



# Unveiling the Landscape of Animal Research Ethics among Saudi Health College Students

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**Abstract** | This study aimed to measure the awareness and prevalence of ethics of animal research among undergraduate health college students in Saudi Arabia. Also, to estimate the prevalence of knowledge and identify the attitudes and beliefs among male and female students. To explore the possible solutions for these gaps of knowledge and areas to recommend these solutions to the concerned authorities. An observational cross-sectional study. This study was conducted at health colleges in Saudi Arabia. Telephone/face-to-face questionnaires were collected by data collectors using multistage and cluster sampling. There were four sections to the questionnaire, which were available in both Arabic and English. The questions in the first section focused on sociodemographic data. The second section asked questions concerning broad research ethics knowledge. In the third section, there were inquiries concerning the moral justifications for animal research arguments. The last section asked about general opinions about animal research. Data were analyzed using the Statistical Package for Social Science (SPSS) version 21.0 (SPSS, Chicago, IL, USA). Categorical variables were identified as frequencies and percentages using the Chi-squared test. Results: The results showed that most participants (89.6%) knew about the ethics of research, and the highest source of knowledge was the college curriculum (44.7%). There was a statistically significant difference in overall knowledge among the age groups, with students above 22 years having the highest mean knowledge. About animal research, most participants agreed that animal research has great benefits for humans (80.7%). Unexpected findings that 39% believed that animal research should be conducted in favor of human benefits even if it causes harm to animals. The study found that a considerable number (75.5%) of participants favored the use of animals in scientific research. There was a statistically significant increase ( $P \leq 0.05$ ) in those who accepted the use of animals as they got older. Binary multivariate logistic regression analysis showed that females and those in the medicine specialty were significant predictors of opinions on animal research. Linear regression analysis showed that age and source of knowledge were significant predictors of overall knowledge score on general knowledge of ethics in research. Conclusion: In conclusion, Saudi Arabia's undergraduate health college students are aware of ethical issues related to animal research, but a sizable part expresses ambivalence. Older age correlates with higher knowledge scores, but there is a lack of recognition for critical ethical documents.

**Keywords** | Research ethics, Health colleges, Students, Animal ethics, Welfare, Saudi Arabia

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The branch of bioethics known as research ethics focuses on finding, analyzing, and resolving ethical issues that arise before, during, and after conducting health-related research, particularly on humans or animals. It is essential for research that involves the collection and further processing of human tissues, biological materials, or identifiable information (Hussein *et al.*, 2015). The research covers unfamiliar and rarely studied subjects. As a result, novel issues appear that are often impossible to solve by simply adhering to established procedures. Medical personnel must uphold the highest standards of ethics to predict novel issues and make wise decisions (American Medical Association, 1879; Harnett, 2021; Parsa-Parsi, 2022).

Animal experimentation research has played a significant role in many scientific developments over the last century and continues to be the source of our knowledge of various diseases. Today, about 20 million animal subjects are used in biomedical research, and mouse and rat models are the most widely used (Festing and Wilkinson, 2007). Animal experiments have additionally contributed to improving vaccines, antibiotics, and essential information on human disease processes. Most antibiotics are tested on animals before being applied to humans. Indeed, animal studies have contributed to human healthcare and provided helpful information to relieve human suffering (Robinson *et al.*, 2019).

The field of laboratory animal science poses a complex and contentious aspect of human-animal interactions due to the intentional and unintentional harm and death inflicted on animals. As a result, animal experimentation has become a subject of significant ethical scrutiny and control all over the world, aiming to reduce the distress and agony endured by animals used as models for human diseases and other purposes (Weiner, 2021).

As the use of experimental animals grows alongside scientific and industrial progress, ethical guidelines for experimental animal studies have been established to prevent unethical experiments and promote the welfare, ethical treatment, and scientific value of experimental animals. Several factors, including the necessity to validate animal research, the expansion of animal experimentation, legal improvements related to animal research and experimental animals, and the advocacy of animal welfare organizations, have influenced the transformation of animal experimentation procedures (Moon *et al.*, 2023).

Researchers are encouraged to explore alternative methods early in the planning stages of an animal experiment, especially if the experiment is expected to cause pain. It is recommended that researchers search multiple databases and provide details of their search strategy, including rel-

evant scientific terms. If appropriate alternative methods are identified through the database search, researchers must provide reasons for not using them. To facilitate an efficient search for alternative methods, researchers should clearly outline the information they aim to gather from animal experiments (European Commission, 2022).

The use of animals in medical studies is controversial. Given the potential for animal suffering during research, researchers must justify their use. A suitable justification necessitates that researchers demonstrate the studies' predicted advantages. The expected benefits of the research outweigh the suffering (Levy, 2012).

Medical and health sciences students must be approved by dedicated Ethics Committees (ECs) to conduct research, so they must be aware of the ethical issues involved. It will help to ensure that these future clinicians have a solid foundation in research from the beginning of their medical education (Patel *et al.*, 2021).

For the farthest, we know that there is no research to measure the awareness of health college students, and there is a shortage of literature that discusses the ethics of research on animals or even research ethics in general among the Saudi population. So, this study aims to measure the awareness and prevalence of knowledge about ethics in animal research among female and male health college students in Saudi Arabia. To estimate the prevalence of knowledge about ethics in animal research among female and male health college students in Saudi Arabia. To identify the attitudes and beliefs among male and female health college students in Saudi Arabia. To explore the potential solutions for these gaps of knowledge.

