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Organ donation and transplantation education in UK medical schools: a protocol for parallel national cross-sectional surveys of students and educators

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ABSTRACT

Introduction Solid organ transplantation is a cornerstone of care for end-stage organ disease and a critical consideration for all doctors managing chronic conditions such as chronic kidney disease. Transplantation is wholly dependent on organ donation (both living and deceased), with shortages directly limiting access to life-saving therapy and resulting in preventable mortality for patients on waiting lists. Yet undergraduate exposure to organ donation and transplantation (ODT) across UK medical schools is anecdotally poor and not mapped nationally. The most substantive UK evidence is more than two decades old and demonstrates limited exposure and significant knowledge gaps among final-year medical students. We here describe a protocol for two coordinated national surveys: U-KNOW-RT (*U*nderstanding and *Know*ledge of *R*enal *T*ransplantation; final-year students) and U-TEACH-ODT (*U*ndergraduate *T*eaching in *ODT*; educator leads). Together, these will provide the first UK-wide mapping of undergraduate ODT education, generating contemporary evidence on teaching provision, student exposure, knowledge, attitudes and career intentions. This work will directly inform the design of a standardised national ODT teaching module to ensure that all UK medical graduates attain a core level of literacy in ODT. Survey distribution is scheduled for January 2026, with completion expected by summer 2026.

Methods and analysis We will conduct two parallel cross-sectional online surveys. U-KNOW-RT will recruit final-year medical students from all 44 UK medical schools via social media, institutional channels and student societies. U-TEACH-ODT will invite deans and senior curriculum leads. The student target is ~1200 responses (≥10 per school) to enable national mapping and triangulation with educator reports. Analyses will follow the Consensus-Based Checklist for Reporting of Survey Studies and the Checklist for Reporting Results of Internet E-Surveys reporting frameworks. Prespecified outcomes include student knowledge, exposure and attitudes alongside educator-reported curricular provision. Primary analyses will use mixed-effects regression with school-level clustering, agreement between student and educator reports will be quantified and selected items will be readministered to allow 20-year comparisons with legacy surveys.

Ethics and dissemination This study involves human participants and was granted ethical approval by the University of Sheffield Ethics Department (reference 070914) on 25 November 2025. Participants provided informed consent before taking part. This manuscript reports a study protocol only; no results will be reported. Findings will be disseminated through peer-reviewed publications, conferences and feedback to medical schools and national bodies. De-identified data, questionnaires and analysis code will be shared openly on Open science framework.

Trial registration number OSF preregistration (DOI 10.17605/OSF.IO/38W5N).

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ First UK-wide mapping of undergraduate organ donation and transplantation education in nearly two decades.
⇒ Prospectively preregistered with transparent analytic plans and reporting aligned with the Consensus-Based Checklist for Reporting of Survey Studies and the Checklist for Reporting Results of Internet E-Surveys guidelines.
⇒ Surveys were developed with input from students, educators, clinicians and recipients and piloted to optimise clarity and comparability with legacy items.
⇒ Recruitment may be uneven across schools, and students with an interest in transplantation may be more likely to participate, although institutional distribution and triangulation with educator data will help mitigate these effects.
⇒ Reliance on self-reported measures limits direct assessment of competence but allows feasible national surveillance and rare temporal benchmarking.

INTRODUCTION

Solid organ transplantation (SOT) is the gold-standard treatment for selected patients with end-stage organ disease, including

kidney, liver, heart and lung failure.[1–4] Renal transplantation, the most common form of SOT, offers superior survival, quality of life and cost-effectiveness compared with dialysis or supportive care.[1 5 6] Transplant recipients typically benefit from improved quality of life: increased physical health, psychosocial well-being and reintegration into daily life.[5 7] In the UK, more than 8000 people are currently on the transplant waiting list, and modelling commissioned by Kidney Research UK projects that demand for kidney transplantation will quadruple to ~12 000 annually by 2033, compared with fewer than 4000 procedures currently performed.[8 9] Three patients die each day in the UK while waiting for a suitable donor organ.[9] Globally, the WHO has declared chronic kidney disease (CKD) a public health emergency and a leading cause of premature mortality.[10]

Organ donation and transplantation (ODT) is not confined to transplant specialists. Clinicians across a wide range of specialties are likely to encounter ODT during their careers, whether through identifying potential donors, supporting families in time-critical decisions or coordinating referrals.[11] Their knowledge, attitudes and communication skills directly influence donation opportunities and patient outcomes.[11 12] It is, therefore, fundamental that all medical graduates attain a baseline literacy in ODT,[13] including (but not limited to) proficient understanding of referral pathways, consent frameworks, brainstem death and donation after circulatory death (DCD), allocation principles and the role of transplantation in the management of chronic disease.[2 9] This should also extend to confidence in initiating and supporting sensitive conversations around organ donation, not only to maximise donor opportunities and patient outcomes but also to provide appropriate support to donor families at a critical time.[11]

Despite this system-wide need, structured undergraduate teaching in ODT remains inconsistent and is often absent altogether.[14 15] Schools without affiliated transplant centres are particularly disadvantaged, and curricular reforms towards outcomes-based frameworks risk further marginalising niche but critical topics.[14–16] To date, undergraduate exposure to ODT in the UK has not been systematically mapped at a national level, leaving a critical evidence gap. The most substantive evidence derives from studies by Edwards *et al*, who reported striking deficiencies in a 2004 single-centre survey of final-year Bristol students (n=76), only 14% had observed a transplant, 35% could not name an immunosuppressant and strikingly, 9% incorrectly believed xenotransplantation was routine in 2003.[14] Edwards *et al*'s parallel national survey of deans found that 12% of schools provided no formal teaching and 24% offered no compulsory clinical exposure, while elective opportunities typically reached fewer than 10% of students.[15] A decade later, Hakeem *et al* surveyed (n=523) UK junior doctors and found that 84% felt inadequately exposed to transplantation during training, and 97% believed ODT should be formally included in undergraduate curricula.[17] Together, these studies demonstrate striking gaps in both student knowledge and institutional provision.

