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Undergraduate medical, health science, and technical students' attitudes and knowledge on organ donation and transplantation

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Abstract

Background Organ shortages remain a primary factor limiting transplant number. Raising awareness about organ donation and its medical benefits is one approach that could help dispel misunderstandings, improve willingness to donate, and increase the number of donors. This study aimed to examine the attitudes and knowledge of undergraduate students in medicine, health sciences, and technical fields regarding organ donation and transplantation, as well as to explore potential differences in perspectives across these groups.

Methods An observational web-based questionnaire survey was created for Finnish undergraduate medical, health science, and technical students. The survey included both multiple-choice questions evaluated on a Likert scale from 1 to 5 and open-ended questions. Descriptive statistical analyses were used to evaluate the results.

Results A total of 559 students completed the questionnaire, comprising 210 (37.6%) medical, 146 (26.1%) health science, and 203 (36.3%) technical students. Willingness to donate was significantly higher among medical and health science students compared to technical students (97.6%, 94.5%, and 85.7%, respectively; $p < 0.001$). A total of 42 respondents indicated they would not donate their organs after death. The prevalence of non-donors was lower among medical and health science students combined compared to technical students (3.7% vs. 14.3%; 95% CI for the difference: 5.8–16.3%; $p < 0.001$). Among non-donors, 78.6% expressed willingness to receive an organ if needed. Non-donors were less likely to have shared their opinion on organ donation compared to donors (21.4% vs. 69.2%, $p < 0.001$). Only 8.8% of respondents felt there is sufficient public discussion about organ donation and transplantation, while 45% considered brain death a valid definition of death.

Conclusions Overall, willingness to donate organs after death is high (92.5%), with the highest willingness observed among medical students. A majority of the respondents expressed their will to donate organs and tissues. Most non-donors cited lack of knowledge as the main reason for not donating, though two-thirds of them indicated willingness to receive an organ if needed. Increased awareness about organ donation is necessary.

Clinical trial number Not applicable.

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Introduction

Organ donation from deceased donors consists of donation after brain death (DBD) and donation after circulatory determination of death (DCD) [1]. Organ transplantation is a well-established medical procedure [2] and is often lifesaving for the recipient and sometimes the only treatment for end-stage organ failure. The biggest limiting factor for organ transplantation is the constant shortage of donated organs [1].

In Finland, the primary source for organ transplants remains DBD, but DCD has started to emerge due to a shortage of brain-dead donors [3]. According to the law, organs of a deceased person may be removed unless it is known or there is reason to assume that the person would have objected while still alive (opt-out consent) [4]. This opt-out consent where silence is considered tantamount to consent has been considered to increase deceased donor rates, but it has been demonstrated that there is no significant difference compared with opt-in system countries where consent must be explicit [1]. Although, different outcomes have been observed. The introduction of the opt-out system in Wales in December 2015 led to an increase in consent rates compared with the rest of the United Kingdom which retained an opt-in system [5].

Another key ethical concern in organ donation is the role of families in overriding individual donation decisions. This issue is particularly relevant in opt-out systems, where a presumed consent policy may still be overridden by relatives, potentially impacting donation rates [6].

Public and social awareness plays a crucial role in organ donation, particularly in how individuals form attitudes toward donation. Studies suggest that younger generations engage with organ donation information differently, with social media and digital platforms acting as key channels to spread awareness [7]. Research indicates that presumed consent alone does not guarantee higher donation rates, and success depends on public awareness, trust in the healthcare system, and effective communication through media and healthcare professionals [5].

Healthcare professionals play a crucial role in the organ donation process, making their knowledge, attitudes, and willingness to support donation essential in improving donor rates and public trust. Accurate information about organ donation is important to correct common misconceptions, such as beliefs of being too old to donate or that religion prohibits it. Despite widespread support for organ donation, a significant gap exists between those who support it and those who are registered donors. For example, in Finland 83% of adults support organ donation, but only 38% have registered [8]. Increasing awareness can help bridge this gap. A single donor provides an average of over 30 additional life-years to patients in need of transplantation [9]. Awareness of these facts may affect attitudes towards organ donation.