## MATERIALS AND METHODS

### STUDY DESIGN, SETTING, AND POPULATION

An observational cross-sectional study was conducted at health colleges in Al-Madinah Al-Monawarah Saudi Arabia from November 2022 to February 2023. Inclusion criteria, all male and female undergraduate Saudi and non-Saudi governmental health college students in Saudi Arabia. The study included students from age 18 years and older. The study's exclusion criteria include students under the age of 18, as the age of majority and decision-making in Saudi Arabia is 18 years old, students from non-health colleges who are not the study's target, and students who did not complete the survey.

### SAMPLE SIZE

The study included all 13 regions of Saudi Arabia. The total population of health college students in Saudi Arabia is 75084 students according to the latest census of the Ministry of Health. The significance level was 5%, and the

confidence level of 95%, a standard deviation of 5%. The power of the test was 90% and the required sample size was 383 participants based on the World Health Organization (WHO) recommendations for the minimal participants required for a prevalence study (Naing, 2003).

**DATA COLLECTION METHODS, SAMPLING TECHNIQUE, AND QUESTIONNAIRE**

Data collectors collected the data from each region in Saudi Arabia. After training those data collectors about conducting telephone/face-to-face questionnaires. It was developed based on the review of literature, a combination of two validated questionnaires by Joffe *et al.* (2016) and El-Shinawi *et al.* (2015), and expert opinion. The questionnaire was given to all data collectors using multistage and cluster sampling. All regions in Saudi Arabia were represented. The researchers randomly chose only four colleges from each region by multistage sampling. Also, cluster sampling was used to divide the students by their level. Furthermore, the students were selected to participate from each level in the study by the data collectors of their same college using simple random sampling. After the study aims and objectives were clearly explained the participants were asked to sign voluntary informed consent forms before data collection. The questionnaire consists of four parts that were provided both in Arabic and English. The first part questions the socio-demographic information of the participants, such as age, sex, and study year for students. The second part questions the general knowledge of ethics in research. The third part questions the arguments of the benefits to morally justify animal research. The last part is questions about general opinion regarding animal research. A pilot study of the questionnaires was pre-tested on ten students and staff members to explore if any ambiguity or items led to misunderstanding in the questionnaire reaching its final form. After that, three experts reviewed the validity and reliability of the questionnaire. After a week, the questionnaire was re-administered to the same pilot study sample to check test-retest reliability. The researchers followed up with the data collectors weekly to increase the response rate and ensure the questionnaire was more accessible to the population.

**ETHICAL CONSIDERATION**

To address potential ethical dilemmas, the researchers obtained written informed consent from all participants, ensuring that they were fully informed about the study’s aims and their right to withdraw at any time without penalty. This process is crucial in promoting respect for autonomy and protecting participants’ rights. Additionally, the researchers established stringent measures to safeguard participant confidentiality and privacy by anonymizing data and restricting its use to the research context only. Ethical approval was also secured from the Al-Rayan Research Ethics Committee No. (HA-03-M-122-036), ensuring adherence to established ethical standards in research.

The study employed robust methodologies, including a pre-tested questionnaire refined by experts, to enhance the validity and reliability of the findings while minimizing any potential harm or discomfort to participants. By aligning with the ethical principles of beneficence and justice, the research sought to contribute positively to the discourse surrounding animal welfare and research ethics among future healthcare professionals.

**THE STATISTICAL ANALYSIS**

Data was statistically described in terms of mean and standard deviation, median (IQR) or frequencies (number of cases), and percentages when appropriate. The comparison of numerical variables between the studied groups was done using the Kruskal Wallis test and Mann Whitney U test. For comparing categorical data, Chi-square ( $\chi^2$ ) and Montecarlo tests were performed. Multivariate logistic regression was performed to detect significant predictors for the opinion of the studied participants regarding animal research. Linear regression was performed to detect significant predictors for the overall knowledge score of the studied participants regarding general knowledge of ethics in research. Two-sided p-values less than or equal to 0.05 were considered statistically significant. All statistical calculations were done using the computer program IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, NY, USA) release 25 for Microsoft Windows.

**RESULTS AND DISCUSSION**

**Table 1: Sociodemographic data of the studied participants.**

Studied variable		N	%
Age	> 18	8	1.2
	18-	425	62.0
	22-	240	35.0
	26-	13	1.7
Gender	Female	383	55.9
	Male	302	44.1
Residence in KSA	West	180	26.3
	North	85	12.4
	Middle	128	18.7
	South	230	33.6
	East	62	9.1
Current academic degree	Vocational student	28	4.1
	Bachelor student	651	95.0
	Postgraduate student	6	0.8
Specialty	Medicine	369	53.9
	Pharmacy	105	15.3
	Nursing	66	9.6
	Others	145	21.2

REGARDING THE SOCIODEMOGRAPHIC DATA

A total number of 685 people participated in the study (Figure 1). Females and males represented 55.9% and 44.1%, respectively. 62 % were of age (between 18 and 22 years). In terms of residency in Saudi Arabia, the south region had the highest participation (33.6%), followed by the west region (26.3%), and the east region (9.1%). 95% of participants were bachelor students. More than half of them were school of medicine students (53.9%) (Table 1).

