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# Student nurses at Spanish universities and their attitude toward xenotransplantation

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## Abstract

**Introduction:** Recent immunological and transgenic advances are a promising alternative using limited materials of human origin for transplantation. However, it is essential to achieve social acceptance of this therapy.

**Objective:** To analyze the attitude of nursing students from Spanish universities toward organ xenotransplantation (XTx) and to determine the factors affecting their attitude.

**Materials and methods:** Type of study: A sociological, multicentre, and observational study. Study population: Nursing students enrolled in Spain (n = 28,000). Sample size: A sample of 10 566 students estimating a proportion of 76% (99% confidence and precision of ±1%), stratified by geographical area and year of study. Instrument of measurement: A validated questionnaire (PCID-XenoTx-RIOS) was handed out to every student in a compulsory session. This survey was self-administered and self-completed voluntarily and anonymously by each student in a period of 5-10 min. Statistical analysis: descriptive analysis, Student's *t* test, the chi-square test, and a logistic regression analysis.

**Results:** A completion rate: 84% (n = 8913) was obtained. If the results of XTx were as good as in human donation, 74% (n = 6564) would be in favor and 22% (n = 1946) would have doubts. The following variables affected this attitude: age ($P < 0.001$); sex ($P < 0.001$); geographical location ($P < 0.001$); academic year of study ($P < 0.001$); attitude toward organ donation ($P < 0.001$); belief in the possibility of needing a transplant ($P < 0.001$); discussion of transplantation with one's family ($P < 0.001$) and friends ($P < 0.001$); and the opinion of one's partner ($P < 0.001$). The following variables persisted in the multivariate analysis: being a male (OR = 1.436; $P < 0.001$); geographical location (OR = 1.937; $P < 0.001$); an attitude in favor of donation (OR = 1.519; $P < 0.001$); belief in the possibility of needing a transplant (OR = 1.497; $P = 0.036$); and having spoken about the issue with family (OR = 1.351; $P < 0.001$) or friends (OR = 1.240; $P = 0.001$).

**Conclusions:** The attitude of nursing students toward organ XTx is favorable and is associated with factors of general knowledge about organ donation and transplantation and social interaction.

**KEYWORDS**
attitude, knowledge, Organ xenotransplantation, student nurses

## 1 | INTRODUCTION

Due to this organ shortage and the increase in the indications for transplantation, there are increasing numbers of patients on the waiting list with the mortality that this brings with it.[1] In the search for definitive solutions, there is continued research into xenotransplantation (XTx) in order to attempt to obtain an inexhaustible source of cells and organs.[2,3] Although clinical XTx is not a reality at present, in preclinical trials it has been possible to obtain a functioning pig-baboon model.[6] Therefore, in vital organs and in emergency situations, XTx could be used as a bridge while waiting for a human organ.[7,8]

A very important aspect of this issue is finding out whether healthcare professionals would be willing to accept it, given that

they are the ones who would offer organ XTx to the patient, if it were confirmed as a real option. This is especially important in those countries in which there are preclinical XTx programs such as Spain where the data suggest that attitude is not as favorable as we would expect.[4,6] For instance, in a transplant hospital with a preclinical XTx program, only 67% of the professionals would be in favor.[9] It should not be forgotten that healthcare professionals play a fundamental role in healthcare programs, given that they have the capacity to generate both favorable and unfavorable attitudes in the general public.[10] It has been seen that public attitude in favor of organ donation and transplantation (ODT) based on information supplied by healthcare professionals is very solid.[11] However, a negative attitude is much more difficult to change given that, in theory, it is provided by a professional who is assumed to be aware of the process.

In this sense, most studies of attitude toward organ XTx focus on medical and nursing staff [9,10] with very few studies being carried out on students. A recent study indicates that Spanish Medical students have a favorable attitude (81%),[13] although the attitude of other healthcare professionals such as student nurses is not known. It should be remembered that these future nurses are the ones who are going to determine whether XTx is successful or not. They are the people who would attend to and care for patients who might receive an animal organ and, therefore, they would also convey information to them about this matter. Therefore, knowing what is the profile of a person who is in favor of XTx could optimize resources invested in carrying out information campaigns about ODT and XTx.

The objective of this study was to analyze the attitude of student nurses in universities in Spain toward XTx and to determine the factors affecting this attitude.

## 2 | MATERIAL AND METHODS

### 2.1 | Type of study

This was a sociological, multicenter, and observational study carried out in Spain in the complete academic year.

### 2.2 | Study population

The study population comprised students of the nursing diploma program in Spain. The size of this population group was estimated using data facilitated by the Ministry of Education, Culture and Sport (MECD).[14] The estimated number of students enrolled on the diploma course in the academic year was approximately 28 000.

### 2.3 | Sample size

The calculated sample size was 10 566 students, estimating a proportion (attitude in favor of donation) of 76%, a confidence level of 99%, and a precision of ±1%.

### 2.4 | Sample stratification

#### 2.4.1 | Geographical stratification of the sample

There were 111 Nursing Faculties and Schools in Spain with teaching activity. These teaching centers were grouped into five geographical regions that represented the whole of the national territory of Spain: (a) The northern area consisted of the Autonomous Communities of Galicia, the Principality of Asturias, and Cantabria. (b) The northeastern area: the Basque Country, La Rioja, Navarre, Aragón, and Catalunya. (c) The central (and western) area: Castilla y León, the Community of Madrid, Extremadura, and Castilla-La Mancha. (d) The eastern area: the Balearic Islands, the Community of Valencia, and the Region of Murcia. (e) And the southern area: Andalusia, the Canary Islands, and Ceuta y Melilla.

The first sample stratified according to geographical area showed that 6.8% students were in the northern area (corresponding to a sample of 718); 22% (n = 2325) in the northeastern area; 28% in the central area (n = 2958), 23.2% in the eastern area (n = 2451); and 20% in the southern area (n = 2114).

#### 2.4.2 | Stratification by year of study

In each geographical area, a second stratification was carried out according to each academic year. To do this, the proportion of students from each year in each geographical area was calculated and the corresponding sample was obtained.

