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An evaluation of knowledge of circular economy among Therapeutic Radiographers/Radiation Therapists (TR/RTTs): Results of a European survey to inform curriculum design

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ABSTRACT

Introduction: Global warming and the increase in greenhouse gases are a current concern worldwide. The healthcare sector constitutes about 4.4% of all emissions. This study aims to evaluate the knowledge, awareness and attitudes of Therapeutic Radiographers/Radiation Therapists (TR/RTTs) regarding environment-related concepts to inform the development of educational curriculum.

Methods: A validated self-designed survey was distributed to TR/RTTs across Europe by the SAFE EUROPE partners and via social media between October 2021 and February 2022. The survey was divided into six sections: (i) demographics, (ii) knowledge of Circular Economy (CE) and Green Skills (GS), (iii) personal attitudes, (iv) TR/RTTs attitudes, (v) the importance of CE, and (vi) education. Questions consisted of mostly Likert scales complemented with other closed- and open-ended questions.

Results: 31%–42% of participants are aware of national and departmental policies in CE and GS concepts. Even though half of the participants considered that they advocate and practice CE, the open questions indicated that participants only focus on waste management, ignoring all the other dimensions of CE in healthcare. Personal attitudes and lifestyles also did not reflect CE.

TR/RTTs considered CE practices and GS development essential. However, the suggested academic level at which these skills should be developed was split between High School (44%) and Bachelor's degree (32%).

Conclusion: It is essential to raise awareness among TR/RTTs about the various dimensions of CE applied to healthcare: “green transportation”, “environment-friendly procurement”, “hospital building design”, “food process optimisation”, “water reduction”, “energy efficiency”, and “waste management”.

Implications for practice: These GS must be developed by TR/RTTs to decrease their impact on the environment. Their training may need to be lifelong, starting during basic high school education and continuing as healthcare professionals after graduation.

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Introduction

Climate change resulting from global warming represents a threat to life on Earth. Global warming is caused by emissions of air pollutants, especially greenhouse gases (GHG), which produce large-scale effects on the climate. Climate change includes increasing levels of carbon dioxide and short-lived climate pollutants, rising temperature, rising sea levels, and increasing extreme weather events, which greatly impact the population's health.[1,2]

Additionally, the healthcare sector is characterised by a large consumption of resources. In part because of infection control procedures, but also because of the linear economy paradigm which has been the status quo in this sector. The linear economic system, still used nowadays, follows a take-make-use-dispose model. This linear economic model is based on exploiting natural resources and converting them into waste in two ways: firstly, by eliminating natural assets from the environment, and secondly, by reducing capital value caused by pollution and waste. Continuous economic growth, production and consumption, as well as increasing resource output, represent the basis of the linear economic model.[3,4]

This long-lasting increase in emissions and resource use across all sectors, including healthcare, have dire consequences for the planet and its population. The increase in GHG in the atmosphere is directly associated with diseases such as lung cancer and ischemic heart disease, among others[5]; climate change is associated with effects on agriculture affecting food production and resulting in malnutrition[6]; and resource depletion affects access to essential goods, escalation of prices and ultimately disruption of services.[7]

As such, it is imperative to reduce emissions and resource use, including from healthcare systems, one of the major contributors to the climate crisis. It is considered one of the largest industries worldwide, with a carbon footprint corresponding to 4.4% of global net emissions.[2,8–10]

To allow a transition to a better balance between economic growth, environmental sustainability, and the population's well-being, the economic paradigm is changing from a linear to a circular economy (CE). In the European Commission's communication "Closing the loop", CE is defined as an "economy where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised".[11] CE also represents the most recent attempt to sustainably integrate economic activity and environmental well-being while decoupling economic growth from the negative consequences of resource depletion and environmental degradation.[12–15]

When referring to sustainability in hospitals and the application of CE to healthcare, common research themes include 'Green team', waste management, travel/transportation/telemedicine, procurement as well as green building, energy consumption/efficiency and alternative energy generation, food, water and behaviour.[16–29] The World Health Organisation (WHO) also identified seven key strategies for a climate-friendly hospital: energy efficiency, green building design, alternative energy generation, transportation, food, waste and water.[28]

