Data Article

Attitudes of food consumers at universities towards recycling human urine as crop fertiliser: A multinational survey dataset

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We present here a data set generated from a multinational survey on opinions of university community members on the prospect of consuming food grown with human urine as fertiliser and about their urine recycling perceptions in general. The data set comprises answers from 3,763 university community members (students, faculty/researchers, and staff) from 20 universities in 16 countries and includes demographic variables (age bracket, gender, type of settlement of origin, academic discipline, and role in the university). Questions were designed based on Ajzen’s theory of planned behaviour to elicit information about three components of behavioural intention—attitudes, subjective norms, and perceived behavioural control. Survey questions covered perceived risks and benefits (attitudes), perceptions of colleagues (injunctive social norm) and willingness to consume food grown with cow urine/faeces (descriptive social norm), and willingness to pay a price premium for food grown with human urine as fertiliser (perceived behavioural control). We also included a question about acceptable urine recycling and disposal options and assessed general environmental outlook via the 15-item revised New Ecological Paradigm (NEP) scale. Data were collected through a standardised survey instrument translated into the relevant languages and then administered via an online form. Invitations to the survey were sent by email to university mailing lists or to a systematic sample of the university directory. Only a few studies on attitudes towards using human urine as fertiliser have been conducted previously. The data described here, which we analysed in “Willingness among food consumers at universities to recycle human urine as crop fertiliser: Evidence from a multinational survey” [1], may be used to further understand potential barriers to acceptance of new sanitation systems based on wastewater source separation and urine recycling and can help inform the design of future sociological studies.

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Specifications Table

| Subject          | Waste Management and Disposal                                      |
|------------------|---------------------------------------------------------------------|
| Specific subject area | Social attitudes towards new sanitation systems and recycling of human urine as crop fertiliser. |
| Type of data     | Excel file                                                          |
| How data were acquired | Text (survey instruments, codebook) GoogleForms (all countries except mainland China) Wenjuanxing market research platform (mainland China) |
| Data format      | Raw                                                                 |
| Parameters for data collection | Surveys were administered to university community members from 20 universities in 16 different countries. Only fully completed surveys were retained, along with a count of individuals who explicitly refused consent after reading the introduction. All respondents were anonymous and gave informed consent for their answers to be used for research. Ethics approval was obtained as required. |
| Description of data collection | Survey administrators sent invitations by email and followed up with reminders on days 7, 14, 21 and 28, closing each survey after 30 days; in a few cases, the survey link was kept open longer due to low initial response rates. Data were cleaned, translated into English where necessary, coded, filtered, and analysed using Excel and R software. Urine recycling perception scores and mean revised New Ecological Paradigm scores were calculated from other item responses. |
| Data source location | Bangladesh Agricultural University, Bangladesh Bangladesh University of Health Sciences, Bangladesh University of Santa Catarina, Brazil University of Science and Technology Beijing, China Tongji University, China Samara University, Ethiopia AgroParisTech, France University of the Aegean, Greece Tezpur University, India Oranim College, Israel University of Haifa, Israel The Hashemite University, Jordan Universiti Malaysia Terengganu, Malaysia University of Academy of Sciences of Moldova, Moldova University of Life Sciences in Lublin, Poland IADE – Universidade Europeia, Portugal National Taiwan University (Department of Bioenvironmental Systems Engineering), Taiwan National Taipei University of Technology, Taiwan Makerere University, Uganda University of South Florida, Florida, USA |
| Data accessibility | Repository name: Mendeley Data Data identification number: http://dx.doi.org/10.17632/kcc8m9pn9.1 Direct URL to data: http://dx.doi.org/10.17632/kcc8m9pn9.1 |
| Related research article | Simha et al., “Willingness among food consumers at universities to recycle human urine as crop fertiliser: Evidence from a multinational survey,” Sci. Tot. Environ. 765 (2021) 144,438. 10.1016/j.scitotenv.2020.144438. |

Value of the Data

- This data set contains respondent opinions on recycling human urine as fertiliser, as well as demographic and environmental outlook data from a multinational sample.
- These data are of use to researchers seeking to understand barriers to implementation of urine diversion and resource recovery technologies.
- These data may be further analysed to identify potential explanatory factors for attitudes towards urine recycling in different cultural contexts and to inform the development of future surveys in this area.
• This data set also offers a multinational collection of environmental outlooks (measured by the revised New Ecological Paradigm) among university communities, obtained through a standardised survey instrument that facilitates comparative study.