### 2.5 | Sampling technique

In each geographical area, a stratified sampling of nursing faculties and schools was formally invited to participate in the study. Contact was made with the head of the school or the dean of the faculty to obtain authorization to allow the study to be carried out. In order to prevent selection bias, the questionnaire was applied in each year of study and in each school or faculty, in one or more compulsory sessions (classes, practical sessions, seminars, or laboratory sessions). The sample was only considered as valid when the completion rate (number of filled in and completed questionnaires/number of administered questionnaires) was greater than 80% of the students present in the compulsory sessions.

A brief explanation of the study and the structure and content of the survey (instructions on how to answer the questions) was provided to the students, and after specifying the confidentiality of the data obtained, the paper questionnaire was handed out to every student in a compulsory session. This survey was self-administered and self-completed voluntarily and anonymously by each student in a period of 5-10 min. The questionnaires were administered to student nurses by collaborative members of the "International Donor Collaborative Project" group in the schools and faculties that agreed to take part in the study.

The final selection of the participating groups was carried out using non-probabilistic convenience sampling until the necessary number of questionnaires for each academic year was reached

according to the proportionality factor: number of students registered in each academic year in each geographical area. Given that the questionnaires were applied in sessions that were compulsory for the students, a year of study was considered to be full when the number of questionnaires that were administered ranged between ±5% of the number of questionnaires calculated to be necessary.

### 2.6 | Instrument for measuring attitude

The measurement instrument used was a validated questionnaire of attitude toward XTx (PCID-XENO RIOS: A questionnaire designed by the "International Collaborative Organ Donation Project about XTx" in Spain developed by Ríos et al).[13,15,16] This questionnaire included 31 items distributed in the following four subscales, and it was validated in the Spanish population: (a) transplant origins (8 items); (b) consequences (10 items); (c) associated risks (7 items); and (d) transmission of infections (6 items). This model accounted for 61.18% of the cumulative variance. Each factor was internally consistent ($\alpha$ = 0.72; $\alpha$ = 0.91; $\alpha$ = 0.92; and $\alpha$ = 0.89). In addition, an ad hoc questionnaire was applied including other variables.

### 2.7 | Study variables

Attitude toward acceptance of an organ of animal origin (XTx) was used as the dependent variable, assuming that the outcomes of this organ were the same as those obtained using human organs. The independent variables analyzed were grouped into (a) socio-personal and academic variables (age, sex, geographical area, year of study, and type of university); (b) variables related to ODT and social interaction (attitude toward deceased donation, a respondent's belief in the need for a transplant for him or herself, commenting on and talking about the subject of ODT within the family and friends, a partner's opinion about ODT); and (c) variables of prosocial and religious behavior (the respondent's religious attitude, the attitude of his or her religion toward ODT, and participation in voluntary and prosocial type activities).

### 2.8 | Statistical analysis

A descriptive statistical analysis was carried out on each of the variables, and for a comparison of the different variables, Student's *t* test and the chi-square test complemented by an analysis of the remainders were carried out. Fisher's exact test was applied when the contingency tables had cells with an expected frequency of <5. For the multivariate analysis, a logistic regression test was used including variables that had a significant statistical association in the bivariate analysis. *P* values of <0.05 were considered to be statistically significant.

## 3 | RESULTS

### 3.1 | Student nurses and completion rate

A total number of 52 schools and faculties agreed to participate in the study. All of them participated to a greater or lesser extent. Of the 10 590 students selected (10 566 selected plus 0.9% because of the type of sample: applying the questionnaire in compulsory sessions), the questionnaire was successfully completed in 8913 cases (overall response rate: 84%).

The percentage and number of students in each area in each academic year were as follows: The lowest response rate (83.37%) was located in the central area, given that universities C14 and C15 did not obtain valid questionnaires in the first and third year, following the methodological validity criteria. In the northern area (response rate: 85.37%), university N4 did not provide valid questionnaires in the 1st and 2nd year. In the northeastern area (completion rate: 83.60%), university NE2 did not provide valid questionnaires in the 1st year; NE4 did not hand in completed questionnaires in the 2nd and 3rd years. In the eastern area (completion rate: 84.53%), E7 did not hand in valid questionnaires in the 1st year; and in E8, the 2nd and 3rd years were excluded because there was a completion rate of <80%. In the southern area (completion rate: 86.08%), the 3rd year (in S3) and 1st and 2nd year (in S11) were excluded due to a completion rate of less than 80%. In Table 1, there is a description of the sample stratification together with the sample completion rate according to geographical area, university, and year of study.

### 3.2 | Attitude toward xenotransplantation

If the outcomes of organ XTx were similar to those achieved using human donors, 74% (n = 6564) of the respondents would be in favor, while 4% (n = 403) would be against, and the remaining 22% (n = 1946) would have doubts.

However, if the results were worse than those achieved using human donors, 7% (n = 629) would be in favor, 44% (n = 3883) against, and 49% (n = 4382) undecided.

When the students were asked how XTx could change their life, 22% (n = 1867) believed that XTx would change something in their life; 3% (n = 276) believed that it would change their personality; 14% (n = 1150) believed that it would change their way of thinking; and 6% (n = 514) believed that it would change their nature.

With respect to the acceptance toward XTx of different organs, 64% (n = 5552) would accept a heart; 63% (n = 5481) would accept a liver; 66% (n = 5770) would accept a kidney; 15% (n = 1311) would accept other organs; and 23% (n = 2014) would be undecided.

### 3.3 | Factors affecting attitude toward xenotransplantation. A bivariate analysis

#### 3.3.1 | Socio-personal variables

On analyzing the variables affecting attitude toward organ XTx, there were significant differences in terms of age, with older students being more in favor (26 vs 22 years; $P < 0.001$). With regard to sex, males were more in favor (78% vs 73%; $P < 0.001$) (Table 2).