According to a 2020 survey conducted in Andalusia, Spain, 80% of medical students and 77% of nursing students supported organ donation [10]. According to a survey conducted in Poland in 2022, 73% of medical student respondents expressed they would agree to donate their organs, with religion having a significant effect on students' willingness to act as an organ donor after death [11]. In a German study, higher-year medical students showed more positive attitudes toward organ donation after death than students who had just started their studies. Health care field (medical, nursing, and other health sciences) did not have a significant effect on the willingness to be an organ donor after death, and 86.5% of respondents would be willing to donate organs [12].

The main purpose of this study was to investigate the attitudes and knowledge of undergraduate medical, health science, and technical students toward deceased organ donation and transplantation. Surveys from various countries show that medical and nursing students generally support organ donation. Despite widespread support for organ donation, there is a significant gap between those who support it and those who are registered donors. By surveying medical and health science students, our study aims to provide insights into how education and exposure to organ donation topics can influence attitudes. The hypothesis was that medical and health science students have more favorable attitudes toward organ donation and transplantation than students in the other fields of study.

Materials and methods

This observational survey study was conducted at the Faculty of Medicine and Faculty of Technology at the University of Oulu, and at the University of Applied Sciences during the autumn of 2023. The survey was sent to approximately 1500 undergraduate medical and health science students and students from different fields at the technical university including architecture, bioanalytics, radiography, occupational therapy, optometry, social work, dental hygiene, digital solutions for well-being, industrial engineering and management, computer science and engineering, environmental engineering, civil and construction engineering, electronics, mechanical engineering, biomedical engineering and process engineering.

The Institutional Review Board (IRB) and ethics committee of Oulu University Hospital and the Northern Ostrobothnia Hospital District waived the need for ethical approval or a signed written informed consent from the participants. According to the research policies of the University of Oulu and Oulu University of Applied Sciences, an IRB permit was waived for studies that use general student surveys without requesting personal data. Since the survey contained indirect identifiers, a preliminary data protection assessment and notice were submitted to the National Data Protection Ombudsman which was approved by a data protection specialist and administrative head in Oulu University and Oulu University of Applied Sciences. Data collection adhered to EU GDPR standards and to the Finnish legislation, the Act on the Protection of Privacy in the Processing of Personal Data (1050/2018). A student register information request was filed via the University of Oulu's digital services (for medical and technical students), and a survey permit was obtained through Oulu University of Applied Sciences' system (for health science students). No additional research permit was required.

Information about the survey's purpose and goals was included in the questionnaire. Students were informed beforehand that by answering the questionnaire the student consented to participation in the survey. Answering the survey was voluntary, and students had the option to stop at any stage of the survey. The questionnaire was based on a Finnish version previously used in similar surveys for healthcare professionals in Finland [13], and the survey questions in the present study were modified for undergraduate students (Supplementary file 1: The Survey Questionnaire).

The material was collected electronically with a Google Forms questionnaire distributed to students using general e-mail lists of the targeted fields of study. Answering was done anonymously, without any identifying data. The questionnaire consisted of both open and multiple-choice questions. Some of the questions used a 5-point Likert scale (1 = totally disagree to 5 = totally agree).

In terms of the success of the project, the most critical factors were reluctance to participate in the survey and the low number of responses. To reduce this risk, we twice sent information about participating in the survey via email lists. The electronic materials collected during the research were stored in Oulu University's data center, to which only the researchers had access. The files were used only for the pre-agreed research purpose. The data were collected and reported in such a way that no individual survey participant could be identified.

Descriptive and statistical analyses were performed using SPSS for Windows software (IBM SPSS Statistics for Windows, version 27.0; IBM Corp, Armonk, New York). Categorical data are expressed as numbers (n) and percentages (%).

The question of whether the respondent would donate his or her own organs and tissues after death was used to calculate the power analysis and the required sample size. Two different power analysis models were used to calculate the sample size. In the first calculation, the sample size was calculated assuming that 80% of all respondents have a positive attitude towards organ donation, which is in line with previous European research [10]. According to the first power analysis, with a confidence interval of 95% and a margin of error of 5%, at least 246 survey respondents were needed. The second power analysis was calculated as above, but with the assumption that the favorability of organ donation among technical students would be 10% lower than that of both medical and health science students. To detect this difference, at least 247 technical students and 247 health science students would be required to participate in the survey. Assuming a response rate of about 50%, the survey needed to be sent to at least 988 (2×494) students. The difference between health science or medical students and technical students is represented as a percentage unit with 95% confidence interval. For continuous variables, between-group comparisons were performed using analysis of variances or Welch's test.