To address this, we will deliver two coordinated national surveys: U-KNOW-RT (*U*nderstanding and *Know*ledge of *R*enal *T*ransplantation), targeting final-year students, and U-TEACH-ODT (*U*ndergraduate *T*eaching in *ODT*), targeting medical school educators. U-KNOW-RT focuses on renal transplantation while incorporating wider ODT-related knowledge domains and will capture student exposure, knowledge, attitudes and career intentions. U-TEACH-ODT will survey deans and curriculum leads to map the breadth of ODT provision, assessment and perceived barriers and facilitators. Together, these studies will provide the first contemporary national baseline of undergraduate ODT education in the UK, enabling triangulation between student and educator perspectives.

The timing of this work is critical. CKD prevalence continues to rise due to ageing populations, diabetes, hypertension and cardiovascular disease.[18] Transplantation rates remain constrained by organ shortages and workforce limitations.[9] While simultaneously, undergraduate educational time constraints threaten to further marginalise the inclusion of ODT teaching.[16] Without robust national evidence, it is impossible to design or advocate for a standardised teaching module that ensures all graduates attain core ODT literacy. This study responds directly to recent calls, including from the *Lancet* Commission on Transplantation, to 'reposition transplantation not as a niche intervention, but as a strategic health function'.[19]

By generating national evidence, we aim to underpin the development of a standardised undergraduate ODT teaching module, equipping future doctors with the knowledge and confidence required to support donation and transplantation across the health system.

Aims

This study has three interlinked aims:

1. Provide a contemporary national baseline of undergraduate ODT education by mapping student exposure, knowledge, attitudes and career intentions alongside institutional provision reported by deans and curriculum leads.
2. Enable both longitudinal and cross-sectional comparisons: selected Edward's knowledge items are re-administered verbatim to allow a 20-year temporal comparison of student understanding and exposure, while triangulation of student and educator surveys will reveal areas of concordance and misalignment within schools.[14]
3. Generate the empirical foundation for the design and advocacy of a standardised, evidence-based national ODT teaching module across all UK medical schools, with the long-term ambition of facilitating international benchmarking and comparison (figure 1).

While this protocol focuses on delivering U-KNOW-RT and U-TEACH-ODT as the first coordinated national surveys of undergraduate ODT education, these projects