Greening the European economy is a process that requires monitoring in particular of which skills are needed in which sector, which parties are providing the solutions to meet these skills, and what Europe needs to do to respond effectively and facilitate the transformation of the labour market to meet the demand for green skills (GS) or to help up- and re-skill workers through partnering with all stakeholders. It is crucial to ensure that the European workforce acquires the necessary skills to transition to a low-carbon and sustainable economy.[30,31]

Reports from the European Commission, European Economic and Social Committee, United Nations and OECD show the importance of the skills and knowledge needed to tackle climate change and ensure the transition to a greener economy.

GS had been defined by the Organisation for Economic Co-operation and Development as *"the knowledge, abilities, values and attitudes needed to live in, develop and* support *a sustainable and resource-efficient society"*.[32] According to the European Economic and Social Committee, "*Green skills and competences should be understood as those skills which society and the economy need in relation to the environment*".[33] The European Union commission (skills panorama) stated that "environmental awareness skills refer to the knowledge, abilities, values and attitudes needed to live in, develop and support a society which reduces the impact of human activity on the environment. These generic 'green' skills include the capacity to include environmental concerns alongside others (such as performance and safety) in taking decisions, including in the choice of processes and technologies".[34]

Specifically, this research focuses on the GS needs for TR/RTTs as part of a larger project aimed at understanding the educational needs of these professionals. Nevertheless, GS of TR/RTTs is a particularly understudied area despite the great contributions of radiotherapy (RT) to emission (e.g. large energy consumption by equipment and cooling systems) and resource use (e.g. equipment, consumables, water). Therefore, all professionals, such as Therapeutic Radiographers/Radiation Therapists (TR/RTTs), should acquire knowledge and awareness of environmental responsibility subjects. Therefore, research is vital to inform the key areas that need to be developed in professionals' education, which should apply transversally in all education sectors.[33] This research aligns with the European Union's vision on this subject.[31] Healthcare professionals also have a pivotal role in engaging administrators and policy-makers and raising awareness among patients.[2]

Aim and objectives

The aim of this project was to analyse the Therapeutic Radiographers/Radiation Therapists (TR/RTTs) knowledge and awareness of circular economy (CE) and green skills (GS) and their engagement with CE within hospitals across Europe. A secondary aim was to identify educational needs regarding CE and GS to inform the curriculum and the appropriate academic level at which these should be developed.

This research will inform managers, leaders, and policy-makers regarding the importance of adapting the education of TR/RTTs to the current context of global warming, climate change, and environmental sustainability.

Method

This study adopted a cross-sectional design. Data were collected through a European survey distributed to TR/RTTs between October 2021 and February 2022 as part of the SAFE EUROPE project.

SAFE EUROPE was a European-funded project that aimed to identify the educational gaps of European TR/RTTs and close those gaps by offering free webinars. The seven partners were Ulster University (project leader – UK), University of Malta (MT), Associação Portuguesa de Radioterapeutas (ART – PT), Polskie Towarzystwo Elektroradiologii (PTE – PL), Society of Medical Radiographers (SRM - MT), Instituto Portugues de Oncologia Porto (IPOP – PT), European Federation of Radiography Societies (EFRS – Europe-wide organisation). All information about the SAFE EUROPE project and the free webinars were available on www.safeeurope.eu.

Questionnaire design

To our knowledge, there was no tool available in the literature that captures the subject matter under study. The questionnaire was, therefore, self-designed based on a comprehensive literature review and was reviewed by a team of 8 experts, which consisted of academics, researchers and RTT clinicians. It comprised a mix of closed and open-ended questions, divided into three parts and six sections (Table 1).

The first part (Section I) of the survey recorded characteristics such as education level, age, gender, work experience and training (adapted from European Commission[35]). The second part of the survey (Sections II, III, IV, V) assessed the level of awareness of these professionals. These sections were mainly composed of Likert-scale questions complemented with multiple-choice and open questions. The third part (Section VI) identified educational needs and the appropriate academic level to develop them.