REGARDING THE GENERAL KNOWLEDGE OF ETHICS IN RESEARCH

Most participants knew about the ethics of research (89.6%), and the highest source of knowledge was the college curriculum (44.7%). (67.2%) knew about the conflict of interest and (78.7%) identified the Animal Welfare Act, but the majority did not recognize the Belmont report and Institutional Review Boards (IRB) (84.7% and 62.5%), respectively. The overall knowledge score is (2.88 ± 1.17) (Table 2).

Table 2: General Knowledge of Ethics in Research.

Studied variable		N	%
Source of knowledge	Internet	104	15.2
	Reading a textbook/article/paper	25	3.6
	College curriculum	306	44.7
	Attending research course/conference	10	1.5
	More than one	240	35.0
Ethics of research	No	71	10.4
	Yes	614	89.6
Conflict of interest	No	225	32.8
	Yes	460	67.2
Animal welfare act	No	146	21.3
	Yes	539	78.7
Belmont report	No	580	84.7
	Yes	105	15.3
Institutional Review Boards (IRB)	No	428	62.5
	Yes	257	37.5
Overall knowledge score	Min. – Max.	0-5	
	Mean ± SD	2.88± 1.17	
	Median (IQR)	3 (2)	

SD: standard deviation; IQR: interquartile range.

OVERALL GENERAL KNOWLEDGE OF ETHICS IN RESEARCH AS REGARDS SOCIODEMOGRAPHIC FACTORS OF THE STUDIED PARTICIPANTS AND SOURCE OF THEIR KNOWLEDGE

There was a statistically significant difference in overall general knowledge of ethics and research among the studied participants about the age group, as students above 22 years had the highest mean overall knowledge (P = <0.001).

There was no statistically significant difference in overall general knowledge as regards gender, residence, and current academic degree (p = 0.452, 0.475, and 0.357, respectively). However, there was a statistically significant difference as regards specialty and source of knowledge, as students in the faculty of pharmacy had the highest mean knowledge (0.036) and students who used to attend research courses and/or conferences had the highest mean knowledge (p = <0.001) (Table 3).

CONCERNING BENEFITS ARGUMENTS TO MORALLY JUSTIFY ANIMAL RESEARCH

About 553 (80.7%) of participants agreed that *animal research has great benefits for humans*, while around 19% of them showed that experimentation on animals has no benefits for humans. By asking them if *there are any alternatives for animal experimentation*, 58.5% said no and 41.3% said yes. Also, regarding their belief that “humans can do anything to seek knowledge.” 57.1% agreed with this opinion, while 42.8% disagreed with it (Table 4).

GENERAL OPINION REGARDING ANIMAL RESEARCH

*Using vulnerable humans in experiments instead of animals is wrong*; 72% stated that they are still humans (Figure 2). *Animal research should be conducted in favor of human benefits*. Even though it may cause harm to animals, 39% are neutral, while 14.7% disagree (Figure 3). *Scientists should be allowed to experiment on different animal species*, showing that 41.4% agree, 39.4% are neutral, and 19.2% disagree (Figure 4).

BY ASKED ABOUT THEIR OPINION ABOUT THE POTENTIAL SUFFERING OF ANIMALS, THERE WERE MULTIPLE DIFFERENT OPINIONS

*Testing to ensure the safety and impact of medicine and medical devices*, 52.7% accepted this opinion (49.3% and 3.44% acceptable and somewhat acceptable respectively), neutral 18.5% and those who are variably disagreeing are 28.8%. *Developing products or devices for humans or animals such as artificial organs*, 52.3% are erratically agreeing, 16.6% are neutral and 31.3% are unevenly unaccepted. *When conducting medical research that relates to human or animal disease or disorder*, more than half are accepting (53.7%), 17.2% are neutral, and 29.1% disagree with alterable degrees (Table 5).

ANOTHER IMPORTANT QUESTION IS ABOUT THE PARTICIPANT’S OPINIONS ON THE USE OF ANIMALS IN SCIENTIFIC RESEARCH

The most appropriate theory to reflect the opinions of the participants is the welfare of the animal is important in determining what is acceptable or unacceptable (53.7%), while in the other theory, benefits in the fields of medicine and science outweigh the welfare of the animals; about 46.3% of the participants saw that it was more accepted. By asking the participants about their beliefs in reasons why we expose animals instead of humans, 23.4% of them

**Table 3:** Overall general knowledge of ethics in research as regard sociodemographic factors of the studied participants and source of their knowledge.