**TABLE 1** Sample and questionnaire completion data of the university nursing students according to geographical area, university, and year of study

| | 1st | | 2nd | | 3rd | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1st $N_0$ | 1st $N_R$ | 2nd $N_0$ | 2nd $N_R$ | 3rd $N_0$ | 3rd $N_R$ | $TN_0$ | $TN_R$ | TR (%) |
| Northern | | | | | | | | | |
| N1 | 40 | 39 | 45 | 45 | 41 | 41 | 126 | 125 | |
| N2 | 39 | 39 | 19 | 19 | 24 | 23 | 82 | 81 | |
| N3 | 53 | 53 | 56 | 56 | 59 | 53 | 168 | 162 | |
| N4 | 41 | 0 | 40 | 0 | 92 | 77 | 173 | 77 | |
| N5 | 50 | 50 | 63 | 62 | 56 | 56 | 169 | 168 | |
| $N_T$ | 223 | 181 | 223 | 182 | 272 | 250 | 718 | 613 | 85.37 |
| Northeastern | | | | | | | | | |
| NE1 | 93 | 92 | 54 | 51 | 66 | 65 | 213 | 208 | |
| NE2 | 36 | 0 | 18 | 16 | 131 | 117 | 185 | 133 | |
| NE3 | 68 | 62 | 52 | 50 | 65 | 55 | 185 | 167 | |
| NE4 | 100 | 92 | 66 | 0 | 72 | 0 | 238 | 92 | |
| NE5 | 86 | 78 | 107 | 103 | 107 | 96 | 300 | 277 | |
| NE6 | 93 | 88 | 136 | 129 | 123 | 114 | 352 | 331 | |
| NE7 | 15 | 12 | 22 | 20 | 29 | 25 | 66 | 57 | |
| NE8 | 69 | 65 | 70 | 68 | 82 | 81 | 221 | 214 | |
| NE9 | 134 | 107 | 128 | 102 | 46 | 37 | 308 | 246 | |
| NE10 | 143 | 122 | 67 | 57 | 47 | 41 | 257 | 220 | |
| $N_T$ | 837 | 718 | 720 | 596 | 768 | 631 | 2325 | 1945 | 83.66 |
| Central | | | | | | | | | |
| C1 | 114 | 113 | 102 | 85 | 123 | 123 | 339 | 321 | |
| C2 | 35 | 35 | 65 | 54 | 36 | 30 | 136 | 119 | |
| C3 | 60 | 52 | 85 | 71 | 57 | 49 | 202 | 172 | |
| C4 | 42 | 41 | 3 | 3 | 19 | 19 | 64 | 63 | |
| C5 | 87 | 83 | 110 | 90 | 75 | 71 | 272 | 244 | |
| C6 | 25 | 24 | 37 | 31 | 32 | 29 | 94 | 84 | |
| C7 | 56 | 46 | 67 | 53 | 43 | 40 | 166 | 139 | |
| C8 | 74 | 73 | 85 | 63 | 83 | 83 | 242 | 219 | |
| C9 | 55 | 49 | 69 | 56 | 59 | 51 | 183 | 156 | |
| C10 | 68 | 60 | 145 | 120 | 28 | 27 | 241 | 207 | |
| C11 | 94 | 88 | 61 | 51 | 73 | 73 | 228 | 212 | |
| C12 | 62 | 54 | 69 | 56 | 21 | 19 | 152 | 129 | |
| C13 | 63 | 53 | 65 | 54 | 78 | 69 | 206 | 176 | |
| C14 | 56 | 0 | 103 | 87 | 53 | 47 | 212 | 134 | |
| C15 | 89 | 70 | 25 | 21 | 107 | 0 | 221 | 91 | |
| $N_T$ | 980 | 841 | 1091 | 895 | 887 | 730 | 2958 | 2466 | 83.37 |
| Eastern | | | | | | | | | |
| E1 | 15 | 15 | 16 | 16 | 10 | 10 | 41 | 41 | |
| E2 | 15 | 15 | 7 | 6 | 9 | 9 | 31 | 30 | |
| E3 | 60 | 60 | 72 | 72 | 123 | 120 | 255 | 252 | |
| E4 | 129 | 128 | 31 | 31 | 136 | 131 | 296 | 290 | |
| E5 | 96 | 94 | 89 | 88 | 130 | 128 | 315 | 310 | |
| E6 | 37 | 36 | 49 | 48 | 38 | 39 | 124 | 123 | |

(Continues)

**TABLE 1** (Continued)

| | 1st | | 2nd | | 3rd | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1st $N_0$ | 1st $N_R$ | 2nd $N_0$ | 2nd $N_R$ | 3rd $N_0$ | 3rd $N_R$ | $TN_0$ | $TN_R$ | TR (%) |
| E7 | 96 | 0 | 167 | 150 | 130 | 117 | 393 | 267 | |
| E8 | 42 | 37 | 90 | 0 | 52 | 0 | 184 | 37 | |
| E9 | 190 | 168 | 259 | 223 | 172 | 142 | 621 | 533 | |
| E10 | 82 | 81 | 98 | 98 | 11 | 9 | 191 | 188 | |
| $N_T$ | 762 | 634 | 878 | 732 | 811 | 705 | 2451 | 2071 | 84.53 |
| Southern | | | | | | | | | |
| S1 | 39 | 35 | 50 | 48 | 70 | 60 | 159 | 143 | |
| S2 | 61 | 60 | 45 | 44 | 26 | 20 | 132 | 124 | |
| S3 | 73 | 62 | 14 | 12 | 58 | 0 | 145 | 74 | |
| S4 | 34 | 30 | 20 | 17 | 14 | 13 | 68 | 60 | |
| S5 | 70 | 70 | 62 | 61 | 70 | 68 | 202 | 199 | |
| S6 | 124 | 106 | 137 | 116 | 115 | 134 | 376 | 356 | |
| S7 | 113 | 112 | 60 | 60 | 68 | 65 | 241 | 237 | |
| S8 | 110 | 107 | 105 | 101 | 102 | 89 | 317 | 297 | |
| S9 | 19 | 15 | 10 | 8 | 18 | 14 | 47 | 37 | |
| S10 | 56 | 50 | 45 | 38 | 29 | 24 | 130 | 112 | |
| S11 | 49 | 0 | 48 | 0 | 92 | 82 | 189 | 82 | |
| S12 | 41 | 37 | 38 | 34 | 29 | 26 | 108 | 97 | |
| $N_T$ | 789 | 684 | 634 | 539 | 691 | 595 | 2114 | 1818 | 86.08 |
| $N_T$ | 3591 | 3058 | 3546 | 2944 | 3429 | 2911 | 10 566 | 8913 | |