Population and sampling

The target population encompassed all TR/RTTs in Europe. However, to our knowledge, there is no European registry nor reliable information regarding how many TR/RTTs exist in Europe, making it impossible to access all TR/RTTs in Europe or to calculate the sample's power. Convenience sampling was used since the SAFE EUROPE partners distributed the survey to the TR/RTTs within their reach (including European-wide dissemination through the EFRS). All SAFE EUROPE partners distributed the questionnaire via email to their members following applicable General Data Protection Regulations (GDPR). The EFRS distributed the questionnaire to all its member organisations (40 professional and 60 educational organisations across Europe), who shared the survey to their members. In addition, all partners shared the survey on social media platforms (Twitter, Facebook, and LinkedIn).

Questionnaire validation

To test the validity of the proposed questionnaire, a group of five RT experts from the SAFE EUROPE consortium were invited to rate the relevance of each question using a four-point Likert scale from 1 to 4 (not relevant to relevant, respectively). Content validity was performed to ensure that the questions in the survey measured what was intended: knowledge and awareness of CE and GS.[36,37] The experts included 5 TR/RTTs with more than 15–35 years of experience but with a variety of expertise in the area of RT, such as education, research, treatment delivery, planning and physics. All the experts were chosen based on their practice and management skills.

The Item-Content Validity Index (I-CVI) and the Average Content Validity (Ave-CVI) were calculated. The Item-Content Validity Index (I-CVI) was calculated by adding together all questions rated 3 or 4 and then divided by the number of experts. An excellent content validity is achieved for I-CVI of 0.78 or higher. The minimum value obtained for I-CVI was 0.80. The formula to calculate the Ave-CVI consists of addind the I-CVI of each question and divide it by the total number of items and should be 0.90 or higher. The Ave-CVI value obtained was 0.95,[38] showing that experts agreed that the items were relevant to the study aims. Following the experts' feedback, minor amendments to the wording were made to the questionnaire.

To evaluate the reliability of the tool, a test-retest was performed by three TR/RTTs experts in clinical practice, who answered the survey twice (two weeks apart). The Cronbach alpha reliability coefficient of 0.918 showed the high reliability of the questionnaire.

These tests have therefore increased our confidence in the validity and reliability of the tool for this study's population.[39]

Internal consistency of sections was also measured through Cronbach's Alpha. They ranged between 0.735 and 0.946, demonstrating an acceptable level of internal consistency reliability (Table 2).

Data analysis

Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences IBM, v.28) and Microsoft Excel.

Categorical variables were summarized as frequencies and percentages. Chi-square or Fisher's exact tests were used to evaluate the association between two categorical variables.

All tests of statistical significance were two-sided; a p value < 0.05 was considered significant. Content analysis of open questions provides more details and complements the quantitative analysis. This content analysis identified significant data from a body of data provided by the open-ended questions. This data aimed to complement the quantitative data provided by the close-ended questions rather than draw conclusions on their own.[40]

Ethical considerations

Ethics approval was attained by the Institute of Nursing and Health Research Ethics Committee at Ulster University, Belfast (Project Number: FCNUR-21-068), which requires that GDPR and UK data protection laws are followed. A participant information sheet was provided, and a within-informed consent field was visible at the start of the survey. Participation was voluntary, and submission of the completed survey also offered implied consent. The information requested in section I (socio-demographic evaluation) was intentionally designed to avoid the identification of participants. In the information letter participants are informed that all data will be processed according to GDPR. The SAFE EUROPE partners distributed the anonymous online questionnaire to European TR/RTTs. The questionnaire was also available on the SAFE EUROPE social media (Twitter, Facebook and LinkedIn).

Table 1
The questionnaire is divided into three parts and six sections.