Studied variables		Overall knowledge score		P value
		Mean ± SD	Median (IQR)	
Age	>18	2.13±1.36	2(1.75)	<0.001 <sup>(1)</sup>
	18-	2.78±1.18	3(2)	
	22-	3.07±1.15	3(2)	
	26-	3.4±0.99	3.5(1)	
Pairwise comparison <18: 18- (0.545) <18: 22-(0.094) <18: 26- (0.05*) 18-: 22- (0.006*); 18-: 26- (0.240) 22-: 26- (1.000)				
Gender	Male	2.8±1.25	3(2)	0.452 <sup>(2)</sup>
	Female	2.9±1.11	3(2)	
Residence	West	2.87±1.2	3(2)	0.475 <sup>(1)</sup>
	North	2.78±1.23	3(2)	
	Middle	2.8±1.07	3(2)	
	South	2.9±1.2	3(2)	
	East	3.04±1.15	3(2)	
Current academic degree	Vocational student	2.7±1.21	3(2)	0.357 <sup>(1)</sup>
	Bachelor student	2.88±1.17	3(2)	
	Postgraduate student	3.6±1.67	4(3)	
Specialty	Medicine	2.82±1.2	3(2)	0.036 <sup>(1)</sup>
	Pharmacy	3.14±1.02	3(1)	
	Nursing	2.66±1.12	3(2)	
	Others	2.93±1.2	3(2)	
Pairwise comparison Nursing- Medicine (>0.999) Nursing- others (0.796) Nursing- Pharmacy (0.043*) Medicine- others (>0.999) Medicine- Pharmacy (0.104) Others- Pharmacy (0.719)				
Source of knowledge	Internet	2.38±1.26	3(2)	<0.001 <sup>(1)</sup>
	Reading a textbook/article/paper	2.76±1.39	3(1.5)	
	College curriculum	2.98±0.99	3(2)	
	Attending research course/conference	3.4±0.96	3.5(1.25)	
	More than one	2.96±1.29	3(2)	
Pairwise comparison Internet- Reading a textbook/article/paper (>0.999) Internet- College curriculum (<0.001*) Internet- More than one (<0.001*) Internet- Attending research course/conference (0.056) Reading a textbook/article/paper- College curriculum (>0.999) Reading a textbook/article/paper- More than one (>0.999) Reading a textbook/article/paper- Attending research course/conference (>0.999) College curriculum- More than one (>0.999) College curriculum- Attending research course/conference (>0.999) More than one- Attending research course/conference (>0.999)				

**IQR:** interquartile range (1) Kruskal Wallis test (2) Mann Whitney U test; \*: Statistically significant at  $P \leq 0.05$ .

believe that humans have a higher moral status, 7% agree that humans have higher intelligence, 2% believe that animals do not have a soul, 8.3% agree that animals suffer less than humans do, and the majority, 45.3%, agree that there are other relevant differences (Table 6).

**ONE OF THE IMPORTANT QUESTIONS IS: DO YOU FAVOR OR OPPOSE THE USE OF ANIMALS IN SCIENTIFIC RESEARCH?**

75.5% of participants favor it, while only 24.5% oppose it. By analyzing the last question using chi square, there is a

statistically significant increase ( $P \leq 0.05$ ) in those who accept the use of animals (Table 5 and 7).

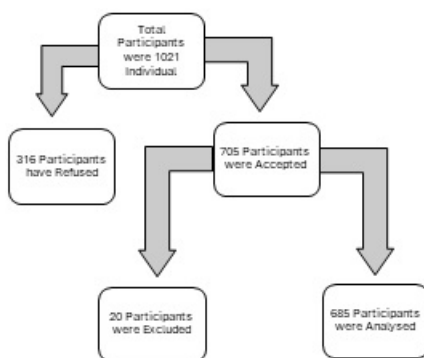
**BY COMPARING THE STUDIED VARIABLES**

Comparing those who are in favor or opposed between the age groups using the Montecarlo test, there is no statistically significant difference (0.980). Comparing those who are in favor or opposed between the female and male groups using the Chi Square test, there is a statistically significant difference (<0.001). Regarding the residence area, there is no significant difference between the studied groups (0.196)

**Table 4:** Benefits Arguments to morally justify animal research.

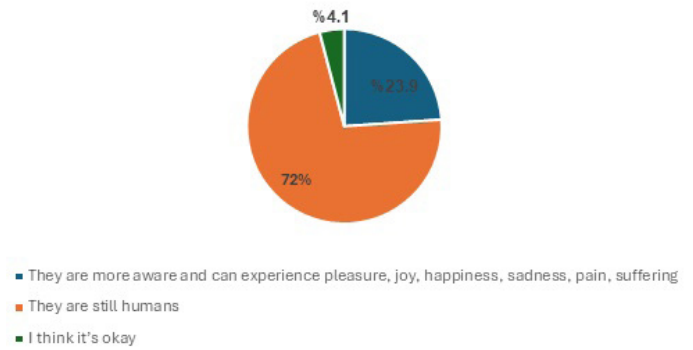
		N	%
Great benefit on humans	No	132	19.3
	Yes	553	80.7
Justification for no	This justifies using humans in the same medical research	11	1.6
	It is immoral	77	11.2
	Both	44	6.4
Belief in animal experimentation is necessary for human benefit	No	122	17.8
	Yes	563	82.2
Justification for no	Spending money on enhancing humanitarian aid would be benefit more	25	3.6
	Presence of alternative	85	12.4
	Justification of 'animal experimentation rather than 'human experimentation	12	1.8
No alternative for animal experimentation	No	402	58.7
	Yes	283	41.3
Explanation	Using animal is legal by the law	66	9.6
	More effort should be put in finding a new alternative	336	49.1
Belief in "human can do anything to seek knowledge"	No	293	42.8
	Yes	391	57.1
Justification for no	Justify anything, including harmful experiments	165	24.1
	This is not an excuse	129	18.8

using the Chi Square test. According to their current academic degrees, there are no significant differences between them (0.809) using the Chi Square test. When comparing different specialty groups, there are significant differences between the studied groups (<0.001) using the Chi Square test (Table 8).