Results

In total, 559 students completed the questionnaire, of which 210 (37.6%) were medical, 146 (26.1%) health science, and 203 (36.3%) technical students (Table 1). The median age of the respondents was 23 years [21–27], 77.6% were female, and 48% were first- or second-year students. The proportion of respondents older than 35 years was highest among health science students compared with medical and technical students (18.5%, 3.8% and 9.4%, respectively). Of the technical students, 14.8% had previous healthcare education and 24.6% of them had work experience in healthcare (Table 2).

Table 1 Willingness to donate one's organs after death

	ALL, *n* = 559 (100%)	Medical students, *n* = 210 (37.6%)	Health science students, *n* = 146 (26.1%)	Technical students, *n* = 203 (36.3%)	*p*-value
Would you donate your organs after death?					< 0.001
Yes, n (%)	517 (92.5%)	205 (97.6%)	138 (94.5%)	174 (85.7%)	
No, n (%)	42 (7.5%)	5 (2.4%)	8 (5.5%)	29 (14.3%)	

Table 2 Background variables. Regarding willingness to donate *$p < 0.001$ between medical, health science, and technical students

	ALL, $n = 559$ (100%)	Medical students, $n = 210$ (37.6%)	Health science students, $n = 146$ (26.1%)	Technical students, $n = 203$ (36.3%)
Sex Female	434 (77.6%)	170 (90.0%)	133 (91.1%)	131 (64.5%)
Age	Median 23 (IQR 21–27)			
18–24	325 (58.3%)	138 (65.7%)	72 (49.3%)	116 (57.1%)
25–34	179 (32.1%)	64 (30.5%)	47 (32.2%)	68 (33.5%)
35–44	36 (6.5%)	7 (3.3%)	18 (12.3%)	11 (5.4%)
45–54	14 (2.5%)	1 (0.5%)	7 (4.8%)	6 (3.0%)
≥ 55	4 (0.7%)	-	2 (1.4%)	2 (1.0%)
Academic years				
1–2	267 (47.8%)	112 (53.3%)	62 (42.5%)	93 (45.8%)
2–4	201 (36.0%)	63 (30.0%)	72 (49.3%)	66 (32.5%)
4–6	76 (13.6%)	31 (14.8%)	9 (6.2%)	36 (17.7%)
> 6	15 (2.7%)	4 (1.9%)	3 (2.1%)	8 (3.9%)
Previous education in				
- Healthcare	109 (19.5%)	24 (11.4%)	55 (37.7%)	30 (14.8%)
- Technical	31 (5.5%)	6 (2.9%)	4 (2.7%)	21 (10.3%)
- Neither	419 (75.0%)	180 (87.5%)	87 (59.6%)	152 (74.9%)
Any work experience in healthcare	231 (41.3%)	81 (38.6%)	100 (68.5%)	50 (24.6%)

IQR = interquartile range [25th – 75th percentile]

Willingness to donate

The main outcome, willingness to donate, is presented in Table 1. Of all 559 students, 517 (92.5%) would be willing to donate their organs after death. A total of 42 (7.5%) respondents would not donate their organs after death. There was a significant difference in the prevalence of non-donors between medical and health science students combined and technical students (3.7% vs. 14.3% [95% CI of the difference: 5.8–16.3%], $p < 0.001$). Those not willing to donate had less information about the subject compared with those willing to donate (19% vs. 55.1%, $p < 0.001$,), and had received less education on the subject (7.1% vs. 19.5%, $p < 0.013$) (Table 4). Eight of the students not willing to donate (19%) were worried that their organs would go to someone who does not deserve them. Non-donors less often expressed their own opinions about donation compared with donors (21.4% vs. 69.2%, $p < 0.001$).

In addition, 95.3% would be willing to receive an organ if needed. Willingness to receive an organ if needed was highest among those willing to donate (96.7% vs. 78.6%, $p < 0.001$). Comparing non-donors and donors, there was no significant difference in the opinion as to whether it is right to receive an organ even though one refuses to donate their own organs (52.5% vs. 49.7%). The willingness to have one's own child's organ(s) donated in case of the child's brain death was lowest in those not willing to donate (26.2% vs. 77.0%, $p < 0.001$) (Table 4).