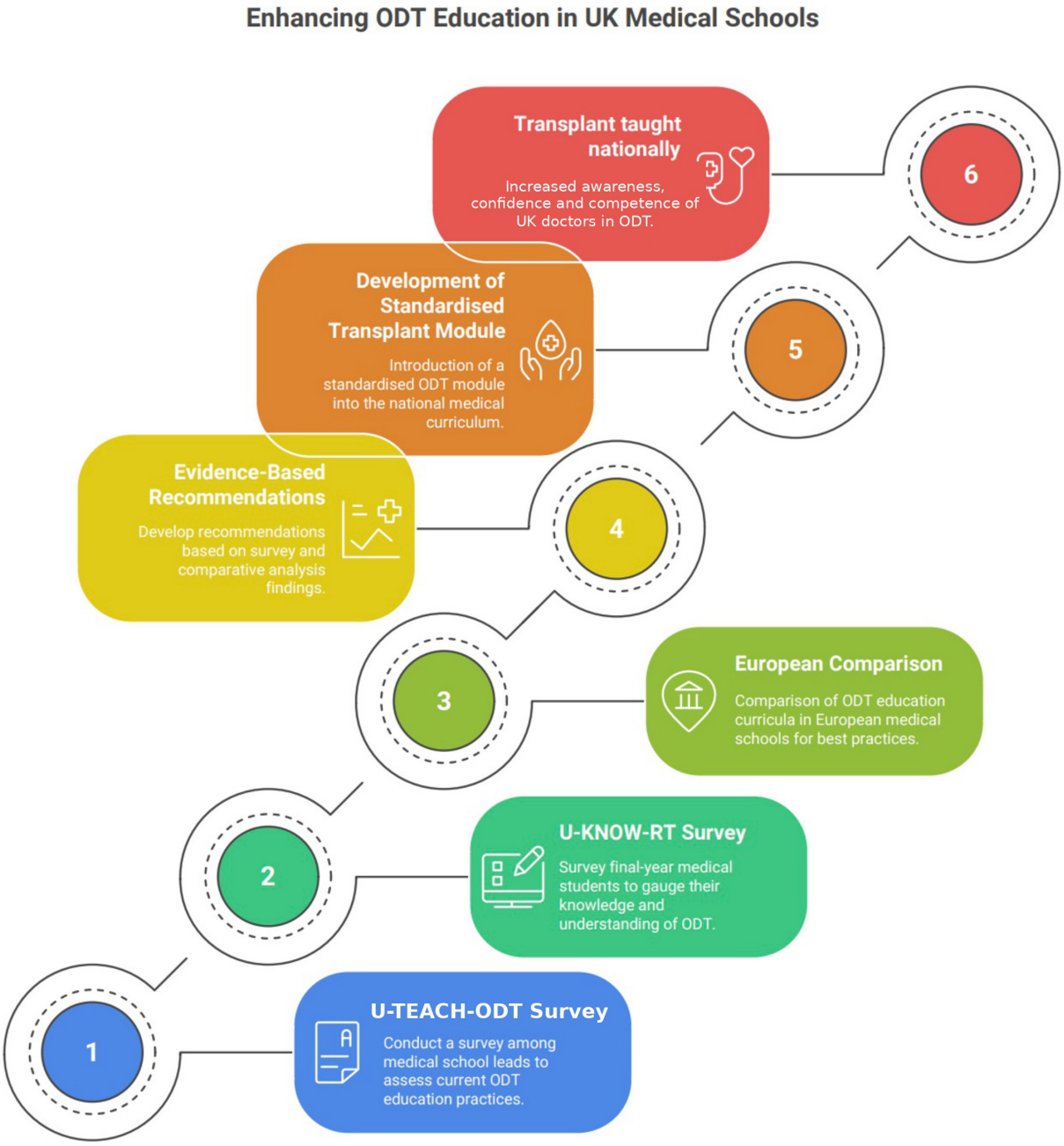

Figure 1 Planned trajectory of the study. ODT, organ donation and transplantation; U -KNOW-RT, Understanding and Knowledge of Renal Transplantation; U-TEACH-ODT, Undergraduate Teaching in Organ Donation and Transplantation.

are explicitly positioned as foundational steps within a broader trajectory (figure 1). A subsequent European comparison will provide critical benchmarking; countries such as Spain, where undergraduate exposure to transplantation is embedded, exemplify how education aligns with world-leading organ donation rates and outcomes.[20] This comparative insight will directly inform the design of a standardised, evidence-based transplant module for UK medical schools, codeveloped with national transplant leads, educators, patients and donor families to ensure it reflects clinical priorities, lived experience and societal values.

METHODS

Study design and setting

This is a descriptive, parallel, national, cross-sectional study comprising two coordinated online questionnaires. U-KNOW-RT will be distributed to final-year UK medical students, and U-TEACH-ODT to medical school educator leads. Both questionnaires were developed from prior UK research on ODT education, refined through consultation with clinicians, educators and transplant recipients and piloted at two UK medical schools.[14 15] Questionnaires will be distributed simultaneously across all UK medical schools in January 2026, with a 1-month study window.

Table 1 U-KNOW-RT PICO

PICO	Inclusion	Exclusion
Population (P)	► Final-year medical students enrolled at UK medical schools during 2025–2026.	► Prefinal-year students. ► Postgraduate doctors (Foundation year 1/ Foundation year 2/ trainees). ► Non-medical students. ► Non-UK.
Intervention (I)	► Structured student questionnaire on ODT: exposure to teaching/clinical experiences, knowledge (including selected Edwards items), attitudes/ comfort discussing donation and career intention.	► Non-completion or >50% missing data.
Comparator (C)	► Cross-school contrasts (transplant-centre affiliation, assessed vs unassessed ODT content, exposure index quartiles, region/course length). ► Triangulation with educator reports (U-TEACH-ODT). ► Temporal comparison with historic Edwards undergraduate surveys.	
Outcomes (O)	► Primary: knowledge score and adequacy threshold, association with exposure index. ► Secondary: attitudes, comfort discussing donation, career intentions and observed/placement exposure.	

ODT, organ donation and transplantation; PICO, Population, Intervention, Comparator and Outcomes; U-KNOW-RT, Understanding and Knowledge of Renal Transplantation; U-TEACH-ODT, Undergraduate Teaching in Organ Donation and Transplantation.

Selected knowledge and exposure items from Edwards *et al* will be re-administered verbatim within U-KNOW-RT, enabling a 20-year temporal comparison.[14]

Full versions of both surveys are included in the online supplemental appendix.

Participants and eligibility

The student survey (U-KNOW-RT) will be open to all final-year MBBS/MBChB students enrolled at UK medical schools (during the survey window) (table 1). Final-year students were selected, as they will have completed the majority of their school's curriculum, ensuring maximum potential exposure to available ODT teaching and clinical opportunities. This approach also facilitates comparability across schools by reducing heterogeneity in exposure linked to course stage. We considered including allied healthcare professional students, but this was beyond the intended scope of creating a medical-school module and risked diluting comparability across schools. Within medicine, we chose to focus primarily on renal transplantation, which is by far the most common form of SOT.[21] This also allows direct comparison with the landmark Edwards *et al*'s undergraduate studies, which centred on renal transplantation.[14]

The educator survey (U-TEACH-ODT) will be restricted to those in senior leadership roles with a whole-programme 'view' of undergraduate curricula, including deans and phase/year or assessment leads (table 2). For the educator survey, the unit of analysis is the medical school rather than the individual respondent. Requesting one authoritative response from a dean or senior curriculum lead is therefore appropriate, as these roles hold oversight of the entire MBBS/MBChB programme. To improve responsiveness, up to three senior leads per school will be contacted, with reminders issued until a definitive institutional response is secured. The aim is to increase the likelihood of the survey reaching the most appropriate lead with full oversight of the curriculum, recognising variability in roles and structures between medical schools. If >1 educator response is received, we will apply a prespecified adjudication hierarchy: Dean>Undergraduate programme lead>Phase/Year Lead>Specialty/Module Lead. Where responses differ, we will first seek reconciliation from respondents. Notably, unlike U-KNOW-RT, which focused primarily on renal transplantation, the educator survey was deliberately broader in scope. This reflects the fact that curriculum leads are responsible for the entirety of ODT teaching provision, spanning renal, hepatic, cardiac, pulmonary and cross-cutting domains such as consent and donor identification. A wider scope was therefore necessary to capture the full institutional landscape of ODT education.

