.317	0.412***	1.81 (1.11–2.51)	0.357	0.358***	
Model statistics	F(9, 259) = 32.393, p	< 0.001, R2 = 0.	534	F(9, 259) = 9.77, p <	0.001, R2 = 0.2	60	

Table 5 Multiple Linear Regression Analysis to Determine the Predictors of Knowledge and Sensitivity Towards Social and EthicalIssues in Stem Cell Donation, Treatment and Research (n=260)

Notes: ****p<0.001; ***p<0.01, *p<0.05.

Abbreviation: ns, non-significant.

of predictors of sensitivity towards social and ethical issues related to stem-cell donation, therapy, and research shows that being a pharmacist (β =0.14; t=2.08; p<0.05), having work experience in stem-cell donation (β =0.21; t=3.41; p<0.01) and work exposure in stem-cell research (β =0.35; t=5.09; p<0.001) significantly predicted sensitivity scores.

Table 6 shows findings from the multiple regression analysis to determine whether demographic variables and the nature of work experience determine medical professionals' acceptance and rejection attitudes about stem-cell donation, transplant, and research. In multiple linear regression analysis, male gender (β =0.13; t=2.15; p<0.05) and older age (β =0.14; t=2.12; p<0.05) and work experience in stem-cell research (β =0.22; t=2.92; p<0.01) significantly predicted acceptance attitudes. Female professionals and Saudi nationals are more likely to hold rejection attitudes (β =-0.18; t=2.97; p<0.01) and (β =1.64; t=2.73; p<0.01), respectively. Those who were not clinicians were also likely to hold rejection attitudes (β =-0.22; t=2.59; p<0.05), and those who did not have work exposure to stem-cell donation likely to hold negative attitudes (β =-0.18; t=2.73; p<0.01).

Table 6 Multiple Linear Regression Analysis to Determine the Predictors of Acceptance and Rejection Attitudes Towards Stem CellDonation, Treatment and Research (n=260)

	Acceptance Attitude as Outcome Variable			Rejection Attitude as Outcome Variable		
	B (95% Cls)	Std. Error	β	B (95% CIs)	Std. Error	β
(Constant)	15.23 (14.6–15.84)	0.308		3.57 (2.47–4.66)	0.556	
Gender (Male)	0.303 (0.026–0.580)	0.141	0.139*	-0.755 (-1.25-0.256)	0.253	-0.189**
Age (Older group)	0.313 (0.023–0.602)	0.147	0.146*	-0.162 (-0.684-0.361)	0.265	-0.041
Profession (Clinician)	0.121 (0.259–0.501)	0.193	0.055	-0.902 (0.217-1.58)	0.348	-0.224*
Profession (Pharmacist)	0.310 (-0.029-0.649)	0.172	0.136	0.351 (-0.260-0.962)	0.310	0.084

(Continued)

	Acceptance Attitude as Outcome Variable			Rejection Attitude as Outcome Variable			
	B (95% Cls)	Std. Error	β	B (95% Cls)	Std. Error	β	
Nationality (Non-Saudi)	0.178 (-0.421-0.776)	0.304	0.050	1.64 (0.568–2.72)	0.549	0.253**	
Religion (Non-Muslim)	0.417 (1.13–1.32)	0.365	-0.097	-0.012 (-1.31-1.28)	0.659	-0.001	
Work experience in stem-cell donation	0.168 (0.633–0.296)	0.236	-0.048	-1.164 (0.326-2.01)	0.425	-0.182**	
Work experience in stem-cell therapy	0.142 (0.528–0.244)	0.196	-0.058	0.049 (-0.648-0.746)	0.354	0.011	
Work experience in stem-cell research	0.481 (0.158–0.805)	0.164	0.226**	-0.493 (-1.07-0.091)	0.296	-0.126	
Model statistics	F(9, 259) = 3.416, p < 0.01, R2 = 0.110 F(9, 259) = 9.77, p < 0.001, R2 = 0.26)		

Table 6 (Continued).

Notes: **p<0.01, *p<0.05.

Abbreviation: ns, non-significant.