Of all the respondents, 49.9% felt that it would be right to receive an organ even if they would refuse to donate their own organs. This opinion was least common among health science students followed by medical and technical students (42.5%, 51.4% and 53.2%, respectively, $p = 0.016$). The willingness to have one's own child's organ(s) donated after death was highest among medical students followed by health science and technical students (80.5% vs. 70.5% vs. 67.5%, $p = 0.025$) (Table 3). Of all the respondents, 66.2% did not know their loved one's intent regarding donating organs or tissues after death. Also, 78.8% agreed that it would be normal to discuss organ donation with their loved ones. Of those who would refuse to donate their organs after death, 50% (21/42) found it natural to discuss organ donation. Further, 361/559 (64.6%) would accept their loved one's organs being donated even if they did not know if that person had consented or what their opinions were about organ donation, and 8.1% of the students would not accept their loved one's negative opinion about organ donation.

Knowledge

Of the respondents, 69.1% had not been educated about organ donation and transplantation during their studies (Table 3). The percentage of those affirming that they had received education was highest among medical students, second highest among health science students, and lowest among technical students (29.1%, 22.6%, and 4.9%, respectively, $p < 0.001$). The proportion of medical and health science students who felt they had enough information about the subject was significantly higher than technical students (59.0%, 61.6%, and 39%, respectively, $p < 0.001$). Of the respondents, 67.8% stated that there is

Table 3 Knowledge about and willingness to receive an organ or tissue transplant from a brain-dead donor

	All, *n* = 559	Medical students, *n* = 210	Health science students, *n* = 146	Technical students, *n* = 203	*p*-value
"I have received education about organ donation and transplantation during my studies."					< 0.001
Agree	104 (18.6%)	61 (29.1%)	33 (22.6%)	10 (4.9%)	
Undecided	50 (8.9%)	24 (11.4%)	17 (11.6%)	9 (4.4%)	
Disagree	386 (69.1%)	118 (56.2%)	96 (65.8%)	172 (84.8%)	
Did not answer	19 (3.4%)	7 (3.3%)		12 (5.9%)	
"During the past year, have you heard, read, or seen information about organ transplantation or donation?"					< 0.001
Yes	142 (25.5%)	77 (13.8%)	43 (7.7%)	22 (4.0%)	
"I have enough information about organ donation and transplantation."					< 0.001
Agree	293 (52.4%)	124 (59.0%)	90 (61.6%)	79 (39.0%)	
Undecided	71 (12.7%)	24 (11.4%)	11 (7.5%)	36 (17.7%)	
Disagree	194 (34.7%)	61 (29.1%)	45 (30.8%)	88 (43.3%)	
Did not answer	1 (0.2%)	1 (0.5%)	-	-	
"Do you think there is enough information available about organ donation and transplantation?"					0.14
Yes	144 (38.4%)	82 (39.0%)	93 (63.7%)	7.4 (7.4%)	
"I think there is enough public discussion about organ donation and transplantation."					0.56
Agree	49 (8.8%)	17 (8.1%)	18 (12.3%)	14 (6.9%)	
Undecided	131 (23.4%)	51 (24.3%)	28 (19.2%)	52 (25.6%)	
Disagree	379 (67.8%)	142 (67.6%)	100 (68.5%)	137 (67.5%)	
"Do you think it is right that you can get a new organ or tissue transplant even if you refuse to donate your own organs after death?"					0.016
Yes	278 (49.9%)	108 (51.4%)	62 (42.5%)	108 (53.2%)	
No	119 (21.3%)	43 (20.5%)	28 (19.2%)	48 (23.6%)	
I don't know	160 (28.8%)	59 (28.1%)	56 (38.3%)	47 (23.2%)	
"If in need, I would be willing to receive organ or tissue transplantation from a brain-dead donor."	553 (95.3%)	203 (96.7%)	142 (97.3%)	188 (92.6%)	0.106
"I would agree to my own child being an organ donor after his/her death." (opinion regardless of whether the respondent has children or not)					0.025
Yes	409 (73.2%)	169 (80.5%)	103 (70.5%)	137 (67.5%)	
No	14 (2.5%)	2 (1.0%)	4 (2.7%)	8 (3.9%)	
I don't know	136 (24.3%)	39 (18.6%)	39 (26.7%)	58 (28.6%)	

not enough public discussion about organ donation and transplantation.