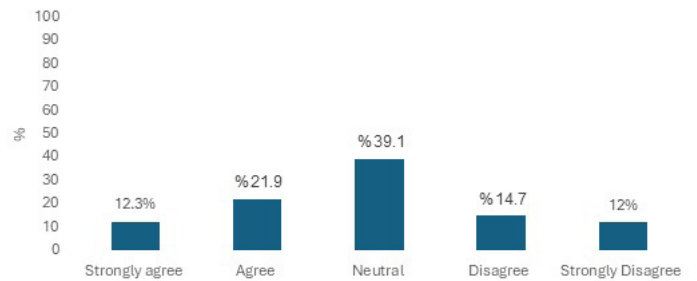
**Figure 1:** Study participants.

**Use vulnerable humans in experiments instead of animals is wrong**



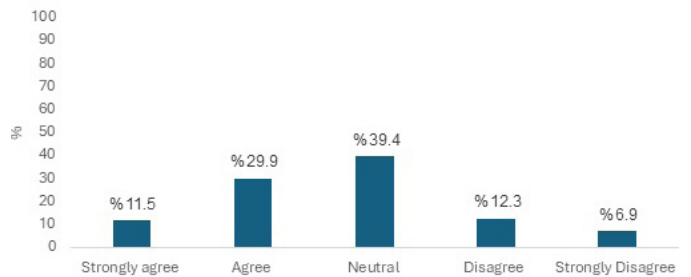
**Figure 2:** Use vulnerable humans in experiments instead of animals is wrong.

**Animal research should be conducted in favor of human benefits even it may cause harm to animals**



**Figure 3:** Animal research should be conducted in favor of human benefits even it may cause harm to animals.

**Scientists should be allowed to experiment on different animals' species**



**Figure 4:** Scientists should be allowed to experiment on different animals' species.

**BINARY MULTIVARIATE LOGISTIC REGRESSION**

shows that females and specialty notably medicine, were the significant predictors of the opinions of the studied participants regarding animal research (Table 9).

**LINEAR REGRESSION TO DETECT SIGNIFICANT PREDICTORS FOR OVERALL KNOWLEDGE SCORE OF THE STUDIED PARTICIPANTS REGARDING GENERAL KNOWLEDGE OF ETHICS IN RESEARCH**

Shows that age and source of knowledge were significant predictors of the overall knowledge score of the studied

participants regarding general knowledge of ethics in research (Table 10).

lying on college curricula or multiple sources ( $p < 0.001$ ), indicating that the source of knowledge significantly impacted overall knowledge scores.

**Table 6:** Another important question is about the participants opinions on the use of animals in scientific research.

		N	%
Theory reflect opinion	Benefits in the field of medicine and science outweigh the welfare of the animals	317	46.3
	Welfare of the animal is important in determining what is an acceptable or unacceptable	368	53.7
Believe in relevant reason to expose animals to research instead of human	Humans have higher moral status	160	23.4
	Humans have higher intelligence	48	7.0
	Animals do not have a soul	14	2.0
	Animals suffer less than humans do	57	8.3
	There are other relevant differences	310	45.3
Favor or oppose the use of animals in scientific research	Favor	517	75.5
	Oppose	168	24.5

The overall knowledge scores on ethics in research varied significantly with age  $p < 0.001^*$ ; Participants aged 26 and older had the highest mean score ( $3.4 \pm 0.99$ ), while those older than 18 had the lowest ( $2.13 \pm 1.36$ ), suggesting that older participants had better knowledge of research ethics. There was no significant difference in knowledge scores between male ( $2.8 \pm 1.25$ ) and female participants ( $2.9 \pm 1.11$ ) ( $p = 0.452$ ). This indicates that gender did not have a significant effect on participants' knowledge of ethics in research. Knowledge scores did not significantly vary by residence location (West, North, Middle, South, East), with all regions showing similar mean scores (ranging from 2.78 to 3.04) and a p-value of 0.475. Participants with post-graduate degrees had higher knowledge scores ( $3.6 \pm 1.67$ ) compared to vocational students ( $2.7 \pm 1.21$ ) and bachelor students ( $2.88 \pm 1.17$ ), though the difference was not statistically significant ( $p = 0.357$ ). Participants from Pharmacy ( $3.14 \pm 1.02$ ) had higher knowledge scores compared to those in Medicine ( $2.82 \pm 1.2$ ) and Nursing ( $2.66 \pm 1.12$ ). The difference was statistically significant between Nursing and Pharmacy ( $p = 0.043$ ), but not between other pairs. Participants who attended research courses or conferences had the highest knowledge scores ( $3.4 \pm 0.96$ ), followed by those who used more than one source of knowledge ( $2.96 \pm 1.29$ ), and those who relied on college curricula ( $2.98 \pm 0.99$ ). Participants using the internet had the lowest scores ( $2.38 \pm 1.26$ ). Pairwise comparisons showed significant differences between those using the internet and those re-

**Table 7:** Use of animals in scientific research, favor or oppose.

		Use of animals in scientific research				P value of chi square test	
		Favor		Oppose			
		N	%	N	%		
Think about medical testing on animals	Morally acceptable	440	85.1	54	32.1	<0.001*	
	Morally wrong	77	14.9	114	67.9		
Total		168	100	517	100		685

\*: Statistically significant at  $P \leq 0.05$ .