N1-N5: University nursing school in the northern area; NE1-NE10: University nursing school in the northeastern area; C1-C15: University nursing school in the central area; E1-E10: University nursing school in the eastern area; S1-S12: University nursing school in the southern area; First-third: years of study; $N_0$: questionnaires administered; $N_R$: questionnaires obtained; $TN_0$: total number of questionnaires administered; $TN_R$: total number of questionnaires obtained; $N_T$: total number of questionnaires in the corresponding column; TR (%): questionnaire completion rate.

### 3.3.2 | University academic variables

There were differences in terms of geographical area: Students from the northern area had a better attitude than in the rest of the areas, especially in the northeast (82% vs 71%; $P < 0.001$). In addition, the students in the final year (3rd year) also had a better attitude (76% vs 71% in the first year; $P < 0.001$). Regarding type of university, students from publicly funded universities had a better attitude than those from private ones (74% vs 69%; $P = 0.002$; Table 2).

### 3.3.3 | Variables related to ODT and social interaction

The students who had a more favorable attitude toward XTx were those who would donate their organs after death (77% vs 62%; $P < 0.001$), those who believed that there was a possibility that they might need a transplant in the future ($P < 0.001$), those who had commented on and/or discussed the topic of donation within the family ($P < 0.001$) or with friends ($P < 0.001$); and those who knew that their partner had a favorable attitude toward ODT ($P < 0.001$; Table 2).

### 3.3.4 | Religious variables and variables of prosocial behavior

After analyzing the variables related to religion, being a non-practicing Catholic or an agnostic/atheist ($P < 0.001$) and knowing the favorable attitude of one's religion toward ODT were factors related to a more favorable attitude toward XTx ($P = 0.002$). Furthermore, the students who had carried out voluntary type activities had a more favorable attitude toward XTx than those who were not be prepared to participate in them (77% vs 64%; $P < 0.001$).

## 3.4 | Factors affecting attitude toward xenotransplantation: a multivariate analysis

The variables that persisted in the multivariate analysis that were associated with a more favorable attitude toward XTx were being a man (odds ratio [OR] = 1.436; $P < 0.001$); studying in the northern area (OR = 1.937; $P < 0.001$); studying in a publicly funded university (OR = 1.322; $P = 0.002$); being in favor of donating one's organs after death (OR = 1.519; $P < 0.001$); having a belief that one might need a transplant in the future (OR = 1.497; $P = 0.036$); having commented on the topic of ODT with one's

**TABLE 2** Variables affecting the attitude of nursing students toward xenotransplantation

| Variable total: 8913 | In favor n = 6564 (74%) | Not in favor n = 403 (4%) | Doubts n = 1946 (22%) | *P* |
|---|---|---|---|---|
| Psychosocial and academic variables | | | | |
| Mean age (22 ± 5 years) | 26 ± 5 | 22 ± 5 | 22 ± 5 | 0.000 |
| Sex | | | | |
| Male (n = 1484) | 1153 (78%) | 81 (5%) | 250 (17%) | 0.000 |
| Female (n = 7365) | 5369 (73%) | 316 (4%) | 1680 (23%) | |
| MD (n = 64) | 42 | 6 | 16 | |
| Geographical location | | | | |
| Southern area (n = 1818) | 1341 (74%) | 89 (5%) | 388 (21%) | **0.000** |
| Eastern area (n = 2071) | 1571 (76%) | 75 (4%) | 425 (21%) | |
| Central area (n = 2466) | 1763 (72%) | 125 (5%) | 578 (23%) | |
| Northern area (n = 613) | 504 (82%) | 18 (3%) | 91 (15%) | |
| Northeastern area (n = 1945) | 1385 (71%) | 96 (5%) | 464 (24%) | |
| Year at university (year of study) | | | | |
| First (n = 3063) | 2177 (71%) | 166 (5%) | 720 (23%) | **0.000** |
| Second (n = 2936) | 2161 (74%) | 136 (5%) | 639 (22%) | |
| Third (n = 2914) | 2226 (76%) | 101 (4%) | 587 (20%) | |
| Type of university: | | | | |
| Publicly funded university (n = 7979) | 5917 (74%) | 345 (4%) | 1717 (22%) | **0.002** |
| Private university (n = 934) | 647 (69%) | 58 (6%) | 229 (25%) | |
| Variables related to ODT and of social interaction | | | | |
| Attitude toward deceased donation: | | | | |
| In favor (n = 6966) | 5353 (77%) | 243 (3%) | 1370 (20%) | **0.000** |
| Not in favor (n = 1930) | 1197 (62%) | 160 (8%) | 573 (30%) | |
| MD (n = 17) | 14 | 0 | 3 | |
| Possibility of needing a transplant: | | | | |
| Yes (n = 6967) | 5255 (75%) | 267 (4%) | 1445 (21%) | **0.000** |
| No (n = 152) | 100 (66%) | 27 (18%) | 25 (16%) | |
| Doubts (n = 1761) | 1185 (67%) | 108 (6%) | 468 (27%) | |
| MD (n = 33) | 24 | 1 | 8 | |
| Discussion with one's family: | | | | |
| Yes (n = 6289) | 4847 (77%) | 215 (3%) | 1227 (20%) | **0.000** |
| No (n = 2603) | 1702 (65%) | 188 (7%) | 713 (27%) | |
| MD (n = 21) | 15 | 0 | 6 | |
| Discussion with friends: | | | | |
| Yes (n = 6358) | 4860 (76%) | 240 (4%) | 1258 (20%) | **0.000** |
| No (n = 2542) | 1695 (67%) | 163 (6%) | 684 (27%) | |
| MD (n = 13) | 9 | 0 | 4 | |
| Partner's opinion about ODT: | | | | |
| Yesit is favorable (n = 2680) | 2123 (79%) | 93 (4%) | 464 (17%) | **0.000** |
| I do not know it (n = 2914) | 2028 (70%) | 158 (5%) | 728 (25%) | |
| Yesit is against (n = 328) | 231 (70%) | 29 (9%) | 68 (21%) | |
| I do not have a partner (n = 2800) | 2039 (73%) | 115 (4%) | 646 (23%) | |
| MD (n = 191) | 143 | 8 | 40 | |