Overall, 60.8% of all students considered brain death to be a valid definition of death, and 36 (16.7%) of the students expressed doubts related to the definition of brain death. The rate of not accepting brain death as a valid definition of death was lower among those not willing to donate than among those willing to donate (45% vs. 62.4%, $p < 0.01$) (Table 4). Out of the 42 respondents who would not donate their organs after death, 19 (45.2%) would like to receive more education and theoretical information about brain death, 18 (42.9%) on how to identify potential organ donors, 19 (45.2%) on tissue donation and transplantation in general, 18 (42.9%) about legislation and how to start a discussion and support loved ones and 18 (42.9%) how to address a patient's own desire to donate organs. Reasons for refusing to donate organs after death are presented in Table 5.

Discussion

A key objective was to examine whether medical and health science students have more favorable attitudes toward organ donation than technical students. While previous research has primarily focused on healthcare students and professionals, this study includes students from non-health disciplines to compare how different educational backgrounds influence attitudes and knowledge. It also highlights gaps in knowledge and underscores the impact of insufficient education on shaping perspectives on organ donation and transplant.

The overall willingness to donate among students is high. Our survey found three main results. First, the

Table 4 Comparison of responses from students refusing to donate their organs with those who would donate

	Would not donate, $n=42$	Would donate, $n=517$	*p*-value
Gender, Female	31 (73.8%)	403 (77.9%)	0.45
Age n (%)			0.15
18–24	31 (73.8)	294 (56.9%)	
25–34	8 (19.0)	171 (33.1%)	
35–44	2 (4.8)	34 (6.6%)	
45–54	-	14 (2.7%)	
≥ 55	1 (2.4)	3 (0.6%)	
Field of Study			< 0.001
Medical students	5 (11.9%)	205 (39.7%)	
Health science students	8 (19.0%)	138 (26.7%)	
Technical students	29 (69.0%)	174 (33.7%)	
Previous education from healthcare	8 (19.0%)	101 (19.5%)	0.5
"I am willing to receive an organ from a brain-dead donor if needed.", YES	33 (78.6%)	500 (96.7%)	< 0.001
"Do you think it is right that you can get a new organ or tissue transplant even if you refuse to donate your own organs after death?"			0.93
YES	21 (52.5%)	257 (49.7%)	
Unsure	11 (27.5%)	149 (28.8%)	
"What is your opinion regarding your close one's refusal to be an organ donor?": APPROVE OR DON'T HAVE OPINION	42 (100%)	472 (91.3%)	0.003
"If I have or would have children, I would agree to donate my child's organs and tissues after death." YES	11 (26.2%)	398 (77.0%)	< 0.001
"Organ donation after death saves lives." YES	100%	100%	
"Have you expressed your will to donate organs and tissues?" YES	9 (21.4%)	358 (69.2%)	< 0.001
"The patient cannot be an organ donor if…" DON'T KNOW	21 (50.0%)	208 (40.2%)	
"Brain death is a valid definition of death." YES	18 (45.0%)	322 (62.4%)	
"If you answered 'No' or 'I don't know' to the survey item 'Brain death is a valid definition of death', the reason is…"			0.003
Doubts about brain death diagnostics	7 (16.7%)	29 (5.6%)	
"Lack of information and knowledge about organ donation."	14 (33.3%)	160 (30.9%)	
"The decision on the suitability of a potential organ donor's organs should be made by a transplantation surgeon."	11 (26.2%)	125 (24.2%)	0.40
"During the past year, have you heard, read, or seen information about organ transplantation or donation?" YES	6 (14.3%)	136 (26.3%)	0.13
"Is there enough information available?" YES	5 (11.9%)	139 (26.9%)	0.24
"I have received education about organ donation and transplantation during my studies." AGREE	3 (7.1%)	101 (19.5%)	0.013
"I think there is enough public discussion about organ donation and transplantation." AGREE	2 (4.8%)	47 (9.1%)	0.07
"I have enough information about organ donation and transplantation." AGREE	8 (19.0%)	285 (55.1%)	0.001

highest willingness to donate was among medical students, while more than 10% of technical students would not be willing to donate their organs. Second, more than two-thirds of the non-donors were willing to receive an organ if needed. And third, non-donors would like to receive more education and theoretical information about brain death, about how to identify potential organ donors, about tissue donation and transplantation in general, and about legislation.