1. Data Description

Recycling urine collected in new source-separating sanitation systems can improve the sustainability of wastewater management while reducing the environmental impacts associated with sanitation and agriculture [2]. To complement research and development of source separation and human urine-derived fertiliser technologies, we sought to better understand the under-researched area of food consumer attitudes towards urine as fertiliser. We describe here the data collected via a survey instrument revised from that used previously in Simha et al. [3]; these data are analysed in Simha et al. [1].

The data consist of anonymous survey responses from a standardised survey instrument answered by 3763 university community members (students, faculty, and staff) at 20 universities in 16 countries. The survey assessed demographic variables (role in the university, academic discipline, settlement type, age group, and gender), as well as attitudes towards urine recycling, perceptions of the use of cow and human urine as fertiliser for food crops, perceptions of colleagues, willingness to pay for food grown with human urine, and perceptions of health risks associated with using human urine as fertiliser. We also administered a version of the revised New Ecological Paradigm scale [4], a widely used measure of environmental outlooks.

In the data deposit described here, we have provided both raw and cleaned/processed (to correct records that were erroneously split into multiple lines and to standardise language and formatting variable names to facilitate analysis) versions of the data set. Open-ended responses have not been translated from their original languages. Raw data and survey questionnaire files are labelled by country code (see Experimental Design, Materials, and Methods). The original English and the translated survey instruments, the data set files, and the codebook describing the field names/variables are available from Mendeley Data [5]. The following tables provide a descriptive overview of the survey responses.

For individual countries, sample sizes ranged from $n=60$ (India) to $n=716$ (China). The majority of respondents were from China, Brazil ($n=523$), and the United States ($n=437$). More women (56%) than men (44%) responded. More than half of the respondents were from applied science disciplines (52%), and more than half grew up in urban areas (63%). The largest share of respondents (42%) were bachelor's degree students, followed by master's degree students (25%) and faculty (16%). A summary of respondent demographics is shown in Table 1.

The majority of the questions focused on how respondents perceived urine recycling, particularly as fertiliser for food crops. Responses to these questions are further reported and analysed in our associated study [1], and a summary is presented here in Table 2. In addition to the questions focused on urine recycling and use as fertiliser, we also elicited the general environmental outlooks of respondents via the 15-item revised New Ecological Paradigm (NEP) scale [4]. The NEP scale is often used as a single index. In our data set, however, when we tested for internal consistency (with Cronbach’s $\alpha$) to validate its use as a unidimensional index, the results indicated that the scale has at least two dimensions in most of the country samples. Hence, we recommend caution in using the mean NEP scores reported in this data set (overall scores reported in Table 3) without further factor analysis as suggested by Dunlap et al. [4].

The data set also includes open-ended comments on several of the questions, which contain qualitative information that may be used to inform the design of future studies. These open-ended responses are included in their original languages, without translation.
Table 1
Demographics of survey participants.