Animal experimentation is widely used around the world for identifying the underlying causes of a wide range of diseases in both humans and animals as well as investigating potential treatments through animal experiments. Of the various animal species, almost 90% of the animals utilized for study are purpose-bred birds, rats, and mice. However, many scientists and the public now strongly oppose animal research due to growing awareness of animals' consciousness and their ability to feel pain and suffering. Furthermore, it has been questioned if extending artificial data to humans is useful. Because of this, ethical committees have decided to use the "four Rs"—Reduction, Refinement, Replacement, and Responsibility—as a framework for decision-making when it comes to animal experiments (Kiani *et al.*, 2022). So, the purpose of this study was to investigate the prevalence of ethical knowledge in animal research among Saudi health college students.

The current study included a total of 685 students. Of the participants, 59% were female and 49.1% were male. Comparable results were obtained by Al-harbi *et al.* (2022) who reported that the females were the main participants (56% of them were female and 44% were male).

Most of the participants (89.6%) demonstrated awareness of research ethics. The college curriculum emerged as the primary source of knowledge, with 44.7% of participants obtaining information from this educational platform. According to the study conducted by Shivananda *et al.* (2020), who reported that most of the respondents were aware of the research ethics committee's importance in doing health research. And mentioned that many respondents showed that they already had prior knowledge about research ethics and have undergone some type of training, though about 67% of the population have shown that they had prior training in research ethics.

Additionally, a considerable proportion of participants were aware of conflicts of interest (67.2%) and identified

the Animal Welfare Act (78.7%). However, there was a lack of recognition for the Belmont report (84.7%) and Institutional Review Boards (IRB) (62.5%). Comparing our results to previous studies, variations in the levels of knowledge and awareness among participants are evident. For example, in a study conducted in Malla Reddy Medical College by Tekulapally and Padmavathi (2021), who reported that about 43% majority of the students had poor knowledge about animal welfare regulations. These differences could be attributed to cultural and educational contexts, as well as variations in research ethics education programs and practices across different countries.

**Table 8: Comparing the studied variables.**

Studied variable		Oppose		Favor		P value
		N	%	N	%	
Age	> 18	2	25	6	75	0.980 <sup>(1)</sup>
	18-	319	24.9	106	75.1	
	22-	183	23.8	57	76.2	
	26-	9	25	3	75	
Gender	Female	126	32.9	257	67.1	<0.001 <sup>*(2)</sup>
	Male	42	13.9	260	86.1	
Residence	West	48	26.7	132	73.3	0.196 <sup>(2)</sup>
	North	13	15.3	72	84.7	
	Middle	34	26.6	94	73.4	
	South	61	26.5	169	73.5	
	East	12	14.9	50	80.6	
Current academic degree	Vocational student	5	17.9	23	82.1	0.809 <sup>(1)</sup>
	Bachelor student	162	24.9	489	75.1	
	Postgraduate student	1	16.6	5	83.3	
Specialty	Medicine	66	17.9	303	82.1	<0.001 <sup>*(2)</sup>
	Pharmacy	29	27.6	76	72.4	
	Nursing	28	42.4	38	57.6	
	Others	45	31	100	69	

Montecarlo test (2) Chi Square test; \*: Statistically significant at P ≤ 0.05.

According to our results there was a positive correlation between age groups and overall general knowledge of ethics and research, as students above 22 years had the highest mean overall knowledge. There was no statistically significant difference between overall general knowledge, and gender, residence, and current academic degree. On the other hand, there was a statistically significant difference as regards specialty and source of knowledge, as students in the faculty of pharmacy had the highest mean knowledge and students who used to attend research courses and/or conferences had the highest mean knowledge.

Regarding ‘benefits arguments’ (80.7%) of participants agreed that animal research has great benefits for human. However, by asking them if there are any alternatives for animal experimentation research methods may be available, most of them said no. Also, most of them agree regarding their belief that “humans can do anything to seek knowledge. (72%) of participants agreed with using vulnerable humans in experiments instead of animals is wrong and stated that they are still humans. Furthermore, the study found that a massive portion of the participants held neutral views (39%) with the notion of conducting animal research for the benefit of humans, despite potential harm caused to the animals. A considerable proportion of participants (41.4%) agreed that scientists should be allowed to experiment on different animal species, while 39.4% held neutral views, and 19.2% disagreed.

**Table 9: Binary multivariate logistic regression to detect significant predictors for opinion of the studied participants regarding animal research.**

	B	Wald	P value	odds ratio	95% C.I. for odds ratio	
					Lower	Upper
Female	-0.978	22.901	<0.001*	0.376	0.252	0.561
Specialty		13.316	0.004*			
Medicine	0.556	5.788	0.016*	1.743	1.108	2.741
Pharmacy	0.012	0.002	0.967	1.012	.573	1.787
Nursing	-0.372	1.420	0.233	0.689	.374	1.271
Constant	1.509	39.026	<0.001*	4.521		

CI: confidence interval; \*: Statistically significant at P ≤ 0.05.