Our survey indicates that medical and health science students have more positive opinions about organ donation than technical students. This finding supports the primary hypothesis of the study and supports the results of previous surveys [14]. The willingness to donate among medical and nursing students is higher than it is among medical professionals and the general population. Based on a national survey of medical professionals in 2020, 88%,[15] and in 2023, 95%,[13] of hospital staff would donate their own organs and tissues after death. In the US, a survey of surgical attendings, residents, and medical students found that willingness to donate correlated inversely with professional experience, with the highest willingness among medical students (77%) [16]. In the US questionnaire, previous experiences with the organ procurement procedure influenced physicians' negative attitudes. The number of non-donors in our study was less than in a study of medical students in Buenos Aires, in which 18.1% were not willing to donate their organs after death [17]. In that study, reasons for refusal included fears about the possibility of not being dead (36.4%), lack

Table 5 Reasons for refusing to donate organs after death

	Medical students	Health science students	Technical students	All
Don't have enough knowledge or information about organ donation.	4/42	2/42	16/42	22/42
Personal reasons	3/42	3/42	2/42	8/42
Religious or philosophical reasons	1/42	3/42	4/42	8/42
Organs might end up being given to someone who does not deserve them	3/42	2/42	3/42	8/42
Belief that one's organs do not qualify	-	-	7/42	7/42
Doubts related to brain-death diagnosis	1/42	-	3/42	4/42
Do not trust the healthcare system	-	-	1/42	1/42

of confidence in (25.8%) or lack of information about the organ procurement and transplantation system (14.6%), no interest in organ donation (9.3%), and religious reasons (6%). The main reasons in the present study were the lack of knowledge about organ donation, personal and religious reasons, and concern that organs might end up in someone who does not deserve them. More than half of the students who would not donate their organs after death stated that they do not have enough information about the subject. Thus, increasing public knowledge about organ donation and correcting misleading information would likely result in more positive attitudes [18].

Our study had an open-ended question asking where respondents obtained information about organ donation. However, due to the heterogeneity and wide variation in responses—from official sources (e.g., scientific publications, lectures, work, school) to various media platforms, including social media—we did not analyze it in detail. Other studies have shown that educational information about organ donation on social networks significantly influences public knowledge and attitudes, especially among young people [7, 19]. For example, a Spanish study found that an audiovisual website about donation and short films published on YouTube, increased support for organ donation (85–97%), willingness to donate (64–79%), and knowledge of brain death (80–92%).[19] In the present study, understanding the source of information would have been valuable, as it can influence perceptions and attitudes toward donation.

A notable finding from the survey used in this study was that the attitude toward organ donation is more favorable among medical students than technical students. Interestingly, the same was true of medical students compared with health science students, similar to the findings of a previous study carried out in Spain [10]. Again, a more favorable attitude was associated with students having been educated about the subject during their studies. In our survey, 29.1% of the medical students surveyed had received education about organ donation during their studies compared to 22.6% of the health care students. For comparison, 61.6% of the health care students considered brain death was a valid definition of death, while the number among medical students was 67.6%. It has been found that 20–25 potential organ donors remain unrecognized every year in Finland [20]. Other recent studies have also found that medical and health science students are aware of the fact that they do not receive enough education about the subject during their studies [10, 12, 21, 22]. It is crucial to remedy this early in the education of future health care professionals who may be able to influence organ donation rates [21]. In a large survey of Italian university students, only 40.8% considered themselves informed about medical procedures involving organ donation, and only 15.8% thought they had sufficient legal information [23]. Perhaps another way to fill information gaps would be to offer an educational program delivered by a transplant physician and a transplant recipient. A Japanese study found that such a program may alter the attitudes of medical students towards deceased donation [24]. Furthermore, if college students were aware of the positive attitudes of other college students toward organ donation, they might be more likely to sign the organ donation card and to discuss the topic with their loved ones [25].