| Demographic variable | All  | BD  | BR  | CN  | ET  | FR  | GR  | IN  | JO  | MY  | MD  | PL  | PO  | TW  | UG  | US  |
|----------------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Total no. of respondents | 3763 | 155 | 523 | 716 | 324 | 260 | 150 | 60  | 229 | 258 | 96  | 85  | 93  | 88  | 163 | 126 | 437 |
| No. of universities surveyed | 19   | 2   | 1   | 2   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 2   | 1   |
| Age bracket (yrs) |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| <20      | 588  | 7   | 27  | 142 | 112 | 31  | 20  | 2   | 6   | 58  | 4   | 7   | 22  | 1   | 35  | 0   | 114 |
| 21–24    | 1245 | 47  | 124 | 276 | 93  | 170 | 51  | 21  | 35  | 105 | 6   | 32  | 48  | 8   | 60  | 33  | 136 |
| 25–30    | 743  | 66  | 168 | 107 | 34  | 51  | 23  | 21  | 37  | 19  | 11  | 12  | 9   | 55  | 22  | 102 |
| 31–40    | 579  | 22  | 129 | 76  | 44  | 5   | 27  | 10  | 41  | 37  | 42  | 18  | 6   | 34  | 10  | 30  | 48  |
| 41–50    | 374  | 8   | 33  | 75  | 30  | 2   | 19  | 5   | 63  | 31  | 19  | 10  | 4   | 23  | 3   | 28  | 21  |
| 51–60    | 180  | 3   | 31  | 37  | 11  | 0   | 8   | 1   | 34  | 6   | 10  | 2   | 4   | 10  | 0   | 10  | 13  |
| 61–70    | 47   | 1   | 9   | 2   | 0   | 1   | 1   | 0   | 13  | 2   | 4   | 3   | 0   | 6   | 0   | 2   | 3   |
| >70      | 7    | 1   | 2   | 1   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   |
| Gender   |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Female   | 2093 | 56  | 305 | 405 | 97  | 163 | 103 | 19  | 175 | 159 | 39  | 52  | 70  | 58  | 79  | 31  | 282 |
| Male     | 1670 | 99  | 218 | 311 | 227 | 97  | 41  | 54  | 99  | 57  | 33  | 23  | 30  | 84  | 95  | 155 |
| Role in university |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Admin/Staff | 179 | 4   | 15  | 44  | 2   | 0   | 11  | 10  | 28  | 22  | 6   | 4   | 1   | 17  | 3   | 5   | 7   |
| Bachelor’s student | 1583 | 47 | 204 | 256 | 209 | 51 | 69 | 16 | 95 | 169 | 10 | 21 | 78 | 5 | 51 | 46 | 256 |
| Master’s student | 931 | 60 | 117 | 240 | 20 | 142 | 37 | 9 | 52 | 18 | 1 | 26 | 1 | 4 | 67 | 33 | 104 |
| PhD student | 388 | 23 | 108 | 35 | 5 | 56 | 12 | 12 | 1 | 3 | 2 | 9 | 10 | 4 | 37 | 6 | 65 |
| Postdoc    | 71   | 1   | 10  | 8   | 1   | 0   | 8   | 0   | 0   | 2   | 2   | 9   | 0   | 22  | 4   | 2   |
| Faculty    | 611  | 20 | 69 | 133 | 87 | 11 | 13 | 13 | 53 | 44 | 75 | 16 | 3 | 36 | 1 | 34 | 3 |
| Discipline |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Applied Sciences | 1939 | 109 | 346 | 369 | 269 | 159 | 28 | 36 | 7 | 129 | 53 | 17 | 3 | 49 | 86 | 95 | 184 |
| Arts       | 158 | 1   | 2   | 18 | 6 | 0 | 9 | 0 | 13 | 6 | 0 | 4 | 78 | 0 | 6 | 1 | 14 |
| Humanities | 224 | 5 | 27 | 14 | 15 | 1 | 30 | 1 | 72 | 16 | 1 | 3 | 2 | 2 | 8 | 5 | 22 |
| Natural Sciences | 974 | 31 | 114 | 241 | 21 | 82 | 61 | 11 | 72 | 75 | 25 | 57 | 1 | 30 | 54 | 12 | 87 |
| Social Sciences | 468 | 9 | 34 | 74 | 13 | 18 | 22 | 12 | 65 | 32 | 17 | 4 | 9 | 7 | 9 | 13 | 130 |
| Settlement type |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Periurban | 628 | 35 | 41 | 58 | 34 | 58 | 37 | 29 | 41 | 40 | 15 | 14 | 12 | 39 | 39 | 132 |
| Rural     | 733 | 26 | 14 | 184 | 172 | 62 | 19 | 9 | 62 | 43 | 11 | 31 | 8 | 22 | 17 | 11 | 42 |
| Urban     | 2387 | 94 | 468 | 459 | 118 | 140 | 94 | 22 | 126 | 211 | 45 | 39 | 71 | 54 | 107 | 76 | 263 |
| Invalid responses | 15 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Notes: BD, Bangladesh; BR, Brazil; CN, China; ET, Ethiopia; FR, France; GR, Greece; IL, Israel; IN, India; JO, Jordan; MY, Malaysia; MD, Moldova; PL, Poland; PT, Portugal; TW, Taiwan; UG, Uganda; US, United States.

2. Experimental Design, Materials and Methods

2.1. Survey instrument

The survey instrument was originally designed in English, modified from a previous survey we administered at VIT University in South India [3]. Note that all questions numbers here refer to those in the English master survey. The main changes for the international survey described here were as follows. First, demographic questions were adjusted to be general, rather than specific to VIT University or to an Indian context (for example, questions about caste and religion were omitted, and a question about university departments specific to VIT was replaced with one about general categories of academic disciplines [Q3]). We added additional questions about role in the university (Q2) and settlement type of origin (Q4; urban, peri-urban, or rural). Second, we combined questions about substances believed to be present in human urine into a single question with additional options (Q17) and changed a question about whether human urine should be disposed of without reuse to a more neutrally worded question about acceptable ways to reuse or dispose of human urine (Q19).