1st part
Section I–Socio-demographic details
2nd part
Section II–Knowledge of CE and GS
Section III –Personal/Individual attitudes towards CE practices
Section IV –TR/RTTs professional group attitudes towards CE practices within the working environment
Section V –TR/RTTs perception of the importance of CE
3rd part
Section VI –TR/RTTs perception regarding educational needs on CE and GS

Table 2
Internal consistency of the survey through Cronbach's Alpha.

Section	Cronbach Alpha	95% CI
II	0.735	0.668–0.785
III	0.745	0.665–0.802
IV	0.819	0.760–0.860
V	0.946	0.904–0.969
VI	0.894	0.847–0.923

Table 3
Total respondents by country.

Country	n	%
Albania	1	0.5%
Austria	8	4.2%
Belgium	9	4.7%
Bosnia and Herzegovina	2	1.1%
Croatia	12	6.3%
Denmark	3	1.6%
Estonia	1	0.5%
Finland	3	1.6%
France	2	1.1%
Georgia	2	1.1%
Greece	6	3.2%
Hungary	1	0.5%
Ireland	4	2.1%
Italy	1	0.5%
Latvia	4	2.1%
Lithuania	1	0.5%
Macedonia	2	1.1%
Malta	12	6.3%
Netherlands	6	3.2%
Norway	1	0.5%
Poland	9	4.7%
Portugal	71	37.4%
Romania	1	0.5%
Serbia	1	0.5%
Slovenia	1	0.5%
Spain	2	1.1%
Sweden	1	0.5%
Switzerland	6	3.2%
Turkey	1	0.5%
Ukraine	1	0.5%
United Kingdom	15	7.9%
Total	190 respondents 31 countries	100%

Results

Section I Socio-demographics

A total of 220 responses were obtained. Data were filtered to exclude non-European responses or those who do not work in a clinical setting, in keeping with the aim of the study. Therefore, 190 valid responses were analysed, representing 31 European countries (Table 3).

There was considerable variation in the number of respondents amongst the European countries. The total number of respondents ranged from 1 to 71, with a median value of two.

Table 4 summarises the demographic characteristics of the respondents, the area of specialism included in their educational training and the academic level required to practice RT (in the country where they studied).

All age groups are represented, with the age group between 31 and 40 years being the most represented (41%). With regards to gender, most respondents were female (74%).

The educational training programs include different structures allowing TR/RTTs to practice, with an extensive variation in their specialisation areas. Nevertheless, most respondents (74%) require a Bachelor's degree to practice, equivalent to European Qualifications Framework level 6 (EQF 6).

Section II Knowledge of circular economy and green skills

The awareness and knowledge of CE and GS were assessed on the survey. Some TR/RTTs knew what CE and GS meant (42.1% and 36.3%, respectively); around 20.0% neither agreed nor disagreed when asked about these terms; 35.8% and 42.6% were unaware of these concepts (Fig. 1).

Knowledge regarding CE and GS was not related to the country of training, country of practice, or the specialisms in the education programme (Table 5). However, it must be noted that there is an uneven distribution of the responses from the European countries, which affects this analysis.

About one-third of participants were aware of national and department environmentally friendly policies, 34.0% and 31.0%, respectively. However, the vast majority either were not aware or not sure (Fig. 1).

Section III Personal and individual attitudes towards circular economy practices

Regarding personal and individual CE attitudes, 52.1% of TR/RTTs answered that they practice CE in their daily routine. However, the remaining answers contradicted this statement.

The reported primary mode of transportation was internal combustion car (55.3%), followed by public transport (20.0%) and walking (12.6%). Also, when asked regarding CE daily practices, the answers were mostly related to waste separation, recycling and reuse, showing that their knowledge is limited to this dimension of CE. Participants stated that they stay informed about environmental activities at their hospital (42.6%) and encourage their colleagues to take sustainability actions (59.5%).

Section IV TR/RTTs professional group attitudes towards circular economy practices within the working environment

TR/RTTs' perception of the professional group attitudes was that almost half of TR/RTTs advocate CE practices in their daily practice, consistent with individual and personal attitudes. Moreover, 47.9% of TR/RTTs consider that their behaviour and attitudes emphasise GS and competencies.