The rate of not acknowledging brain death as a valid definition of death was lower among those not willing to donate than among those willing to donate. In a single university survey, 81.3% of medical students accepted the definition of brain death, [26] and according to another study, brain death was considered irreversible by 51% among those not willing to donate [17]. A Canadian survey found that among medical students, only 76% acknowledged that someone could be neurologically deceased while maintaining a heartbeat, and 69% were not aware of the option of non-heart beating donation [22]. The uncertainty associated with general information such as brain death being a valid definition of death was revealed in this study and has been reported in other studies [12, 18]. Tackmann et al. [12] found that only about half of the students knew all the correct answers to questions regarding brain death. In a national survey conducted in Finland in 2023, 69% of healthcare professionals knew that the declaration of brain death establishes the time of death [14]. The results of the present and previous studies suggest the need for education regarding the definition of brain death. Knowledge about brain death is also lacking in the general population. Previous studies have shown that only one-third of the

elderly (>65 years old) understood the concept of brain death creating negative attitudes toward organ donation [27]. An annual survey conducted in Finland in 2023 also showed that elderly people were more reserved about receiving a transplant organ [28]. In our study, we did not have specific question addressing brain death and whether the respondents have a clear understanding of this concept.

According to the results of the most recent poll commissioned by the Kidney and Liver Association in 2023, 83% of Finns are supportive of the idea of donating their organs after death, 86% would accept an organ transplant if needed and and 88% of Finnish healthcare professionals have expressed their will to donate organs [15]. However, only 38% of Finns have confirmed their will to donate by adding themselves to the organ donor registry [8]. There is also a significant relationship between the extent of positive attitudes toward organ donation held by English medical and nursing students and their personal willingness to donate organs: 74% of the nursing students had already signed a donor card, compared with only 43% of the medical students [29].

Reasons behind refusal to donate organs are various, and one of the biggest factors cited in previous studies is religion [11]. In our study, religion was not a major factor for refusal. Interestingly, the majority of non-donors were women. This conflicts with other studies stating that a person's sex does not reflect their attitude toward organ donation; [11] on the other hand, women have more favorable opinions about organ donation and transplantation [10, 22].

In this study, we noticed that negative opinions regarding organ donation might be associated with misinformation about organ donation and how organ and tissue procurement is performed (e.g., the misconception that organ donation is incompatible with an open casket funeral). Our survey also asked what words would students use to describe organ donation or what kinds of feelings does organ donation evoke in them. Positive words chosen by most students were "opportunity", "valuable" and "positivity". The most chosen negative words were "uncertainty", "complicated" and "weird". Also, words such as "painful", "suspicious", "fear" and "disrespectful" were chosen. This may reflect general misinformation about organ donation, and how the received information might be interpreted as negative. Another worrying finding about the students' attitudes was that a notable number of them were concerned that their organ would go to someone who would not deserve it. We conclude from this that people can be highly uninformed about the organ donation procedure and organ donation in general, and that their attitudes and beliefs can be overshadowed by false information. We deduce from the results of this and previous studies that educating the public about organ donation and transplantation in general may result in more favorable attitudes and lessen people's concerns [13, 18]. As has been noted, the level of knowledge of nonmedical students and people in general about organ donation is remarkably low [13]. Another important factor affecting donation rates is uncertainty about a loved one's consent to donate after death [11, 21]. Two-thirds of the students in this study would not be able to confirm their loved one's consent if asked; this can be associated with the subject being undiscussed between relatives. Although almost 80% of the students finds it natural to talk about organ donation with their loved ones, only 42.4% had informed their loved one of their position on this. Surprisingly, although only 33.8% knew their loved one's position on organ donation, 64.6% would accept organs of their loved ones being donated after death. As McGlade and Pierscionek stated in their survey, [21] being educated about organ donation is associated with being more comfortable initiating conversations about it.

Strengths and limitations

The sample size was based on a power analysis. The present study includes a diverse range of students from different fields, offering a broad perspective on attitudes toward organ donation. Furthermore, we were able to recruit a relatively large sample size of technical students to compare the impact of study field on the results. We had no information on the response rate, and this may lead to response bias. Also, there is no certainty that students responded to the survey only once, as it was sent to general email lists to protect anonymity. However, double responses are thought to be unlikely because responding was time-consuming and respondent characteristics differ considerably. Also, a positive attitude towards donations and general motivation for participation in questionnaires may have affected willingness to participate in the study. The study relies on self-reported data, which may be subject to bias or inaccuracies. No external motivation factors were used. Our primary focus was on students' overall attitudes rather than their in-depth medical knowledge, and we did not specifically evaluate their understanding of the brain death concept. Including more detailed questions could have provided a deeper insight into students' comprehension of the organ donation process. The study did not analyze the sources of organ donation information in detail, which could have provided deeper insights into how information influences attitudes. Additionally, the study assumes the information received by students is beneficial without assessing its accuracy or impact. A notable factor was that a majority of the respondents were in their first or second year of their studies; therefore, we were not able to compare the knowledge gained during their studies. Our results may

not be generalized to other university-level programs, to other cultural backgrounds or to those who have completed a formal curriculum on organ donation, as well as students ´age and grade of studies, all of which are known to affect attitudes towards organ donation [30].