Discussion

The current study aims to assess knowledge, sensitivity, and attitudes toward stem-cell donation, treatment, and research by collecting data from clinicians, pharmacists, and nurses in Saudi Arabia. Because medical professionals' limited knowledge, negative attitudes, and less sensitivity towards social and ethical aspects of stem-cell donation, treatment, and research can impact the quality of healthcare service provision, the findings have significant implications for improving healthcare risk management. Findings illustrate that around four percent of medical professionals in this sample reported a complete lack of awareness on a direct question about awareness of stem-cell. Moreover, the respondents had average mean scores on the items and scales, which assessed the participants' knowledge about diseases currently being treated in reliable ways by using various types of stem cells, the potential benefits of stem-cell donation, and the potential risks of stem-cell research. Moreover, participants' awareness of the Saudi Stem Cell Donor Registry and other organizations which collect stem cells from donors in Saudi Arabia was relatively low. Findings from our study are comparable with these two studies, which also demonstrated that healthcare providers possess moderate levels of knowledge related to stem-cell-based therapies and research. Most of the previous quantitative, cross-sectional studies from Saudi Arabia have assessed the knowledge and perceptions about stem-cell donation and treatment among medical students^{12,13,19,20} except two,^{14,15} Cumulatively, these findings provide conclusive evidence that some gaps exist in healthcare providers' knowledge about stem-cell donation and treatment possibilities attributed to the several controversies and limited existing evidence about the treatment protocols and effectiveness of these therapies. The low mean scores on items assessing awareness about stem-cell donor agencies indicate the need to create awareness among medical professionals about Saudi Stem Cell Registry and any other organization that collects stem cells from donors in Saudi Arabia. This is also inferred based upon the alignment of our study findings with a prior study 12, which found that in a sample of 606 practitioners in dentistry, two-thirds were not aware of the donor agencies or the procedures followed by these organizations in the collection or supply of stem cells. Therefore, raising awareness about these agencies is essential to prevent malpractice and minimize patient risks. This has also been indicated by a previous study from Jordan, as most physicians lacked the confidence to address patients' queries related to stem-cell donation and therapies.²¹ As clinicians are the primary source of information for most patients, it is vital to conduct seminars in healthcare settings frequently to create more awareness and share authentic information about these advanced forms of treatment. Our findings showed that clinicians had significantly better knowledge, increased sensitivity, and more acceptance towards stem-cell donation, treatment, and research than pharmacists and nurses. These differences were non-significant in rejection attitudes. These findings are interpreted in light of previous literature, which also reported that most nurses need more training, professional experience, and work exposure in this area, thus lacking authentic knowledge in this area.^{14,22} Nurses and pharmacists are also key in providing service and research advancement in this less conventional and specialized treatment area. Appropriate attention should be given to training nurses and pharmacists with updated stem-cell donation and treatment

knowledge. These measures are necessary to prevent the spread of myths and false perceptions related to stem-cell donation and treatment to enhance healthcare risk management at the institutional level.

The findings demonstrated that medical professionals largely disapprove of embryonic stem-cell research involving fetal destruction, understand the requirement of consent and ethical approval for research in this area, and support the need to regularize stem-cell-based therapy in Saudi Arabia. These findings suggest that medical professionals understand the need to regularize and implement ethical practices in stem-cell donation, treatment, and research in Saudi Arabia. Furthermore, the pattern of responses on other items shows that they largely disapprove of the notion that the pharmaceutical industry is hindering the progress in stem-cell research and do not endorse the idea of applying stem-cell-based treatments that have only been tested in laboratory settings on animals or human cells. These indicate that medical professionals understand the possible risks associated with violating ethical practices in stem-cell-based treatments.

The findings show that respondents had higher scores on acceptance than rejection attitude, a positive indicator of progress in stem-cell donation, treatment, and research in Saudi Arabia. A previous study from Saudi Arabia,¹⁴ which mainly collected data from students, teaching staff, and healthcare workers working at King Abdulaziz University, also reported that most of the participants held a positive attitude towards stem-cell donation and research. However, contrary to this study's findings, which reported females possessed higher levels of knowledge and positive attitude,¹⁴ our study found that male participants had significantly higher scores on these variables.

Our survey findings show that participants had low mean scores on most items that assessed rejection attitudes towards stem cell donation, therapy, and research except one item, which asserts that government must prevent all research on embryonic stem cells from embryos or aborted fetuses. These findings are interpretable in the context of local social and cultural influences that might have influenced the general population and professionals' views about this issue, as most participants are Muslims and Saudi.²³

In multivariate analysis, we found that prior work experience in stem cells is the most dominant factor in determining medical professionals' knowledge, sensitivity, and attitudes. Although it is a positive sign that medical professionals who were or are currently involved in stem-cell-based research or treatment are cognizant of the social and ethical issues, it also asserts the need for training and workshops for those who did not have such work exposure. We also found that young medical professionals have less awareness and acceptable attitudes than older respondents. One explanation is that older participants are likely to have relevant work experience associated with better knowledge and acceptance. In our study sample, around half of the medical professionals had work exposure in stem-cell research, and one-quarter had work exposure in the stem-cell donation. It seems that work exposure has contributed to higher levels of awareness, acceptance attitudes, and sensitivity towards stem-cell donation and research in this study sample.