However, similar to their perceptions of personal attitudes, thematic analysis of answers regarding CE practices by the professional group showed that their understanding is focused on waste management. Furthermore, when evaluating the level of agreement with the sentence TR/RTTs behaviour and attitudes underline green skills and competencies, 37.9% neither agree nor disagree, showing that there is still a considerable amount of TR/RTTs who do not fully apply environment-friendly practices. While only a minority (11.6%) "completely agree" that CE and GS are fully implemented (see Fig. 2).

Section V TR/RTTs perception of the importance of the circular economy

TR/RTTs were almost unanimous in respect to the importance of environmental issues, that they must be conscious of the consequences of climate change, and that hospitals must have environmental goals. A minority of respondents disagree with these statements (Fig. 3).

Section VI TR/RTTs perception regarding educational needs

In terms of perception regarding educational needs, TR/RTTs considered environmental training important, that these skills must be a concern of this professional group, and green skills must be part of the TRs/RTTs' education. Furthermore, it was identified that they would like to know more about CE and GS (Fig. 4).

The participants' scores regarding the importance of CE (section V) are related to their perception of educational needs ($p < 0.001$).

Although respondents focused on waste management previously, all dimensions of CE identified in the literature were considered "essential" or "completely essential" to be developed by TR/RTTs by most of the participants (Fig. 5).

Table 4
Demographics of the respondents.

Socio-professional demographics		n (N = 190)	%
Gender	Female	140	74%
	Male	49	26%
	Prefer not to declare	1	0%
Age	<20	0	0%
	20–25	13	7%
	26–30	47	25%
	31–40	78	41%
	41–50	33	17%
	51–60	16	8%
	≥61	3	2%
Area of specialism included in education training	Radiotherapy	106	56%
	Radiotherapy; Medical Imaging/Diagnostic; Nuclear Medicine	37	19%
	Radiotherapy; Medical Imaging/Diagnostic	16	8%
	Medical Imaging/Diagnostic	10	5%
	Radiotherapy; Medical Imaging/Diagnostic; Electrophisiology	7	4%
	Radiotherapy; Medical Imaging/Diagnostic; Sonography	4	2%
	Radiotherapy; Nuclear Medicine	4	2%
	Radiotherapy; Medical Imaging/diagnostic; Electrophisiology	2	1%
	Nuclear Medicine	2	1%
	Nuclear Medicine; Medical Imaging/Diagnostic	1	1%
	Nursing	1	1%
Academic level that allows to practise RT (in the country of study)	EQF4 –High School (Secondary level course)	4	2%
	EQF5 –Post-high school education (short higher education programme)	11	6%
	EQF6 –BSc (Bachelor's degree)/Degree course	140	74%
	EQF7 –MSc (Master's degree)	30	16%
	EQF8 –PhD (Doctoral degree)	5	2%