**Table 10: Linear regression to detect significant predictors for overall knowledge score of the studied participants regarding general knowledge of ethics in research.**

	Unstandardized B coefficient	95% CI		B	P value
		Lower Bound	Upper Bound		
(Constant)	1.687	1.208	2.167		<0.001*
Age	0.304	0.140	0.469	0.140	<0.001*
Specialty	0.060	-0.013	0.133	0.062	0.105
Source of knowledge	0.105	0.041	0.169	0.124	0.001*

CI: confidence interval; \*: Statistically significant at P ≤ 0.05.

Interestingly, when asked about their opinion on the moral acceptance of medical testing on animals, 72.1% of the participants stated that they viewed it as morally acceptable, while 27.9% considered it morally wrong. This finding suggests a general inclination toward supporting the ethical justification of using animals in medical research among the student population, which is similar to Wieschowski et al. (2020) into public acceptance, awareness, and attitudes towards the use of animals in scientific research in the UK



that found two thirds of the public can accept the use of animals for medical research where there is no alternative.

When separate research is analyzed, similar findings about public approval of animal experiments are observed. Accordingly, research from Italy (*Speaking of Research, 2014*) and the US (Pew Center, 2015) revealed acceptance percentages of 49% and 47%, respectively, while a recent study from the UK (*Ipsos MORI, 2018*) found an acceptance rate of 65%.

Previous studies on this topic have not included arguments or justifications; instead, they have only looked at public opinion (*Goodman et al., 2012; Joffe et al., 2014; Master-ton et al., 2014; Chalmers 2009*). These studies clarified that people had no other explanation for why researchers should use animals other than the necessity to do so in order to benefit humanity.

More study is needed, although studies conducted in North America have indicated that there may be greater ramifications for the public's debate about animal experimentation (*Joffe et al., 2016*). One of the study's shortcomings was that it was solely a survey; going forward, it is advised that interviews be conducted to obtain more detailed arguments and succinct opinions.

The results of *Al-harbi et al. (2022)* were near to those of our study, more than half of the participants made persuasive arguments for the necessity of employing animals in research as well as its many advantages for humankind, particularly when it comes to studies on extremely important health issues. About thirty percent thought that there might be an animal substitute in this kind of circumstance. According to *Machan (2002)* and *Gruen (2021)* most individuals believe that animals have moral status and that injuring or abusing pets or other animals is unethical. This is a transition from the historical point of view, where animals had no moral status and treatment of animals was primarily subservient to protecting the health and dignity of humans. Animal rights are similar to that of humans. Many animals, like humans, can sense pain and pleasure. Many animal rights proponents use the same argument: being human does not provide adequate grounds to declare animals morally inferior.

Various opinions from different studies support animal experiments (*Cohen, 1986; Cohen and Wellman, 2005; Liou, 2010*). They advocate the use of animals in study instead of humans for a variety of reasons, including the fact that animals cannot be brought to the level of moral equality with humans, and animals lack the cognitive ability and full autonomy that humans have. Furthermore, European, and American rules back this method as long as their well-being is maintained. Another aspect of this argument is

that the benefits to humans from animal testing outweigh the harm caused to animals. Bateson, the creator of the Bateson's Cube, introduced a method for assessing when *Bateson (1986)*, morally justifies experiments. The cube has three axes: pain, certainty of benefit, and research quality. If the research is high-quality, useful, and does not.

According to the Research Defense Society (RDS), using animals for study can be morally and ethically justified. Animal research has yielded many benefits and abandoning it would have dire ramifications for both medical research and public health. Nevertheless, the use of the 3Rs (Replacement, Reduction, and Refinement) is essential to consistently decrease the quantity and suffering of animals used for research (*Festing and Wilkinson, 2007*).

Legislation governing animal research is predicated on the moral acceptability of planned studies under certain conditions. The importance of scientific ethics in ensuring proper treatment of laboratory animals (*McCance, 2012*). To reduce unnecessary animal suffering, ethical considerations must be considered throughout animal experiments. It is critical to provide the finest human care to these animals from an ethical and scientific standpoint. Poor animal care can affect experimental results. Thus, if experimental animals are mistreated, the scientific knowledge and conclusions drawn from the tests may be damaged and difficult to duplicate, which is a characteristic of scientific research *Fernandes and Pedroso (2017)*. Currently, most ethical rules operate under the assumption that animal experimentation is justified due to the immense potential benefits for humans. These standards often allow for animal research regardless of the animal's welfare if human advantages are obtained (*Ferdowsian and Beck, 2011*).

Animal experiments helped progress biological and biomedical studies, resulting in the discovery of many medications and treatments. However, animal experimentation can cause harm, discomfort, and distress for the animals involved. Animal experiments require careful adherence to ethical norms and proper justification for their use in research efforts. During animal experiments, researchers must adhere to the 4 Rs principles: reduction, refinement, replacement, and responsibility. Before starting a research endeavor, tests should be well-planned and avoid unnecessary animal exploitation. Consider dependability and repeatability while doing animal studies (*Kiani et al., 2022*).