(Continues)

**TABLE 2** (Continued)

| Variable total: 8913 | In favor n = 6564 (74%) | Not in favor n = 403 (4%) | Doubts n = 1946 (22%) | *P* |
|---|---|---|---|---|
| Religious and prosocial behavior variables | | | | |
| The respondent's religion: | | | | |
| Practicing Catholic (n = 989) | 647 (65%) | 58 (6%) | 284 (29%) | **0.000** |
| Non-practicing Catholic (n = 4365) | 3133 (72%) | 196 (5%) | 1036 (24%) | |
| Other religions (n = 281) | 166 (59%) | 46 (16%) | 69 (25%) | |
| Atheist/agnostic (n = 3149) | 2525 (80%) | 99 (3%) | 525 (17%) | |
| MD (n = 129) | 93 | 4 | 32 | |
| Knowing the attitude of one's religion toward ODT: | | | | |
| Yes, in favor (n = 3800) | 2823 (74%) | 173 (5%) | 804 (21%) | **0.002** |
| Yes, against (n = 1183) | 856 (72%) | 72 (6%) | 255 (22%) | |
| I do not know it (n = 2149) | 1507 (70%) | 108 (5%) | 534 (25%) | |
| MD (n = 1781) | 1378 | 50 | 353 | |
| Participation in prosocial activities: | | | | |
| Yes, usually (n = 807) | 614 (76%) | 43 (5%) | 150 (19%) | **0.000** |
| Yes, occasionally (n = 1650) | 1275 (77%) | 56 (3%) | 319 (19%) | |
| No, nor am I going to (n = 580) | 372 (64%) | 58 (10%) | 150 (26%) | |
| No, but I would be prepared to (n = 5838) | 4279 (73%) | 243 (4%) | 1316 (23%) | |
| MD (n = 38) | 24 | 3 | 11 | |

ODT, organ donation and transplantation; MD, missing data.Bold indicates significant less than $P < 0.005$.

family (OR = 1.351; $P < 0.001$) or friends (OR = 1.240; $P = 0.001$); being agnostic or an atheist (OR = 2.481; $P < 0.001$); and being prepared to participate in voluntary activities (OR = 1.519; $P = 0.001$; Table 3).

## 4 | DISCUSSION

Recent immunological and transgenic advances are a promising alternative using limited materials of human origin for transplantation.[20,21] However, it is essential to achieve social acceptance of this therapy. In this regard, attitude studies of the population in Spain and Latin America have shown XTx acceptance rates ranging between 10% and 69%.[15,23,24] What is more, we should not forget that the attitude of healthcare professionals toward this therapy is fundamentally important given that the information they provide to society has a great amount of credibility.[9,10] Nevertheless, it has been detected that these professionals do not have much more of a favorable attitude than the public (61%-79%).[9,10] These are similar rates to those found in this study in which 74% of Spanish student nurses were in favor, a percentage that is actually higher than the rate reported in Polish student nurses (62%).[26]

When we consider factors affecting attitude toward organ XTx in Spanish student nurses, men are more in favor, as already reported in the general public, in healthcare professionals, and other university students.[9,10,13,27,28] Another important aspect is the improvement in attitude during the time at university, with it being more favorable in the final year, as occurs in other health science students[13,28]. Advances at academic level bring with it the gradual acquisition of theoretical knowledge of the donation process. What is more, the students complete their studies having been in contact with the whole healthcare system and with clinical services specially related to ODT. As a result, they are able to view the topic from a personal and professional perspective and they can discuss the matter with their family and society.

In this sense, there is also a close relationship between attitude toward XTx and attitude toward human donation (OR = 1.519) as other authors have already indicated.[9,10,12,15,30,31] Omnell et al[33] also reported this association and stated that if a person was in favor of receiving a human organ, he or she would also be prepared to receive an animal organ assuming the outcomes were the same. In addition, we should take into account the influence of one's family and society on attitude toward XTx. This aspect is well known in research into attitudes toward donation.[30,34,35] The present study has demonstrated that talking about ODT with one's family and knowing the opinion of family one's members affect attitude. Therefore, the promotion of ODT will indirectly promote XTx. This finding is important given that student nurses form part of groups that drive public opinion, and they have an influence on the general public.[13]

We should not forget that apart from healthcare workers, another crucial group is that of patients on the organ transplant waiting list, who, as a last resort, will become real candidates for a XTx. It has been seen that these patients have a more favorable attitude than the general public,[37] possibly due to the fact that they give more priority to their own survival over possible ethical or existential

**TABLE 3** Variables affecting the attitude of nursing students in Spain toward xenotransplantation. Multivariate analysis