Full inclusion and exclusion criteria for both cohorts are outlined in tables 1 and 2.

Recruitment and sampling

U-KNOW-RT

The survey will be distributed nationally in January 2026, with a 1-month study window and automated reminders at 2 weeks. Recruitment will use multiple overlapping channels:

1. Institutional administrators via a publicly available email address.
2. Individual medical and surgical societies will be contacted directly via email.

Table 2 U-TEACH-ODT PICO

PICO	Inclusion	Exclusion
Population (P)	► UK medical-school deans/curriculum/assessment leads with a whole-course view of their curriculum.	► Non-undergraduate roles. ► Non-UK. ► Duplicate entries. ► >50% missing core items.
Intervention (I)	► Structured educator questionnaire on ODT curriculum (coverage/hours, assessment, percentage with clinical exposure, donation-process teaching, barriers/facilitators), plus cascade prompt.	► Non-completion or >50% missing data.
Comparator (C)	Cross-school contrasts (transplant-centre affiliation, assessed vs unassessed, ODT hours, presence of exposure, curriculum model, region, course length) and triangulation with student data (U-KNOW-RT).	
Outcomes (O)	► Primary: presence/extent of formal ODT teaching, percentage of students with structured exposure. ► Secondary: barriers/facilitators, perceived importance/preparedness, institutional readiness, innovations, student–educator agreement.	

ODT, organ donation and transplantation; PICO, Population, Intervention, Comparator and Outcomes; U-KNOW-RT, Understanding and Knowledge of Renal Transplantation; U-TEACH-ODT, Undergraduate Teaching in Organ Donation and Transplantation.

3. Targeted social media promotion (direct messaging to medical societies via Instagram) will supplement these approaches.

To maximise response rates and reduce responder bias (ie, only students with a pre-existing interest in ODT participating), we will prioritise the establishment of a national network of student collaborators (co-affiliates). At least one collaborator will be sought at each UK medical school, with those who secure ≥10 responses from their institution awarded co-affiliation on outputs and certificates of involvement. This approach, which follows precedents from other national undergraduate surveys, is designed to broaden reach, diversify respondents and strengthen institutional coverage.[22] To complement the affiliate scheme, entry into a voluntary, non-coercive raffle (£500 total value) will also be offered. The raffle includes three cash prizes (£125, £75 and £50) alongside additional medical-related items (eg, stethoscopes, scrubs, scrub hats and clogs). A mixed package of monetary and medical prizes was chosen to appeal to a broad cross-section of students, thereby further improving representativeness. Contact details for raffle entry will be stored separately from survey data to preserve anonymity.

We aim to obtain approximately 1200 student responses nationally. As students are clustered within medical schools, precision will be reported using a design effect (Deff=1+(m−1)×ICC), where m is the mean cluster size and ICC is the intraschool correlation. This corresponds to an approximate 3 percentage point margin of error for a population of ~9000 final-year students. A minimum of 10 respondents per school will be required to support stable school-level aggregates and agreement analyses; schools not meeting this threshold will still be reported descriptively but excluded from comparative school-level analyses. This threshold is pragmatic and reflects stability considerations (effective numver per school (n), neff≈n/(1+(n−1)×ICC); with ICC≈0.05, n=10 yields neff≈6). Sensitivity analyses will vary the minimum per-school threshold (eg, ≥8, ≥12 and ≥20 respondents) and will also fit multilevel models that use all individual responses with partial pooling across schools.

We will report view, participation and completion metrics per CHERRIES (Checklist for Reporting Results of Internet E-Surveys) and present a recruitment flow diagram by channel (administrator emails, Virtual learning environments/portals, student societies, affiliate scheme).[23] Metrics will include invitations sent (by channel), link landings/starts, partials and completes. The flow will show exclusions (ineligible, duplicates removed) and final analytic counts.

Patient and public involvement

Patients, educators and professionals contributed at multiple preliminary stages of this project. Clinical medical students at Leeds and Sheffield (n=11) piloted the U-KNOW-RT study to refine the clarity, flow, burden and usability of the questionnaire. Faculty at both Leeds and Sheffield (n=2) piloted the U-TEACH-ODT instrument to ensure alignment with curricular terminology and feasibility for educator respondents.

Transplant recipients and independent donor families reviewed attitude and intention items to ensure sensitivity and acceptability. Finally, clinicians advised on the knowledge domain to confirm clinical accuracy, relevance and appropriate pitch for final-year students. Feedback from these groups informed refinements to wording, ordering, burden and response options.

Measures

The U-KNOW-RT questionnaire captures participants' basic demographics, education and exposure to ODT, knowledge of core ODT concepts and attitudes regarding ODT teaching and future career intentions.

The U-TEACH-ODT questionnaire captures institutional and curricular content/structure, exposure, perceived importance/sufficiency and barriers, with

free-text items for innovations (full questionnaires can be found in the online supplemental appendix).

Outcomes

Primary outcomes

1. Student knowledge of ODT was assessed using a 6-item knowledge score (0–6; adequate≥4 correct items; see Indices for construction details).
2. Educator-reported curricular provision, including the presence, extent and assessment of ODT teaching within undergraduate medical programmes.

Secondary outcomes

3. Student exposure to ODT, summarised using a composite exposure index (see Indices).
4. Student attitudes towards ODT, assessed via a Likert-based Attitudes Scale (0–10), including measures of comfort and confidence in donation discussions.
5. Career intentions relating to transplantation or relevant specialties.
6. Educator perceptions of barriers, facilitators and institutional readiness to expand ODT teaching.
7. Concordance between student-reported and educator-reported provision at the school level.