## IMPLICATIONS OF FINDINGS AND CONTRIBUTION TO EXISTING KNOWLEDGE

The findings of the study measuring the awareness and attitudes of health college students in Saudi Arabia about ethics in animal research hold significant implications for the field of bioethics, especially concerning educational approaches toward understanding animal experimentation

among future healthcare professionals.

**AWARENESS OF RESEARCH ETHICS:** The study revealed that a considerable majority (89.6%) of undergraduate health students proved awareness of research ethics, attributing this knowledge to their college curriculum (44.7%). This is consistent with findings from *Shivananda et al. (2020)*, which highlighted the importance of educational programs in enhancing awareness about research ethics. This suggests that integrating comprehensive bioethics education, particularly concerning animal welfare, into health programs could be beneficial. *Hussein et al. (2015)*, emphasizes the necessity of such education who argue for the role of ethical frameworks in fostering responsible research practices.

**KNOWLEDGE GAPS:** While students showed strong awareness of certain ethical principles, significant gaps were noted in their recognition of key documents such as the Belmont report (84.7% unrecognized) and Institutional Review Boards (IRB) (62.5% unrecognized). This aligns with findings by *Tekulapally and Padmavathi (2021)*, who reported poor knowledge on animal welfare regulations among medical students. This shows the need for systematic and thorough inclusion of core ethical guidelines within medical and health-related curricula to mitigate such gaps.

**DEMOGRAPHIC INFLUENCE ON KNOWLEDGE:** The study found that age was a significant predictor of overall knowledge, with older students (above 22 years) proving better understanding. This finding amplifies the arguments made by *Patel et al. (2021)* about how exposure and maturity can lead to a deeper understanding of ethical issues, suggesting that more targeted educational interventions might be necessary for younger students.

**ETHICAL JUSTIFICATION FOR ANIMAL RESEARCH:** A notable finding is that 80.7% of participants agreed on the benefits of animal research for human health. This mirrors findings from earlier studies (e.g., *Wieschowski et al., 2020*) which show a general acceptance of animal research when justified adequately. However, as highlighted by *Levy (2012)*, it is essential for researchers to balance the justification of benefits against the ethical concerns of animal suffering. There exists a clear need for bioethics courses to emphasize the ethical theories surrounding the moral status of animals and their rights, given the ongoing public discourse on the ethics of animal experimentation.

**SOCIOCULTURAL CONTEXT:** The results underscore the cultural context of ethical considerations in animal research, emphasizing that knowledge and attitudes towards research ethics vary significantly across different educational and sociocultural backgrounds (*Moon et al., 2023*). The findings suggest that the Saudi educational system faces the unique

challenge of integrating culturally proper ethical education into its curriculum.

**FUTURE RESEARCH DIRECTIONS:** The study finds notable gaps in the literature about the awareness of research ethics among health college students, especially in Saudi Arabia. Future research should explore longitudinal studies to assess how attitudes may evolve with increased exposure to ethics training and the implications of such education on actual research practices (*American Medical Association 1879*).

## CONCLUSIONS AND RECOMMENDATIONS

The present study aimed to assess the awareness and understanding of ethical issues related to animal research among undergraduate health college students in Saudi Arabia. The findings show a significant level of awareness on research ethics, with an overwhelming majority (89.6%) of participants acknowledging the importance of ethical considerations in research involving animals. Furthermore, the study notes a positive correlation between older age and higher knowledge scores about ethics in animal research. Female students and those in specialized fields, such as pharmacy, proved higher knowledge levels, underscoring the importance of targeted educational interventions. Unexpected results, there was a notable lack of recognition for critical ethical documents such as the Belmont Report (84.7% unaware) and Institutional Review Boards (62.5% unaware). Also, neutrality among participants: A considerable number of participants displayed neutral views on the moral implications of animal research. This suggests ambivalence and complexity in attitudes toward animal research ethics.

The study suggests five recommendations for improving the ethical understanding of health college students in Saudi Arabia. These include integrating comprehensive ethics education into curricula, promoting research conferences and workshops, developing comprehensive guidelines and resources on alternatives to animal experimentation, encouraging students to engage with Institutional Review Boards and Ethics Committees, and conducting longitudinal studies to track changes in awareness and attitudes. These measures aim to enhance overall awareness and understanding of ethical research practices, promote participation in research conferences and workshops, and ensure that ethical training remains relevant in the evolving scientific and ethical landscape. We also recommend conducting further studies in the field using different or mixed methodologies and expanding the study to include all university students and entire populations.

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## NOVELTY STATEMENT

This study uniquely investigates the awareness and prevalence of ethical considerations surrounding animal research among undergraduate health students in Saudi Arabia, an area that has received limited attention in existing literature.

## AUTHOR'S CONTRIBUTIONS

All authors participated to the study's concept, design, data gathering, and analysis. All contributors wrote the original draft of the manuscript. All authors reviewed and approved the final manuscript.

## LIMITATIONS OF THIS STUDY

The limitations of this study include its cross-sectional design and limited generalizability to other populations. Future studies should aim to recruit a more diverse sample size to enhance generalizability.

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## CONFLICTS OF INTEREST

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