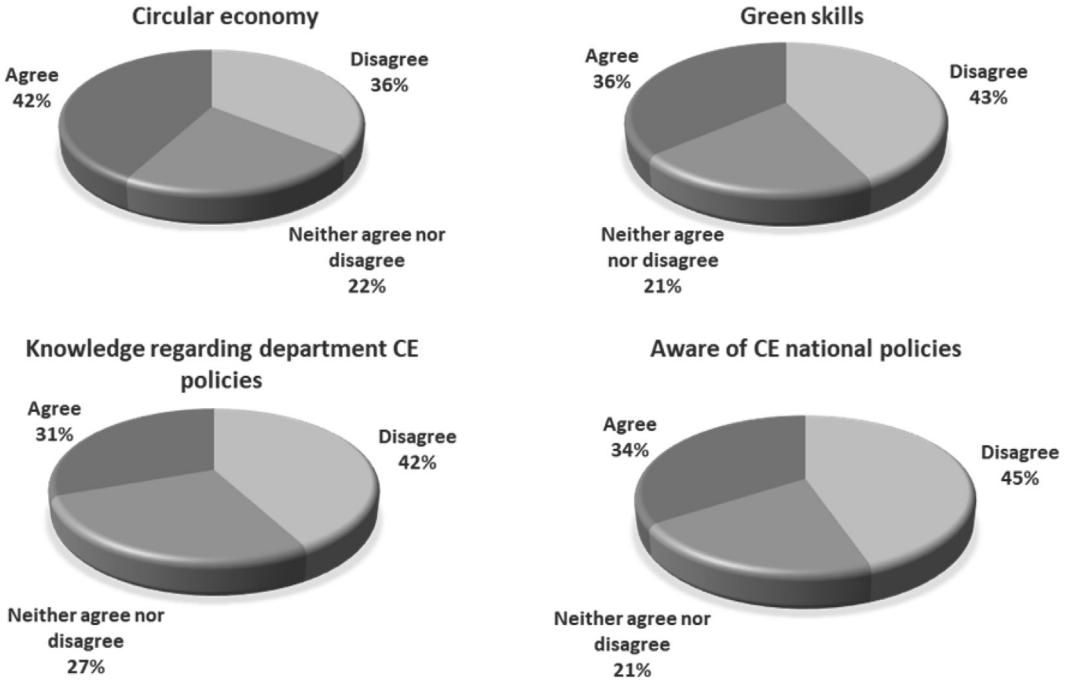

Figure 1. Knowledge of circular economy (CE) and department CE policies, and awareness of green skills and CE national policies.

TR/RTTs considered that the most appropriate academic level to learn about CE and GS is high school, followed by the Bachelor's degree, as seen in Fig. 6.

Discussion

To our knowledge, this is the first study assessing TR/RTTs' knowledge of CE and GS, which is relevant to professional practice across Europe, identifying their educational needs in this area. These results can inform curriculum design and the appropriate academic level at which they should be developed.

The response rate (190 valid replies) and countries represented (31 countries) allow us to have a good level of confidence that the results of this study paint an accurate picture of the European situation as aimed by this study, which is part of the SAFE EUROPE project.

Even though the characteristics of the population are not well known, the respondents' demographics represent what we would

Table 5
Relationship between socio-demographic factors and knowledge of the concepts of CE and GS. P-values from the chi-square test.

		Knowledge	
		Circular Economy	Green Skills
Socio-demographic	Country where obtained the academic level	p = 0.245	p = 0.403
	Country currently working	p = 0.176	p = 0.332
	Area/specialism included in the educational training	p = 0.555	p = 0.730

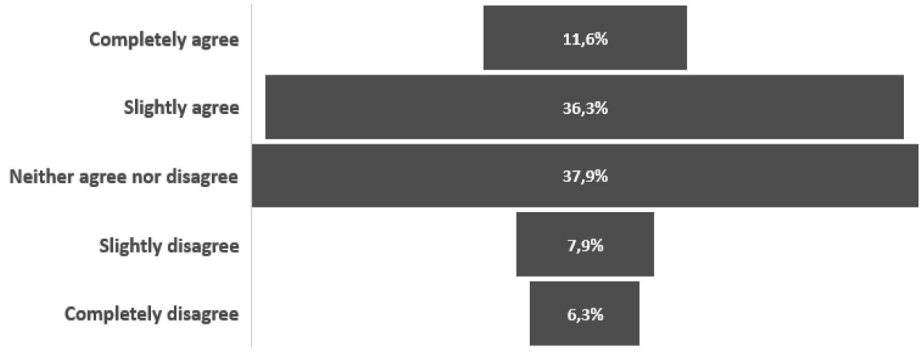

Figure 2. Likert-scale result from the question: "TR/RTTs behaviour and attitudes underline green skills and competencies".