| Variables | Regression coefficient (β) | Standard error | Odds ratio (confidence intervals) | P |
|---|---|---|---|---|
| Sex: | | | | |
| Female (n = 7365) | | | 1 | **<0.001** |
| Male (n = 1484) | 0.362 | 0.080 | 1.436 (1.680-1.228) | |
| Geographical location: | | | | |
| Northeastern (n = 1945) | | | 1 | |
| Southern (n = 1818) | 0.190 | 0.087 | 1.209 (1.432-1.019) | 0.029 |
| Eastern (n = 2071) | 0.347 | 0.088 | 1.414 (1.680-1.190) | **<0.001** |
| Central (n = 2466) | 0.076 | 0.080 | 1.078 (1.262-0.920) | 0.348 |
| Northern (n = 613) | 0.661 | 0.139 | 1.937 (2.544-1.474) | **<0.001** |
| Type of university: | | | | |
| Private university (n = 934) | | | 1 | **0.002** |
| Publicly funded university (n = 7979) | 0.280 | 0.092 | 1.322 (1.584-1.104) | |
| Attitude toward deceased donation: | | | | |
| Not in favor (n = 1930) | | | 1 | **<0.001** |
| In favor (n = 6966) | 0.419 | 0.067 | 1.519 (1.733-1.333) | |
| Possibility of needing a transplant: | | | | |
| No (n = 152) | | | 1 | |
| Yes (n = 6967) | 0.403 | 0.193 | 1.497 (2.183-1.025) | **0.036** |
| Doubts (n = 1761) | 0.156 | 0.198 | 1.168 (1.724-0.792) | 0.432 |
| Discussion with one's family: | | | | |
| No (n = 2603) | | | 1 | **<0.001** |
| Yes (n = 6289) | 0.301 | 0.067 | 1.351 (1.538-1.186) | |
| Discussion with friends: | | | | |
| No (n = 2542) | | | 1 | **0.001** |
| Yes (n = 6358) | 0.215 | 0.065 | 1.240 (1.408-1.091) | |
| The respondent's religion: | | | | |
| Other religions (n = 281) | | | 1 | |
| Practicing Catholic (n = 989) | 0.231 | 0.151 | 1.259 (1.692-0.937) | 0.126 |
| Non-practicing Catholic (n = 4365) | 0.566 | 0.136 | 1.760 (2.304-1.349) | **<0.001** |
| Atheist/agnostic (n = 3149) | 0.908 | 0.143 | 2.481 (3.278-1.872) | **<0.001** |
| Participation in prosocial activities: | | | | |
| No, nor am I going to (n = 580) | | | 1 | |
| Yes, usually (n = 807) | 0.381 | 0.141 | 1.464 (1.926-1.111) | **0.007** |
| Yes, occasionally (n = 1650) | 0.418 | 0.121 | 1.519 (1.926-1.199) | **0.001** |
| No, but I would be prepared to (n = 5838) | 0.301 | 0.106 | 1.351 (1.661-1.097) | 0.004 |

doubts.[38] Nevertheless, although the data in Spain suggest that patients tend to be in favor of XTx (72%),[39] their attitude is not much more favorable than that of the population (74%).[27] Added to this, if we compare health science students, 74% of student nurses, 81% of medical students,[13] and 91% of veterinary science students are in favor.[40,41] Perhaps in the latter group, the closeness and familiarity of this discipline with animals are the difference. All of these studies were carried out using the same questionnaire validated by the research team.

Within the field of healthcare, it is notable that few studies have analyzed the attitude of health science students toward XTx.[28] Studies about the attitude of nurses are very localized and the few that have been carried out have focused on healthcare professionals. Mohacsi et al[42] found that 66% of nurses did not like the idea of XTx and only 19% would accept it. Julvez et al[43] in a French study stated that only 34% of nurses would accept it, a percentage that increases to 55% among physicians. It is notable that these differences had already been found according to job category[9,11] with physicians being

more in favor than nurses (77% vs 51%).[12] This aspect is important, given that we must not forget that nursing personnel would be an essential element in the application of a XTx program and for taking care of these patients.[12] Similar data have been found in Spanish students where students of medicine are more in favor than students of nursing (81% vs 74%).[13] There is even a Swedish study that has shown that among all the health science students, nurses are those who would least approve of this therapy.[29]

Finally, religious factors also have an influence on attitude. It is interesting to note that there is a high percentage of students who are atheists or agnostics, and they have a more favorable attitude than those who state they are practicing their religion (OR = 2.481), as occurs in students of medicine.[13] However, other studies indicate that the religious beliefs of university students do not affect attitude [28] or they correlate with less acceptance of XTx.[44] It is important to indicate that it is essential for students to know that their religion has a favorable attitude toward ODT, given that it has been found that this improves their attitude. For this reason, it is recommended for entities that coordinate the ODT process to facilitate effective communication with religious institutions and for them to suggest to their leaders for the need to remind their followers of the favorable views of their religion on organ donation and transplantation.[45] Therefore, given the high percentage of Catholic students in Spain, it is important to indicate that the Vatican and the Pontifical Academy for Life are not opposed to Xtx.[46] Given the reality of future clinical trials, it is important to explore how religious traditions might view XTx as a therapy, to better understand their theological views how each might address the importance of human health, and the use of pigs to bring health to others. A full understanding of the beliefs and practices of the Jewish, Christian, and Muslim traditions will be necessary to fully prepare for, and implement, clinical trials of XTx.[47,48]

Knowing the attitudes of the population makes it possible to determine the factors affecting these attitudes so that appropriate and effective campaigns can be designed. It must be remembered that in social research, the use of questionnaires is a common data collection technique given its low cost, its ability to reach a large number of participants and the ease with which the results can be analyzed.[30] Even so, it also has limitations such as the loss of information through verbal and non-verbal communication. As a consequence, the questionnaire used should be designed to quantify, universalize, and standardize the information with the ultimate objective of comparing the data obtained, so that it is adequate for investigating the problem at hand and valid for what we intend to measure, as well as being reliable and precise. In order for it to meet all of these characteristics, it should undergo a creation and validation process. In research into attitudes about XTx, this basic premise has not been met until now given that the majority of studies have used measurement tools that were not designed for this purpose and which have not been validated, something that could lead to uncertain interpretations and generalizations about the results. Finally, we should remember that the interpretation of the results should take into account the limitations that can arise in opinion questionnaires. One limitation comes from the tendency to respond according to what we believe to be "socially desirable" where we live. Another comes from the distance between the response and how the respondent would behave if the situation under consideration were to really happen in real life.[30,34,35] One of the efforts of this sociological study was to achieve a representative sample of student nurses from across Spain, conserving proportionality according to geographical area and year of study. What is more, the response rate in any attitude study is an indicator of the quality of the data and it is desirable for it to be above 75% in order to prevent a positive bias taking into account that those who are most interested in this question are those who tend to answer.[12,37]

To conclude, student nurses in Spain tend to have a favorable attitude toward organ XTx, an attitude that is more favorable than in other countries.[26,29] However, we must not forget that the opinions of healthcare professionals have a lot of credibility for the general public. This predisposition and interest could be crucial for the development of training campaigns about this topic.