The final survey instrument was designed loosely around Ajzen's theory of planned behaviour, which posits that the intent to perform a behaviour can to a large extent be predicted by attitudes towards the behaviour, social norms, and perceived behavioural controls, and that this intent then accounts for much of the variance in actual behaviour [8]. Because the behaviour...
Table 2
Descriptive overview of respondent attitudes towards urine recycling as fertiliser.

| Variable | All | BD | BR | CN | ET | FR | GR | IL | JO | MY | MD | PL | PO | TW | UG | US |
|----------|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Q5: Believe cow urine/manure can be fertiliser | | | | | | | | | | | | | | | | |
| No       | 233 | 11 | 20 | 21 | 66 | 7  | 11 | 3  | 11 | 23 | 6  | 7  | 5  | 15 | 7  | 0  | 20 |
| Yes      | 3530| 144| 503| 695| 258| 253| 139| 57 | 218| 235| 90 | 78 | 83 | 78 | 156| 126| 417|
| Q6: Willing to eat food fertilised with cow urine/manure | | | | | | | | | | | | | | | | |
| No       | 421 | 2  | 26 | 95 | 75 | 4  | 18 | 1  | 15 | 66 | 8  | 16 | 11 | 26 | 15 | 0  | 43 |
| Yes      | 3342| 153| 497| 621| 249| 256| 132| 59 | 214| 192| 88 | 69 | 77 | 67 | 148| 126| 394|
| Q7: Believe human urine can be fertiliser | | | | | | | | | | | | | | | | |
| No       | 1426| 74 | 189| 79 | 136| 41 | 82 | 34 | 88 | 216| 41 | 59 | 32 | 62 | 70 | 28 | 195|
| Yes      | 2337| 81 | 334| 637| 188| 219| 68 | 26 | 141| 42  | 55 | 26 | 56 | 31 | 93 | 98 | 242|
| Q9: Willing to eat food fertilised with human urine | | | | | | | | | | | | | | | | |
| No       | 1596| 97 | 205| 155| 157| 52 | 75 | 37 | 94 | 223| 55 | 61 | 47 | 66 | 72 | 29 | 171|
| Yes      | 2167| 58 | 318| 561| 167| 208| 75 | 23 | 135| 35  | 41 | 24 | 41 | 27 | 91 | 97 | 266|
| Q12: Believe colleagues will eat food fertilised with human urine | | | | | | | | | | | | | | | | |
| No       | 2071| 115| 347| 115| 127| 127| 105| 38 | 143| 229| 64 | 67 | 55 | 71 | 111| 57 | 300|
| Yes      | 1131| 40 | 176| 40 | 197| 133| 45 | 22 | 86 | 29  | 32 | 18 | 33 | 22 | 52 | 69 | 137|
| NA       | 561 | NA | NA | NA | 561| NA | NA | NA | NA | NA  | NA | NA | NA | NA | NA | NA | NA |
| Q11: Willingness to pay for food fertilised with human urine | | | | | | | | | | | | | | | | |
| NA       | 1596| 97 | 205| 155| 157| 52 | 75 | 37 | 94 | 223| 55 | 61 | 47 | 66 | 72 | 29 | 171|
| Less     | 479 | 20 | 57 | 80 | 86 | 12 | 12 | 3  | 31 | 11  | 13 | 9  | 11 | 3  | 37 | 25 | 69 |
| Similar  | 1367| 29 | 244| 325| 49 | 170| 56 | 18 | 93 | 23  | 26 | 14 | 26 | 21 | 44 | 47 | 182|
| More     | 321 | 9  | 17 | 156| 32 | 26 | 7  | 2  | 11 | 1   | 2  | 1  | 4  | 3  | 10 | 25 | 15 |
| Q14: Believe fresh, untreated human urine is health risk | | | | | | | | | | | | | | | | |
| No       | 1317| 69 | 190| 275| 97 | 117| 54 | 26 | 58 | 32  | 40 | 27 | 30 | 27 | 61 | 42 | 172|
| Yes      | 2446| 86 | 333| 441| 227| 143| 96 | 34 | 171| 226 | 56 | 58 | 58 | 66 | 102| 84 | 265|
| Q16: Believe human urine can be treated to remove risk | | | | | | | | | | | | | | | | |
| NA       | 1317| 69 | 190| 275| 97 | 117| 54 | 26 | 58 | 32  | 40 | 27 | 30 | 27 | 61 | 42 | 172|
| No       | 432 | 23 | 16 | 109| 42 | 5  | 9  | 8  | 18 | 98  | 8  | 17 | 18 | 16 | 21 | 2  | 22 |
| Yes      | 2014| 63 | 317| 332| 185| 138| 87 | 26 | 153| 128 | 48 | 41 | 40 | 50 | 81 | 82 | 243|

Notes: BD, Bangladesh; BR, Brazil; CN, China; ET, Ethiopia; FR, France; GR, Greece; IL, Israel; IN, India; JO, Jordan; MY, Malaysia; MD, Moldova; PL, Poland; PT, Portugal; TW, Taiwan; UG, Uganda; US, United States; NA, not applicable. Note that Q12 was not required in the mainland China surveys, and only 22% (n = 144) of respondents chose to answer this question.
Table 3
Mean NEP scores, measures of consistency within samples, and inversely correlated items.