Recommendations

This study's findings encourage us to enhance organ donation education and target it to undergraduate students. To improve knowledge about organ donation and transplantation among medical and health science students, there should be regularly performed interventions such as lectures during school years [12]. Even a short intervention on the subject can increase students' knowledge and guide them to pay more attention to the subject in the future [21]. This would make the subject more familiar and information more available to the students, especially regarding discussion with patients when necessary [12, 22]. To improve knowledge about organ donation and transplantation, it is important to implement regular educational programs with precise information and encourage medical students to share information with the public [31]. The effect of education on more favorable attitudes toward organ donation is significant and can be seen in a comparison between early stage and upper stage students [12]. Increasing health care professionals' knowledge may affect every step of the organ donation path, starting from early identification of donors. To address the issue of public awareness, information about organ donation and general information about the whole process—the path of organs from donor to recipients—should be provided in a form that is easy for the public to access and understand. Educating the public, even young students, about organ donation can help dispel myths and misconceptions, raise awareness that leads to more informed decisions, and even influence decisions about joining or intending to join the organ donation registry [32, 33]. Social media campaigns can have immediate and dramatic impacts on organ donor registration rates [34].

Already proven to be effective, [18, 31, 34] social media can be used to raise awareness and serve as a platform for sharing information. However, for future education there are numerous opportunities to create interactive educational tools, intelligent tutorials, personalized virtual learning environments, and chatbots with artificial intelligence [35] to educate students and the general public about organ donation and transplantation. The results of our survey support the conclusion that increased public awareness about organ donation is greatly needed, as most respondents had not seen, heard, or read any information about the subject during the past year.

Future studies should analyze the sources of information about organ donation in detail to better understand their impact on attitudes and knowledge. Further, intervention studies should be conducted to assess the effectiveness of educational programs, social media and digital platforms, as well as to track changes in attitudes and knowledge as students progress through their education.

Conclusion

The overall willingness to donate is high among medical, health care and technical students, with the highest willingness found among medical students. A majority of the respondents have expressed their will to donate organs and tissues. Non-donors cited lack of knowledge as the reason not to donate, but two-thirds of the non-donors were willing to receive an organ transplant if needed. More awareness about organ donation is needed through enhancing public awareness using social media platforms, addressing common misconceptions about organ donation and providing education for healthcare professionals.

Abbreviations

DBD	Donation after brain death
DCD	Donation after circulatory determination of death
GDPR	General data protection regulation

Supplementary Information

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Supplementary Material 1

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Author contributions

IS, PL, and TA conceptualized and designed the research framework, developed and implemented the methodology, conducted the investigation, and performed the formal analysis and interpreted the data, managed and curated the research data, and was responsible for drafting the original manuscript. Additionally, PL and TA supervised the research project. AMK, SS, and HMS participated in conceptualizing and designing the research, developing the methodology, analyzing the data, and drafting and reviewing the original manuscript. SS also managed and curated the research data. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The Institutional Review Board (IRB) and ethics committee of Oulu University Hospital and the Northern Ostrobothnia Hospital District waived the need for ethical approval as well as a signed written informed consent from the participants. The survey is in accordance with the Finnish National Board on Research Integrity TENK guidelines 2019 and with the guidelines of the

Declaration of Helsinki. According to the research policies of the University of Oulu and Oulu University of Applied Sciences, an IRB permit is waived for studies that use general student surveys without requesting personal data. Since this study survey contained indirect identifiers, a preliminary data protection assessment and notice were submitted to the National Data Protection Ombudsman, which was approved by a data protection specialist and administrative head at Oulu University and Oulu University of Applied Sciences. Data collection adhered to EU GDPR standards and to the Finnish legislation, the Act on the Protection of Privacy in the Processing of Personal Data (1050/2018). A student register information request was filed via the University of Oulu's digital services (for medical and technical students), and a survey permit was obtained through the Oulu University of Applied Sciences' system (for health science students). No additional research permit was required.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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