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## AUTHORS CONTRIBUTION

Martínez-Alarcón Laura and Ríos Antonio involved in conception and design of the study; Elena Santainés-Borredá; María Concepción Agras-Suarez; Guillermo Arturo Cañadas-De la Fuente; Bárbara Hurtado-Pardos; Carmen Bárcena-Calvo; Carme Alorda-Terrasa; Juan Manuel Morillo-Velázquez; Celia Martí-García; Mª Dolores Redin-Areta; Ana Rosa Alconero-Camarero; Maria Lourdes Jiménez-Navascues; María Isabel Gutierrez-Izquierdo; Elena Chamorro-Rebollo; Maria de las Nieves Merchán-Felipe; Maite Barandiaran-Lasa; Noelia Martín-Espinosa; Francisco Javier Gala-León; Cristina Oter Quintana; Bibinha Benbunan-Bentata; Francisco Tirado-Altamirano; Maria Blanca Fernández-Vallhonrat; Jesús Ramírez-Rodrigo; Loreto Maciá-Soler; Aida Saez; and Álvaro Sánchez performed acquisition of a substantial portion of the data; Martínez-Alarcón L, Ríos A, López-Navas A, Ramírez P and Parrilla P. analyzed and interpreted the data; Martínez-Alarcón L, Ríos A and López Navas A drafted the manuscript; Martínez-Alarcón L, Ríos A and Ramirez P involved in critical revision of the manuscript for important intellectual content; Martínez-Alarcón L and Ríos A are statistical expertise; Martínez-Alarcón L obtained funding for this project or study; Ramirez P and Ríos A supervised the study; Martínez-Alarcón L, Ríos A, López-Navas A, Ramírez P and Parrilla P involved in final approval of the version to be published.

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## REFERENCES

1. Organización Nacional de Trasplantes (ONT). Newsletter Transplant Europe 2018. http://www.ont.es/publicaciones/Documents/NewsleTTER%202018%20final%20CE.pdf Accessed February 4, 2019.
2. Wu J, Izpisua Belmonte JC. Stem cells: a renaissance in human biology research. *Cell*. 2016;165:1572-1585.
3. Nagashima H, Matsunari H. Growing human organs in pigs-a dream or reality? *Theriogenology*. 2016;86:422-426.
4. Abellaneda Jm, Ramis G, Martínez-Alarcón L, et al. Generation of human-to-pig chimerism to induce tolerance through transcutaneous in utero injection of cord blood-derived mononuclear cells or human bone marrow mesenchymals cells in a preclinical program of liver xenotransplantation: preliminary results. *Transplant Proc*. 2012;44:1574-1578.
5. Quereda Jj, Martínez-Alarcón L, Mendoça L, et al. Validation of xCELLigence real-time cell analyzer to assess compatibility in xenotransplantation with pig-to-baboon model. *Transplant Proc*. 2010;42:3239-3243.
6. Ramírez P, Montoya Mj, Ríos A, et al. Prevention of hyperacute rejection in a model of orthotopic liver xenotransplantation from pig to baboon using polytransgenic pig livers (CD55, CD59, and H-transferase). *Transplant Proc*. 2005;37:4103-4106.
7. Cooper DK, Dou DF, Tao KS, Yang ZX, Tector AJ, Ekser B. Pig liver xenotransplantation: a review of progress toward the clinic. *Transplantation*. 2016;100:2039-2047.
8. Shah JA, Navarro-Alvarez N, DeFazio M, et al. A bridge to somewhere: 25-day survival after pig-to-baboon liver xenotransplantation. *Ann Surg*. 2016;263:1069-1071.
9. Ríos A, Conesa C, Ramírez P, et al. Hospital personnel faced with organ xenotransplantation: an attitudinal survey in a hospital with a pre-clinical liver xenotransplantation program. *Xenotransplantation*. 2006;13:447-454.
10. Ríos A, Martínez-Alarcón L, López-Navas A, et al. Level of acceptance of solid organ xenotransplantation among personnel in Spanish, Mexican, and Cuban hospitals. *Xenotransplantation*. 2014;21:84-90.
11. Conesa C, Ríos A, Ramírez P, et al. Attitudes of primary care professionals in Spain toward xenotransplantation. *Transplant Proc*. 2006;38:853-857.
12. Ríos A, Martínez-Alarcón L, Ayala-García Ma, et al. Level of acceptance of a clinical solid organ xenotransplantation program among personnel in organ transplant-related services in Spanish, Mexican and Cuban hospital centers. *Transplant Proc*. 2010;42:222-227.
13. Ríos A, López-Navas A, López-López A, et al. The level of acceptance of Spanish medical students of the transplantation of solid organs from animals: a stratified and multicentre study. *Xenotransplantation*. 2015;22:476-486.
14. Ministerio de Educación, Cultura y Deporte (MECD). 2016. Web: http://www.mecd.gob.es/servicios-al-ciudadano-mecd/estadisticas/educacion.html. Accessed: February 5, 2019.
15. Ríos A, Ramírez P, Martínez L, et al. British citizens in a regional community of southeastern Spain with a pre-clinical organ xenotransplantation program. a study of attitude toward xenotransplantation. *Xenotransplantation*. 2007;14:255-264.
16. Martínez-Alarcón L, Ríos A, López MJ, et al. Do nursing students understand the meaning of brain death? *Transplant Proc*. 2009;41:2060-2063.
17. Ríos A, Ramírez P, Rodríguez Mm, et al. Personnel in cadaveric organ transplant-related hospital units faced with living liver donation: an attitudinal study in a Spanish hospital with a cadaveric and living liver transplant programme. *Liver Int*. 2007;27:687-693.
18. Martínez-Alarcón L, Ríos A, Pons JA, et al. Attitudes toward islet cell and tissue xenotransplantation among kidney and liver patients on the transplant waiting list. *Transplant Proc*. 2010;42:3098-3101.
19. Martínez-Alarcón L, Ríos A, Ramis G, et al. Impact of 2009 pandemic h1n1 influenza a virus on veterinary students' perception of xenotransplantation. *Transplant Proc*. 2018;50:2291-2295.
20. Ekser B, Cooper DK, Tector AJ. The need for xenotransplantation as a source of organs and cells for clinical transplantation. *Int J Surg*. 2015;23:199-204.
21. Niemann H, Petersen B. The production of multi-transgenic pigs: update and perspectives for xenotransplantation. *Transgenic Res*. 2016;25:361-374.
22. Cooper DK, Ekser B, Ramsoondar J, Phelps C, Ayares D. The role of genetically engineered pigs in xenotransplantation research. *J Pathol*. 2016;238:288-299.
23. Ríos A, López-Navas AI, Martínez-Alarcón L, et al. A study of the attitude of Latin American residents in Spain toward organ xenotransplantation. *Xenotransplantation*. 2014;21:149-161.
24. Ríos A, Martínez-Alarcón L, López-Navas A, et al. Irish citizens resident in the southeast of Spain and xenotransplantation. *Transplant Proc*. 2013;45:3582-3585.
25. Ríos A, López-Navas AI, Martínez-Alarcón L, et al. Acceptance of organ xenotransplantation among Latin American immigrants resident in the United States. *Xenotransplantation*. 2016;23:269-278.
26. Mikla M, Rios A, Lopez-Navas A, et al. Attitude of nursing students at the University of Lublin in Poland toward xenotransplantation of organs. *Transplant Proc*. 2015;47:2593-2596.
27. Rios AR, Conesa CC, Ramírez P, Rodríguez MM, Parrilla P. Public attitude toward xenotransplantation: opinion survey. *Transplant Proc*. 2004;36:2901-2905.
28. Bona MD, Canova D, Rumiati R, et al. Understanding of and attitudes to xenotransplantation: a survey among Italian university students. *Xenotransplantation*. 2004;11:133-140.
29. Hagelin J, Carlsson HE, Hau J. Students' acceptance of clinical xenotransplantation. *Clin Transplant*. 2000;14:252-256.
30. Ríos A, Cascales P, Martínez L, et al. Emigration from the British isles to southeastern Spain: a study of attitudes toward organ donation. *Am J Transplant*. 2007;7:2020-2030.
31. Ríos A, Martínez-Alarcón L, Sánchez J, Jarvis N, Parrilla P, Ramírez P. German citizens in south-eastern Spain: a study of attitude toward organ donation. *Clin Transplant*. 2010;24:349-357.
32. Ríos A, Ramírez P, Mar Rodríguez M et al. Attitude of ancillary personnel faced with living kidney donation in a hospital with a living donor kidney transplant program. *Transplantation*. 2007;83:336-340.
33. Omnell M, Persson NH, Ranstam J, Hermeren G. Xenotransplantation public perceptions: rather cells than organs. *Xenotransplantation*. 2003;10:72-79.
34. Ríos A, Ramírez P, Galindo PJ, et al. Primary health care personnel faced with cadaveric organ donation: a multicenter study in southeastern Spain. *Clin Transplant*. 2008;22:657-663.
35. Ríos A, Sánchez J, Jarvis N, et al. Factors that influence the attitude of East European residents in Spain toward living kidney donation. *Transpl Int*. 2009;22:707-716.
36. Zambudio AR, Conesa C, Ramírez P, et al. What is the attitude of hospital personnel in transplant related services towards donation? *J Heart Lung Transplant*. 2006;25:972-976.
37. Omnell Persson M, Persson NH, Ranstam J, Hermerén G. Attitudes toward xenotransplantation – patients waiting for transplantation versus the general public. *Transpl Int*. 2001;14:334-342.
38. Lundin S. The boundless body: cultural perspectives on xenotransplantation. *Ethnos*. 1999;64:5-31.