| Country       | n    | NEP score (mean ± SD) | Cronbach’s α | Cronbach’s α range | Inversely correlated item numbers |
|---------------|------|------------------------|--------------|--------------------|-----------------------------------|
| All Countries | 3763 | 3.48 ± 0.5             | 0.7          | 0.69 to 0.72       | 6                                 |
| Bangladesh    | 155  | 3.33 ± 0.38            | 0.53         | 0.42 to 0.53       | 2, 4, 6, 8, 10, 14                |
| Brazil        | 523  | 3.11 ± 0.23            | −0.33        | −0.5 to −0.17      | 5, 7, 9, 11, 13, 6, 8, 12         |
| China         | 716  | 3.64 ± 0.47            | 0.8          | 0.77 to 0.82       | None                              |
| Ethiopia      | 324  | 3 ± 0.27               | −0.31        | −0.52 to −0.1      | 2, 4, 6, 8, 10, 12, 14            |
| France        | 260  | 3.88 ± 0.37            | 0.66         | 0.6 to 0.72        | None                              |
| Greece        | 150  | 3.66 ± 0.41            | 0.59         | 0.59 to 0.75       | None                              |
| India         | 60   | 3.69 ± 0.4             | 0.59         | 0.44 to 0.74       | 4, 6, 10, 12, 14                  |
| Israel        | 229  | 3.7 ± 0.47             | 0.77         | 0.73 to 0.82       | None                              |
| Jordan        | 258  | 3.35 ± 0.37            | 0.53         | 0.45 to 0.61       | 2, 4, 6, 8, 10, 12, 14            |
| Malaysia      | 96   | 3.38 ± 0.39            | 0.47         | 0.31 to 0.63       | 2, 4, 6, 8, 10, 12, 14            |
| Moldova       | 85   | 3.57 ± 0.42            | 0.65         | 0.55 to 0.75       | 4, 6, 10, 14                      |
| Poland        | 88   | 3.61 ± 0.5             | 0.7          | 0.61 to 0.79       | None                              |
| Portugal      | 93   | 3.36 ± 0.43            | 0.71         | 0.63 to 0.8        | 4, 6, 12, 14                      |
| Taiwan        | 163  | 3.52 ± 0.46            | 0.71         | 0.63 to 0.8        | 2, 4, 6, 8, 10, 14                |
| Uganda        | 126  | 3.23 ± 0.46            | 0.62         | 0.52 to 0.72       | 2, 4, 6, 12, 14                   |
| USA           | 437  | 3.74 ± 0.56            | 0.82         | 0.8 to 0.85        | None                              |

Notes: Cronbach’s α is a measure of internal consistency commonly used to validate the use of the NEP scale as a unidimensional measure; a value between 0.70 and 0.90 is usually considered good, although a value of >0.50 may be acceptable for a preliminary study [4,6]. Negative α scores may indicate incorrectly coded data or, as in this case, that a large number of item scores were strongly inversely correlated with the overall score, making use of the mean NEP score as a unidimensional measure invalid because more than one axis exists [4]. In the last column, the numbers of the inversely correlated items are listed. The internal consistency check was run using RStudio version 1.2.5042 and R version 4.0.0 [7].

in question (consumption of food grown with human urine as fertiliser) was largely hypothetical to our target audience, we focused on the intentional components. We also included additional questions about general environmental outlook as measured by the revised NEP scale [4], since environmental outlooks have been previously hypothesised to be relevant to attitudes towards urine source separation and use as fertiliser [9]. We slightly modified the wording of NEP item 4 in the English master survey after Ogunbode [10] from “Human ingenuity will insure [sic] that we do not make the earth unlivable” to “Human intelligence will ensure that we do not make the Earth unlivable” to facilitate comprehension.

The questions and resulting variables in our survey can be divided into the following groups: (i) demographics, (ii) willingness to consume food grown with human urine, (iii) willingness to pay for food grown with human urine, (iv) social norms, (v) benefits and risks, and (vi) environmental outlook. For a table of all variables with type (categorical, continuous, etc.) and the text of the survey questions, see “IndexCodebook.pdf” in the data deposit.

2.1.1. Demographics

We included standard demographic questions concerning age bracket (Q21; <20, 21–24, 25–30, 31–40, 41–50, 51–60, 61–70, or >70), gender (Q23; male or female), role in university (Q2; bachelor’s student, master’s student, PhD student, postdoctoral researcher, faculty, or staff/administrator), and discipline (Q3; applied sciences, natural sciences, social sciences, arts, or humanities), as well as a question about the settlement type where the respondent grew up (Q4; urban, peri-urban, or rural), based on the hypothesis that familiarity with or proximity to agricultural practices might affect perceptions of using human urine as crop fertiliser.