Exploratory outcomes

8. Cross-school comparisons stratified by transplant-centre affiliation, curriculum model, course length and geographical region.
9. Subgroup contrasts among students (sex, ethnicity, graduate-entry status and widening participation status).
10. Temporal benchmarking with legacy survey items from Edwards *et al*.[14 15]

Student-educator alignment: shared constructs

To enable triangulation between student and educator data, we define the following shared constructs a priori:

1. Assessed ODT content in the core curriculum (yes/no).
2. Taught hours of ODT content (ordinal bands: 0, 1–2, 3–5, 6–10, >10 hours).
3. Structured clinical exposure related to transplantation (yes/no and proportion of cohort exposed: none, <25%, 25%–49%, 50%–74%, ≥75%).
4. Observation opportunities (eg, theatre/clinic; yes/no).
5. Perceived preparedness for ODT topics (5-point anchors from 'not at all' to 'very well'). These constructs are asked of educators directly and derived from student responses via prespecified aggregation rules.

Mapping rules

Student responses will be aggregated to the school level using predefined rules. Assessed ODT content is present if ≥50% of students at a school report that ODT is assessed. Taught hours will be summarised as the school-level median response category. Structured clinical exposure will be considered present if ≥50% report exposure, with the cohort proportion taken as the median response category. Observation opportunities are present if ≥40% of students report at least one opportunity. Preparedness is summarised as the school-level mean on the 1–5 scale. Sensitivity analyses will repeat these summaries using thresholds of 40% and 60% and will use trimmed means for preparedness (trimming 5% in each tail). An online supplemental appendix table will list item-to-construct mappings for both instruments.

Indices: knowledge score, exposure index and attitude scale

Composite indices were prespecified to capture complex domains of ODT education.

The knowledge index comprises six single-best-answer items covering core ODT concepts: (1) donation legislation/consent, (2) contraindications, (3) brain death/DCD, (4) organ-specific referral pathways, (5) transplant risks/benefits and (6) equity/ethics. Items were selected for content coverage and blueprint balance following PPIE (Patient/Public involvement) and clinician consultation and cognitive piloting with medical students. A total of six items was chosen to minimise respondent burden while permitting a broad blueprint and acceptable reliability for group-level comparisons.

Adequate knowledge was defined a priori using a modified Angoff standard-setting procedure with five judges (consultants in transplantation/renal medicine and senior medical educators).[24] For each item, judges estimated the probability that a minimally competent final-year student would answer correctly. The cut score was defined as the sum of the item-level mean probabilities, rounded to the nearest whole number, yielding a cut of 4/6 items correct. The knowledge score (0–6) will therefore be analysed both as a continuous variable and dichotomised at this adequacy threshold. As an external validity check, we will examine the association between total score and external anchors (self-rated confidence; prior exposure to ODT teaching/clinical experience) and report ROC (Receiver Operating characteristics) for this cut-score.

In the primary specification, each component will be z-standardised and averaged with equal weights; the composite will then be restandardised to mean 0 and SD 1 (and rescaled to 0–100 for figures). The index will be computed when ≥4 of 6 components are non-missing; otherwise, it will be set to missing. Sensitivity specifications (policy-weighted variant, Principical component analysis-based index and models with components entered separately) are detailed in the Statistical analysis plan.

The Attitudes Scale will be calculated as the mean of selected 0–10 Likert items (comfort, importance, scenario confidence), with internal consistency reported using Cronbach's α; if $\alpha<0.70$, items will also be reported individually.[25]

All construction rules, coding keys and cut points will be documented a priori in a public OSF codebook (DOI 10.17605/OSF.IO/38W5N).

Data collection and confidentiality

Both surveys will be administered via Google Forms, optimised for desktop and mobile devices. Google Forms will be configured with 'collect email addresses' switched off, no institutional sign-in required and Internet protocol addresses or device identifiers will not be recorded. At the start of each survey, participants will view an online Participant Information Sheet (online supplemental appendix C, D) followed by a mandatory consent item; respondents cannot proceed without explicitly confirming consent.

The main survey datasets will not contain direct identifiers (no names, student numbers, email addresses or IP addresses). For the student survey only, participants may optionally provide an email address for entry into a prize draw via a separate (optional) item. These contact details will be stored in a separate, password-protected file, used solely to contact prize winners and will not be linked back to survey responses. For the educator survey, publicly available email addresses used for survey distribution or follow-up clarification will likewise be stored separately from the research dataset.

Duplicate and low-quality responses will be addressed using prespecified rules. For educators, duplicate institutional responses will be identified using self-reported institution and role; the predefined seniority hierarchy will be used to select a single 'definitive' institutional response. For students, potential duplicates or implausible submissions will be explored using completion timestamps and internal consistency checks (eg, medical school, year of study, key knowledge items). Implausibly short completion times, >50% missing data and major internal inconsistencies will be flagged and excluded in sensitivity analyses.

After export, de-identified survey data will be stored on secure, access-controlled university servers, with role-based permissions and two-factor authentication. Access to any file containing personal contact details (prize-draw emails or educator contact lists) will be restricted to the chief investigator and the supervisory team.

Identifiable personal data will be retained only for as long as needed for their specific purpose and then destroyed: student prize-draw contact details will be deleted once winners have been selected and notified (within 1 month of prize draw completion); educator contact details used for distribution or clarification will be deleted within 12 months of survey closure. Anonymised analysis datasets and accompanying code will be archived for a minimum of 10 years in line with institutional policy and deposited on OSF, where only fully de-identified data will be shared.