Our study findings align with a previous study which demonstrated that male professionals' knowledge levels were higher compared to female.²¹ This could be due to limited opportunities and support for the training of female medical staff at various professional forums. A qualitative study of healthcare workers from Saudi Arabia also indicated that most professionals needed more awareness about national and local laws and emerging ethical challenges related to stem cell therapies and research.²⁴ These findings support the need for more educational seminars and workshops. Additionally, specific training in ethical issues related to stem-cell donation and treatment is mandatory to minimize the risk of professional negligence due to a lack of knowledge of the negative attitudes of healthcare providers. An intervention study from Saudi Arabia also demonstrated the effectiveness of the educational program in improving the knowledge and attitudes towards umbilical cord stem-cell preservation among nurses.²⁵

We found that mean scores on knowledge, sensitivity, and acceptance attitudes were significantly lower among Saudi nationals than non-Saudi medical professionals. This finding has significant implications regarding healthcare risk management policy and practice because, in the past few years, under the framework of Saudization, an increasing number of Saudi nationals are entering the medical workforce.¹⁷ Therefore, training programs at the institutional level should target and ensure enrollment of female staff, young professionals, Saudi nationals, and those who still need to gain earlier work experience in stem cell donation and research.

Current study findings have relevance in local, regional, and global contexts, considering that improving healthcare services and health justice for people is a shared concern at the global level. Moreover, in the current era, medical

professionals are involved in care and research at different levels due to the advanced use of technology in healthcare and research. In addition, health professionals are collaborating with international agencies in stem-cell donation, treatment, and research due to the focus on a collaborative approach in providing healthcare services and research. It is, therefore, important that both local and international healthcare organizations understand factors associated with the knowledge, attitudes, and sensitivity of medical professionals about social and ethical aspects of stem cell-based treatment and research. Furthermore, this understanding might be helpful in the adoption of adequate measures to increase general awareness and acceptance attitudes in the target population.

Strengths and Limitations

The present study has several strengths; firstly, it focuses on assessing the knowledge and attitudes of medical professionals currently providing services in different roles. Clinicians, nurses, and pharmacists are the core component of healthcare services and research teams to develop and implement advanced therapies. Therefore, insights gained from this study have direct implications for improving healthcare risk management and policies. Given the fast pace of research progress in this field and the popularity of stem-cell-based therapies in high-income-countries, there is a need for systematic cross-sectional studies to assess the current situation in various regions of the world, and this study fulfills this requirement by providing the most recent picture of the situation in Saudi Arabia. While interpreting findings, some limitations of the present study need to be considered, such as an electronic survey form distributed through organizations' online portals. Many medical professionals were automatically excluded as prospective participants who ignored the study invites. Besides, we collected data from various health and research organizations, including those involved in stem-cell treatment and research. Respondents from these organizations were over-represented in this study sample, and the elevated score on awareness, attitudes, and sensitivity is attributable to sampling bias. There is a growing debate in scientific communities about social and ethical aspects of stem-cell research; the social desirability element might impact respondents' ratings on these items. For instance, it is observed that most of the participants disapprove of the perception that the negative competitive environment in the pharmaceutical industry hinders progress in stem-cell research due to the tendency to present the positive side of the situation.

Among other limitations, the items on the survey related to the knowledge dimension needed to be narrower to assess the specific areas of knowledge related to stem-cell donation, treatment, and research.

Conclusion and Recommendations

Understanding the social and ethical implications of stem-cell donation, treatment, and research are of prime importance to ensure best practices in healthcare and minimize the risk for donors and patients. The study findings also revealed that medical professionals endorse the need to regularize stem-cell-based therapies in Saudi Arabia. However, cognizance and sensitivity about these issues need to be raised for nurses, pharmacists, females, young, less experienced, and Saudi healthcare workers to achieve significant gains in healthcare risk management at the institutional level and community levels. Including topics such as psychological, social, and ethical aspects of stem-cell therapy in the curriculum for medical and nursing students can achieve this. In addition, online resources such as journals and books on these topics are provided through institutional subscriptions and access to literary databases. Moreover, seminars and specialized training in hospitals and research centers can effectively dissolve negative attitudes and strengthen acceptance attitudes.

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Disclosure

The authors report no conflicts of interest in this work.

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