2.1.2. Willingness to consume food grown with human urine

Our primary study question was a dichotomous yes/no question about whether people would be willing to consume food grown with human urine as a fertiliser (Q9). Respondents were able to comment further on their answers in an open-ended comment field (Q10).
2.1.3. Willingness to pay for food grown with human urine

Perceived behavioural control could only be assessed indirectly since food grown with urine as fertiliser is not readily available on the market. We therefore asked respondents to complete the hypothetical statement “I would eat food that was grown using human urine as a fertiliser, ____.” (Q11) with “even if it costs more/similar/less than what I usually pay,” in order to determine whether respondents thought such food would be worth paying a price premium, whether they viewed it as less desirable than their usual food, or whether they considered the products to be of similar value.

2.1.4. Social norms

Social norms, both descriptive and injunctive, play a major role in behaviour that is often underestimated, particularly in environmental behaviours [11]. Although we were unable to address descriptive norms directly because food grown with human urine is not yet widely available, we included questions about cow urine as fertiliser (Q5 and Q6). Similarly, we asked whether respondents believed their colleagues would be willing to consume food grown with human urine as fertiliser (Q12) to assess perceptions of the injunctive social norm.

2.1.5. Benefits and risks

The main components of attitude addressed in our survey were those of perceived risks and benefits. Since food grown with human urine as fertiliser is not widely available, we addressed the perception of benefits obliquely. First, we asked if respondents believed human urine can be used as fertiliser (Q7 and open-ended comment field Q8). Second, we asked which of the following seven choices for handling human urine respondents thought were acceptable: crop fertiliser, watering lawns/gardens, electricity generation, processing at a wastewater treatment plant, dilution and disposal in surface water, landfilling, and incineration. Respondents were asked to check one or more options, but not to rank them from most to least acceptable.

Risk perception can also affect consumer attitudes. We asked if respondents believed fresh, untreated human urine used as crop fertiliser posed a health risk to them as food consumers (Q14); respondents who answered “yes” were then asked if they believed that risk could be mitigated with treatment (Q16). In Q15, respondents could provide additional open-ended comments about perceived risks.

As possible explanatory factors for perceived health risk from using untreated human urine as fertiliser, we asked respondents to indicate what substances they believed urine normally contained from a list of 7 items (Q17; vitamins, salts, radioactive substances, pharmaceutical residues/medicines, hormones, heavy metals, and pathogens) previously reported in literature [12]. In Q18, respondents could provide additional comments.

2.1.6. Environmental outlook

Since we posited that a generally pro-environmental outlook might be associated with acceptance of urine recycling and food grown with human urine as fertiliser, we evaluated environmental outlooks using Dunlap’s revised New Environmental Paradigm (NEP) scale [4]. This scale has been widely used in the environmental literature and, although it was originally developed and validated in Western contexts as a unidimensional scale, it is often more appropriate to split it into multiple axes [4]. The NEP scale consists of 15 Likert-type items ranked from “strongly disagree” to “strongly agree,” which are coded for analysis from 1 to 5, respectively. The odd-numbered items were considered by Dunlap to be “pro-ecological,” and the even-numbered items to be “pro-dominant social paradigm” (anthropocentric). When treated as a unidimensional scale, the even-numbered items are reverse-coded from 5 to 1. We presented these items at the end of our survey in blocks of 5 (Q20, Q22, and Q24), with each block randomised and separated by demographic questions (age and gender).

NEP data were initially validated using Cronbach’s $\alpha$, determined using RStudio version 1.2.5042, R version 4.0.0, and the psych package. Based on internal consistency measures for the overall scale (Table 3), we then decided to split the data into two scales in our associated
study [1]. However, we have provided calculated overall mean scores in the cleaned data sheet (AllData.xlsx).

2.2. Translation and ethics approval

Survey instruments were translated into the appropriate languages where necessary (Table 4). For the United States, ethics approval was obtained from the University of South Florida Institutional Review Board, which determined that the research met criteria for exemption from the federal regulations as outlined by Office for Human Research Protections regulation 45 CFR 46.101(b). For other countries, ethics approval was not required due to the anonymous nature of the survey. All respondents gave informed consent for their answers to be used for research. Data collection and demographics.

We surveyed community members at 20 universities in 16 countries, selected by convenience based on our professional networks and the ability to gain permission from university administration. These universities are based in countries with various income levels, comprising low-, lower-middle-, upper-middle-, and high-income World Bank economic categories, with at least one country included from each World Bank region.