Statistical analysis plan

Analysis population

Two linked datasets will be analysed:

1. U-KNOW-RT (primary dataset).
2. U-TEACH-ODT (secondary dataset).

Descriptive statistics and visualisation

All variables will be summarised using means (SD), medians (IQR) and proportions, with school-level and region-level maps/plots to display national variation. Distributions of composite indices will be examined for floor/ceiling effects.

Primary analysis (students)

The primary analysis will test the association between student exposure and knowledge. Knowledge will be modelled both continuously (mixed-effects linear regression of knowledge score on the exposure index, with school as a random intercept and prespecified covariates as fixed effects) and dichotomously (logistic regression for adequate knowledge, ≥4/6). Effect modification by assessed content will be explored.

Secondary analyses (students)

Secondary analyses will examine student attitudes (mixed-effects linear models, with proportional-odds models as sensitivity checks), career intentions (logistic/ordinal regression) and subgroup differences by sex, ethnicity, graduate-entry status and local transplant-centre affiliation.

Educator analyses

Curricular provision and assessment outcomes (eg, presence of assessed ODT content, proportion with structured exposure) will be modelled using logistic or ordinal regression, with transplant-centre affiliation as the main predictor and region, programme length and cohort size as covariates.

Agreement analyses

Agreement between educator reports and student-derived school aggregates will be quantified using:

1. Cohen's kappa (κ; and weighted κ for ordinal categories) for binary/ordinal constructs (assessed content, exposure, observation opportunities and taught-hour bands).[26]
2. Two-way random-effects intraclass correlation, ICC(2,1), for continuous indices (eg, mean preparedness).
3. Bland-Altman plots for continuous measures as a diagnostic. We will report point estimates with 95% CIs and interpret κ/ICC using prespecified thresholds (poor <0.40, fair 0.40–0.59, good 0.60–0.74, excellent ≥0.75).[27]

Item-level diagnostics and bias/misfit checks

We will report classical item statistics for the knowledge index (difficulty (p) and point-biserial discrimination (rpb)). Item bias will be screened using differential item functioning for sex, ethnicity and graduate-entry status via Mantel-Haenszel and logistic regression approaches.[28 29]

Exposure index robustness

Primary analyses will use the equal-weighted exposure index. To assess robustness, we will:

Table 3 Study timeline

Activity	Timing
Preparation and piloting: OSF preregistration, ethics application, protocol submission to *BMJ Open*, pilot testing at Leeds and Sheffield and instrument refinements following stakeholder feedback	July–December 2025
National launch: primary distribution of U-KNOW-RT and U-TEACH-ODT through university administrators, medical societies, surgical/transplant societies and e-noticeboards	January 2026
First reminder: circulated through all recruitment channels to maximise reach	Mid-January 2026
Second reminder: follow-up through administrators and societies, highlighting study importance and non-coercive prize incentives	Late January–early February 2026
Survey closure: both student and educator surveys closed after 6 weeks of fieldwork; raffle conducted 2 weeks after closure	Mid-February 2026
Initial data work: data cleaning, duplicate checks, codebook generation and preliminary descriptive analyses; review representativeness and completeness of school-level responses	Spring 2026
Full analysis: mixed-effects modelling, triangulation of student and educator data and 20-year temporal comparisons with Edwards *et al*[14 15]	Summer 2026
Dissemination: preparation of manuscripts for submission to *BMJ Open* and other journals; presentations at conferences (BTS, ASiT); feedback to medical schools, MSC and GMC; deposition of de-identified data, questionnaires, codebook and scripts on OSF.	Autumn 2026

ASiT, Association of Surgeons In tranining ; BTS, British Transplant Society ; GMC, General medical council ; MSC, Medical school council ; OSF, Open science framework; U-KNOW-RT, Understanding and Knowledge of Renal Transplantation; U-TEACH-ODT, Undergraduate Teaching in Organ Donation and Transplantation.

1. Repeat key analyses using a policy-weighted variant that gives double weight to assessed ODT content and structured clinical exposure.
2. Re-run models with the six components entered separately instead of the composite index.
3. Construct a principal-components-based index from the six components and repeat key models using its standardised scores. We will report correlations between the alternative indices and summarise any material differences in effect estimates in a sensitivity table.

Legacy comparisons

Items retained from Edwards' previous surveys will be compared with contemporary responses, using risk differences (95% CI) for proportions and Welch's t-tests for continuous and ordinal variables.[14 30]

Missing data and coding

Responses with >50% item non-completion will be excluded. If <5% of covariate data are missing, complete-case analysis will be used; if ≥5%, multiple imputation (m=20) will be applied, incorporating outcomes and clustering variables.

Non-response and incentive-related bias

We will compare prize-entry versus non-entry groups on demographics, exposure index, knowledge score and attitudes. Differences will be summarised with cluster-robust tests and effect sizes; if systematic, sensitivity analyses will re-weight or adjust for these indicators.

Accounting for clustering and variance estimation

All descriptive estimates and regression models will account for clustering at the medical-school level. For descriptive statistics and group comparisons, we will report cluster-robust SEs and 95% CIs. For regression analyses, we will fit models with school-cluster-robust variance estimators as the primary specification. As a sensitivity analysis, we will fit multilevel mixed-effects models with a random intercept for school to allow partial pooling across schools.