39. Martínez-Alarcón L, Ríos A, Pons JA, et al. Attitudinal study of organ xenotransplantation in patients on the kidney and liver transplant waiting list in a country with a high rate of deceased donation. *Xenotransplantation*. 2011;18:168-175.
40. Martínez-Alarcón L, Ríos A, Ramis G, et al. Are veterinary students in favor of xenotransplantation? An opinion study in a Spanish university with a xenotransplantation program. *Transplant Proc*. 2010;42:2130-2133.
41. Mendonça L, Martínez-Alarcón L, Ríos A, et al. Are veterinary students in favour of xenotransplantation? Comparative opinion study in a Brazilian and a Spanish university. *Transplant Proc*. 2013;45:1046-1049.
42. Mohacsi PJ, Blumer CE, Quine S, Thompson JF. Aversion to xenotransplantation. *Nature*. 1995;378:434.
43. Julvez J, Tuppin P, Cohen S. Survey in France of response to xenotransplantation. *Lancet*. 1999;353:726.
44. Hagelin J, Hau J, Schapiro SJ, Suleman MA, Carlsson H-E. Religious beliefs and opinions on clinical xenotransplantation – a survey of university students from Kenya, Sweden and Texas. *Clin Transplant*. 2001;15:421-425.
45. Wakefield CE, Reid J, Homewood J. Religious and ethnic influences on willingness to donate organs and donor behavior: an Australian perspective. *Prog Transplant*. 2011;21:161-168.
46. Pontifical academy for life. Prospects for xenotransplantation scientific aspects and ethical considerations 2018. http://www.vatican.va/roman_curia/pontifical_academies/acdlife/index_sp.htm. Accessed February 4, 2019.
47. Paris W, Jang K, Bargainer R, et al. Psychosocial challenges of Xenotransplantation: the need for a multi-disciplinary; religion; and cultural dialogue. *Xenotransplantation*. 2016;23:335-337.
48. Paris W, Seidler R, FitzGerald K, Padela AI, Cozzi E, Cooper D. Jewish, Christian and Muslim theological perspectives about xenotransplantation. *Xenotransplantation*. 2018;25:e12400.


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