The survey was administered through the online GoogleForms platform (https://www.google.com/forms/about/) in most countries, and in mainland China through Wenjuanxing (https://www.wjx.cn/), a market research platform widely used in China. At each university, researchers sent invitations to participate by email to university mailing lists, resulting in a convenience sample, or, in the case of the University of South Florida, an initially systematic sample consisting of every fourth full-time domestic student [13]. The responsible researcher at each university then followed up with emailed reminders after days 7, 14, 21, and 28, closing the survey at 4 weeks. In the cases of Israel and Jordan, the survey link was left open for 3 months due to low initial response rates. In total, 3763 respondents gave consent and completed the survey, and 57 refused consent and exited without completing the survey. Data on respondents who exited the survey after giving consent but before completion or who clicked on the link but did not answer any questions are not available.

2.3. Data cleaning

We have deposited these data with Mendeley Data. The cleaning process for the combined data file (AllData.xlsx) was as follows:

a. Field names and styling differences in options (e.g., hyphens vs. en dashes) were standardised for consistency against the original English survey to facilitate filtering of data.

b. Responses erroneously split by the survey platform into two lines of the raw CSV file were manually combined into single records.

c. In the Greek survey, the willingness to pay question (Q11) was erroneously required, even for respondents unwilling to consume food grown with human urine who would not be expected to be willing to pay at all for such products. For consistency in the cleaned data sheet (AllData.xlsx), we removed the answers to Q11 from those who should not have received this question. These answers remain in the raw data file (GR_raw.xlsx).

d. NEP items (randomised in blocks of five in the survey) were reordered to the original order. For calculation of mean NEP scores, odd-numbered items were coded from 1 (strongly disagree) to 5 (strongly agree), whereas even-numbered items were coded in the reverse order, following Dunlap et al. [4], and the mean scores were added as an additional column to the cleaned data sheet (AllData.xlsx in the data deposit).

This cleaned data sheet can be filtered by field in Excel or other programs to select subsets of the data as needed, but we also deposited raw data files for transparency and data verification purposes.
| Country  | University                                      | Survey language(s) | Survey platform | Survey period          | No. of completed responses (no. of refusals) | File name(s) for Survey instrument(s) | Raw data |
|----------|-------------------------------------------------|--------------------|-----------------|------------------------|---------------------------------------------|---------------------------------------|----------|
| Bangladesh | Bangladesh Agricultural University             | English            | GoogleForms     | 19-Sep-17 - 19-Oct-17  | 51 (1)                                      | EN.pdf                                | BN_BAU_raw.xlsx |
| Bangladesh | University of Health Sciences                  | English            | GoogleForms     | 14-Sep-17 - 14-Oct-17  | 104 (1)                                     | EN.pdf                                | BN_BUHS_raw.xlsx |
| Brazil    | University of Santa Catarina                   | Brazilian          | GoogleForms     | 10-Oct-17 - 09-Nov-17  | 155                                         | N/A                                   | BR_raw.xlsx   |
| Brazil    | University of Science and Technology Beijing   | Portuguese         | Wenjuanxing     | 26-Oct-17 - 25-Nov-17  | 532                                         | SIM_CN.pdf                            | CN_USTB_raw.xlsx |
| China     | Tongji University                              | Simplified Chinese | Wenjuanxing     | 23-Nov-17 - 22-Dec-17  | 184                                         | SIM_CN.pdf                            | CN_Tongji_raw.xlsx |
| Ethiopia  | Samara University                              | English            | GoogleForms     | 14-Oct-17 - 13-Nov-17  | 324                                         | EN.pdf                                | ET_raw.xlsx   |
| France    | AgroParisTech                                  | French             | GoogleForms     | 13-Feb-18 - 16 Mar-18  | 260                                         | FR.pdf                                | FR_raw.xlsx   |
| Greece    | University of the Aegean                       | Greek              | GoogleForms     | 20-Oct-17 - 19-Nov-17  | 150                                         | GR.pdf                                | GR_raw.xlsx   |
| India     | Tezpur University                              | English            | GoogleForms     | 03-Oct-17 - 02-Nov-17  | 60                                          | EN.pdf                                | IN_raw.xlsx   |
| Israel    | University of Haifa and Oranim College         | Arabic, Hebrew     | GoogleForms     | 10-Feb-18 - 08-May-18  | 229                                         | AR.pdf, IL_HB.pdf                      | IS_AR_raw.xlsx, IS_HB_raw.xlsx |
| Jordan    | The Hashemite University                      | Arabic             | GoogleForms     | 18-Dec-17 - 14-Mar-18  | 258 (11)                                    | AR.pdf                                | JO_raw.xlsx   |
| Malaysia  | Universiti Malaysia Terengganu                | English            | GoogleForms     | 26-Sep-17 - 26-Oct-17  | 96                                          | EN.pdf                                | MY_raw.xlsx   |
| Moldova   | University of Academy of Sciences for Moldova  | Moldovan (Romanian)| GoogleForms     | 02-Nov-17 - 02-Dec-17  | 85                                          | MD.pdf                                | MD_raw.xlsx   |
| Poland    | University of Life Sciences in Lublin          | English            | GoogleForms     | 05-Oct-17 - 04-Nov-17  | 93                                          | EN.pdf                                | PO_raw.xlsx   |
| Portugal  | IADE – Universidade Europeia                   | Portuguese         | GoogleForms     | 14-Mar-18 - 15-Apr-18  | 88                                          | PT_PT.pdf, EN.pdf                     | PT_PT_raw.xlsx, PT_EN_raw.xlsx |
| Taiwan, ROC | National Taiwan University (Department of Bioenvironmental Systems Engineering) | Traditional Chinese | GoogleForms     | 21-Sep-17 - 21-Oct-17  | 39                                          | TR_CN.pdf, TW_CN_NTUT_raw.xlsx, TW_EN_NTUT_raw.xlsx |
| Taiwan, ROC | National Taipei University of Technology      | Traditional Chinese | GoogleForms     | 17-Oct-17 - 16-Nov-17  | 124                                         | TR_CN.pdf, TW_CN_NTUT_raw.xlsx, TW_EN_NTUT_raw.xlsx |
| Uganda    | Makerere University                           | English            | GoogleForms     | 10-Nov-17 - 11-Dec-17  | 163                                         | EN.pdf                                | UG_raw.xlsx   |
| USA       | University of South Florida, Florida           | English            | GoogleForms     | 28-Jan-18 - 26-Feb-18  | 437 (13)                                    | EN.pdf                                | USA_raw.xlsx   |