Poststratification weighting

To improve national representativeness, we will apply poststratification weights at the medical-school level. Calibration variables will be (1) school size (final-year cohort size), (2) UK region, (3) programme length/type (4/5/6 years; graduate entry) and (4) transplant-centre affiliation (yes/no). Published or administrative totals for these cells will be used as calibration margins. Weights will be constructed by iterative proportional fitting (raking) applied to school-level aggregates; individual student records inherit their school's weight. Where small cells produce extreme weights, trimming will be applied at the 1st/99th percentile with re-normalisation. Missing administrative totals for any school will be imputed from the most recent publicly available figures and flagged in a sensitivity analysis. All primary estimates will be presented both unweighted and weighted, with CIs computed using cluster-robust variance estimators at the school level. Sensitivity analyses will (a) remove trimming, (b) vary trimming cut-points and (c) present results using an

Table 4 CROSS framework [31]

CROSS item	How is item addressed in U-KNOW-RT/U-TEACH-ODT?
Title/abstract	► The title specifies 'protocol' and 'cross-sectional surveys'. ► Abstract includes introduction, methods, ethics/dissemination.
Introduction	► Background provided; evidence gap identified (no UK-wide data in 20 years). ► Objectives and aims are clearly stated.
Methods—survey development	► Instruments informed by Edward's legacy items.[14] ► PPI input from students, educators, surgeons and recipients. ► Piloted at Leeds/Sheffield.
Methods—sampling and recruitment	► U-KNOW-RT (school administrators, student societies, social media and affiliate network). ► U-TEACH-ODT (publicly available emails and MSC distribution).
Methods—sample size/precision	► Student target: ~1200. ► Precision accounts for clustering by medical school using the Deff=1+(m−1)×ICC. For ICC 0.02–0.05 and m≈25–30, Deff≈1.5–2.3→effective n≈520–800; national proportion MOE≈3.5–4.8%. We report Deff and effective n alongside counts.
Methods—outcomes	► Primary, secondary and exploratory outcomes specified. ► Indices predefined. ► Preregistered on OSF.
Methods—analysis	► Predetermined in the statistical analysis plan. ► Descriptives and models use school-cluster-robust CIs; multilevel random-intercept models as sensitivity. ► Poststratification weighting applied (school size, region, programme type and transplant-centre affiliation). ► Student-educator agreement prespecified (κ/weighted κ, ICC(2,1), Bland-Altman plots). ► Exposure index robustness reported (equal-weights primary; PCA/factor and policy-weighted variants). ► Missing-data plan: complete case if <5%; MICE otherwise.
Ethics and funding	► Approved 25 November 2025 (reference 070914). ► Funding from SAKA (£500) declared.
Discussion	► Limitations (bias, uneven responses and self-report) acknowledged with mitigation strategies.

CROSS, Consensus-Based Checklist for Reporting of Survey Studies; Deff, design effect; Effective n, Effective sample size; ICC, intraclass correlation; m, mean cluster size; MICE, Multiple Imputation by Chained Equations; MOE, Margin of Error; MSC, Medical School council ; OSF, Open science framework ; PCA, Principal Component Analysis; PPI, Patient public involvment ; SAKA, Sheffield Area Kidney Association; U-KNOW-RT, Understanding and Knowledge of Renal Transplantation; U-TEACH-ODT, Undergraduate Teaching in Organ Donation and Transplantation; κ, Cohen's kappa.

alternative calibration set that excludes transplant-centre affiliation.

Software and reproducibility

Analyses will be conducted in R. Code, a codebook, and a de-identified dataset will be deposited on OSF to ensure transparency and reproducibility.

STUDY TIMELINE

Preparation and piloting will occur during July–September 2025, including OSF preregistration, protocol submission and instrument refinements. The national launch is scheduled for January 2026, with reminders at ~2 and ~4 weeks, and data collection closing in mid-February. The student raffle will be conducted a month later. Data cleaning, codebook generation and initial descriptive analyses will be undertaken in spring 2026, followed by full statistical modelling, triangulation and temporal comparisons in summer 2026, with dissemination thereafter (table 3).

ETHICS AND REGISTRATIONS

Ethical approval was granted by Sheffield University on 25 November 2025 (reference 070914).

All participants will receive an electronic Participant Information Sheet outlining the study's aims, voluntary nature, confidentiality safeguards and data handling. Consent will be obtained via a mandatory checkbox on the first question; respondents cannot proceed without confirming consent.

This study has been prospectively preregistered on the Open Science Framework (DOI 10.17605/OSF.IO/38W5N), including hypotheses, sample size rationale, indices, data handling and analysis plans.

Reporting and dissemination

Findings from this study will be reported in accordance with the CROSS (Consensus-Based Checklist for Reporting of Survey Studies) (table 4) and CHERRIES (table 5) guidelines to ensure transparency and reproducibility.[23 31]

Table 5 CHERRIES framework[23]

CHERRIES item	How is item addressed in U-KNOW-RT/U-TEACH-ODT?
Survey design and ethics	► Cross-sectional online surveys. ► Participant information sheets. ► Mandatory consent checkbox. ► Ethics approval as above.
Development and pretesting	► Cognitive debriefing with students. ► Piloting with Leeds/Sheffield faculty.
Recruitment	► U-KNOW-RT (school administrators, student societies, social media and affiliate network). ► U-TEACH-ODT (publicly available emails and MSC distribution).
Eligibility	► U-KNOW-RT: final-year MBBS/MBChB only. ► U-TEACH-ODT: senior leads with whole-course oversight.
Survey administration	► Google Forms ('collect email addresses' off, 'IP addresses' not collected). ► Mobile and desktop compatible.
Prevention of multiple entries	► No login required. ► U-TEACH-ODT (duplicate institutional responses identified using self-reported institution and role; prespecified seniority hierarchy used to select the definitive institutional response). ► U-KNOW-RT (potential duplicates or implausible submissions screened using completion timestamps and internal consistency (eg, school, year, key items); extreme cases excluded in sensitivity analyses). ► Linkage and prize-draw files stored separately with restricted role-based access and 2FA.
Response rates	► U-KNOW-RT targeted a minimum of 10 per school; national reminders at 2 and 4 weeks; administrator-led distribution to maximise reach. Aim: 1200 respondents. ► U-TEACH-ODT aims for responses from all 44 medical schools.
View rate	► Number of invitation deliveries (by channel) and landing-page starts where available; reported by channel and in aggregate.
Participation rate	► Starts÷invitations delivered (by channel).
Completion rate	► Completes survey/those who started survey.
Recruitment flow	► CONSORT-style diagram across all channels (invited→started→completed→analysed).
Data completeness	► >50% missing core items excluded.
Data security	De-identified at source; the survey dataset contains no direct identifiers: ► Raffle and linkage files stored separately. ► Role-based access with 2FA and a deletion schedule specified.
Analysis	See table 4.

CHERRIES, Checklist for Reporting Results of Internet E-Surveys; CONSORT, Consolidated Standards of Reporting Trials; 2FA, Two factor authentication ; IP, Internet protocol ; MBBS/MBChB, Bachelor of Medicine, Bachelor of Surgery ; MSC, Medical School council ; U-KNOW-RT, Understanding and Knowledge of Renal Transplantation; U-TEACH-ODT, Undergraduate Teaching in Organ Donation and Transplantation.

Findings will be submitted to peer-reviewed journals (eg, *BMJ Open*, *BMC Medical Education*) and presented at national (and international meetings) (British transplant society). Results will also be shared with transplant forums and professional bodies (Medical Schools Council, GMC), with aggregated feedback provided to participating schools to inform curricular discussions. To support open science, de-identified survey data, full questionnaires, a public codebook (scoring rules, weights, thresholds) and version-controlled analysis scripts will be deposited on OSF.

DISCUSSION

This protocol sets out a rigorous, preregistered approach to deliver the first national mapping of undergraduate ODT education in nearly two decades. It addresses a well-recognised gap in the evidence base, building on limited historical studies that demonstrated poor student knowledge, limited clinical exposure and striking heterogeneity in curricular provision.[14 15 17] By integrating both student (U-KNOW-RT) and educator (U-TEACH-ODT) perspectives, this study enables institutional triangulation, revealing not only the extent of provision but also the degree of alignment between what students experience and what educators report delivering. The inclusion of selected legacy items verbatim provides a unique opportunity to compare contemporary findings with those reported 20 years ago, generating rare longitudinal insight into the evolution of ODT education.

The study incorporates several methodological strengths. First, preregistration on OSF ensures transparency in hypotheses, sample size justification, analytic approaches and data quality checks. Second, rigorous piloting and stakeholder consultation (including students, educators, transplant surgeons and transplant recipients) strengthen content validity and ensure that instruments are relevant, clear and feasible to complete. Third, the application of the CROSS and CHERRIES guidelines, coupled with a comprehensive statistical plan that specifies indices, handling of missing data and predefined sensitivity analyses, maximises reproducibility and credibility.[23 31]

Nevertheless, limitations must be acknowledged. As a voluntary survey, recruitment is subject to self-selection bias, with potential over-representation of students already motivated or interested in transplantation. Within-school heterogeneity, driven by electives, student-selected components and opportunistic placements, may further limit representativeness. These challenges are mitigated through broad institutional dissemination, non-coercive incentives, a minimum response threshold per school and poststratification weighting.[32] Similarly, reliance on self-reported knowledge and attitudes cannot substitute for direct competency assessment; however, they provide a feasible, scalable and comparable measure across schools, and their inclusion enables triangulation with educator reports.

The anticipated impact of this study is substantial. By providing a contemporary national baseline, the findings will generate the empirical foundation for the design of a standardised, evidence-based national ODT teaching module across all UK medical schools. Embedding such a module would ensure that all graduates attain a core level of ODT literacy, regardless of institutional affiliation or access to a local transplant centre.

This aligns directly with the GMC's *Outcomes for Graduates*, the WHO's call to address kidney failure as a global priority and the *Lancet* Commission's recommendation to reposition transplantation as a strategic health-system function.[16 19 33] Beyond the UK, the protocol offers a replicable model that can be adapted to other health systems, enabling international comparison and collaboration in transplant education.

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Contributors All authors made substantial contributions to the conception and design of this protocol, participated in drafting and revising the manuscript for important intellectual content, approved the final version and agreed to be accountable for all aspects of the work in ensuring its accuracy and integrity. ARP: conceived the study, led on conceptualisation and methodology, developed the data curation and formal analysis plan, coordinated project administration and drafted the original manuscript. OAS: contributed to methodology and questionnaire design, led the recruitment strategy and contributed to manuscript review and editing. GL: contributed to critical revision and review of the manuscript. AO: contributed and led on the ethics application. KP: contributed to methodology development, validation of instruments and provided critical revision of the manuscript and questionnaires for important intellectual content. DD: provided supervision, oversight of methodology and resources and contributed to manuscript review and editing. ARP is the guarantor of this work.

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Patient and public involvement Patients and/or the public were involved in the design, conduct, reporting or dissemination plans of this research. Refer to the Methods section for further details.

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