Notes: Refusals represent individuals who declined consent after reading the introduction to the survey. Only fully completed surveys were retained, and the exact number of individuals originally approached with an invitation is unknown. Survey instrument and raw data files have been deposited in Mendeley Data [5]. N/A, not applicable.
2.4. Data limitations

First, most of the samples in our study are non-probabilistic convenience samples that are not necessarily representative of the larger university populations and should not be extrapolated to national populations; in particular, the samples are biased towards those in applied and natural science disciplines, and arts and humanities disciplines are underrepresented. It is possible that respondents therefore had a higher degree of interest in and/or knowledge about the topic than might be expected in the general population. Second, our question about gender only provided two options, male and female, and was required, which may have resulted in some respondents exiting the survey at that point. Finally, despite our goal of administering a relatively standardised survey, the process of translation inevitably changes meaning in subtle ways. Some options were also erroneously combined in some surveys, requiring recoding for comparison across countries.

For our associated study [1], we further processed the data for comparison purposes. In the Simplified Chinese surveys administered in both mainland China and Taiwan, the “landfill” and “incinerate” options were combined in the recycling/disposal question (Q19 in the master survey). We coded selection of this option for both landfill and incineration, although this may overstate the acceptability of one or both options. However, these options were among the most infrequently selected overall, so this did not significantly alter our overall interpretation of the question. In the Hebrew-language survey, “pharmaceuticals” and “hormones” were similarly combined into a single option in Q17 and we handled them the same way in our analysis. In both the raw and cleaned data described here, however, we have left these responses combined as originally given.

A few other inconsistencies in survey administration may also affect the comparison of the data between countries. In particular, in the mainland China surveys administered by mobile app, the question about colleagues’ perceptions (Q12) was not forced, and only 22% of the Chinese respondents \(n = 155\) chose to answer this question. Some open-ended comment fields were also combined in the mobile app surveys, resulting in a slightly different order of questions. Finally, 2\% \(n = 15\) of the answers for the settlement type question (Q4) in mainland China were invalid, likely due to a glitch in the mobile application.

CRediT Author Statement

Prithvi Simha and Björn Vinnerås with the help of all authors: Conceptualisation; Prithvi Simha and Melissa A. Barton: Data curation; Björn Vinnerås: Funding acquisition; All authors: Investigation; Prithvi Simha and Björn Vinnerås: Methodology; Prithvi Simha and Björn Vinnerås: Project administration; Prithvi Simha and Björn Vinnerås: Supervision; Melissa A. Barton and Prithvi Simha: Validation; Melissa A. Barton: Writing—original draft; All authors: Writing—review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Data Availability

Multinational survey of attitudes towards recycling urine as fertiliser (Original data) (Mendeley Data).
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