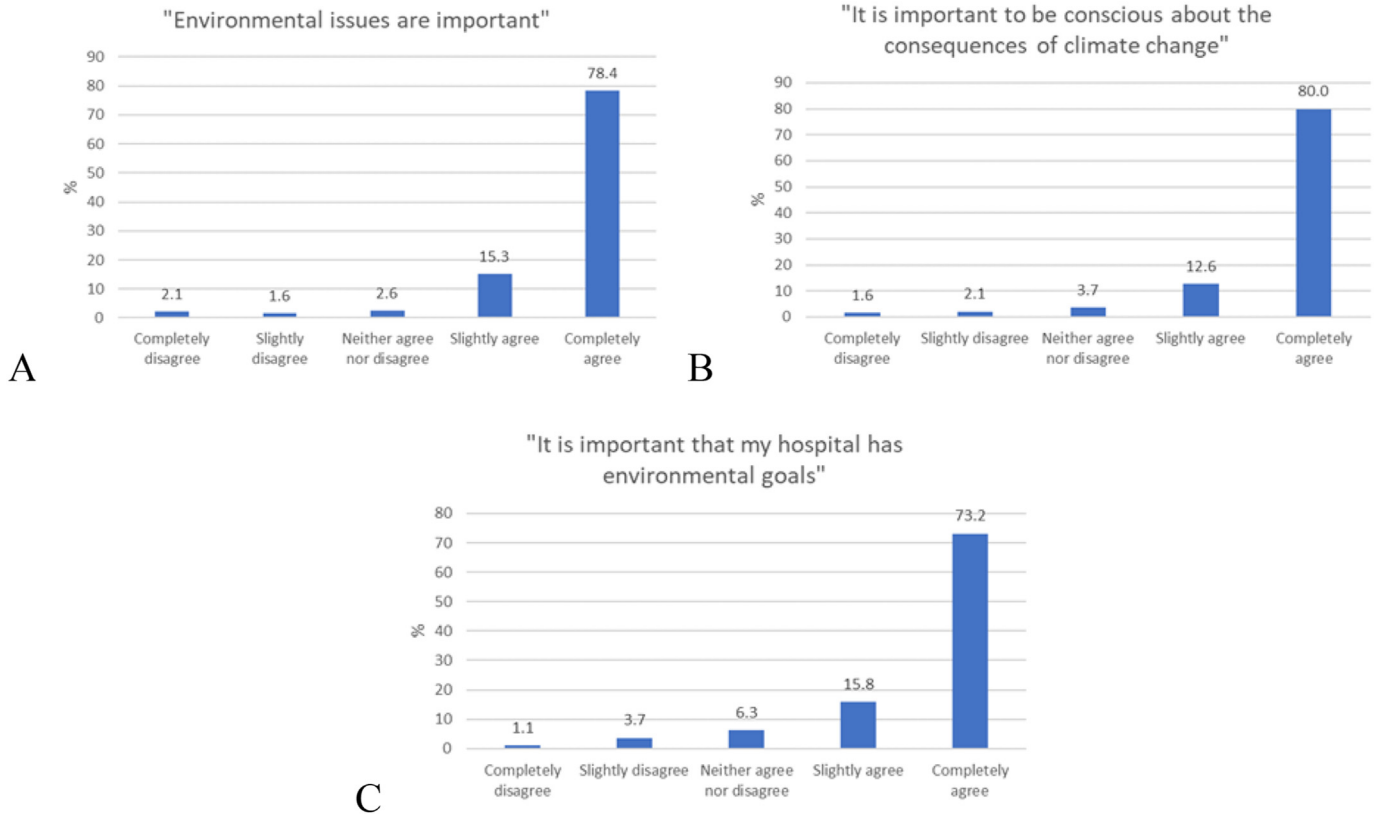

Figure 3. a–c – Levels of agreement with statements regarding the importance of environmental issues.

expect of the RT professionals across Europe: mostly female, between 26 and 50 years old, with a BSc degree but with a variety of specialisms in their education.[41,42]

The knowledge of the "circular economy" and "green skills" concepts and the awareness of national and institutional environmental-friendly policies was incomplete. Only 31%–42% of participants were aware of these concepts and policies, meaning that most of respondents, 58%–69%, do not know or are not sure about these concepts. This may be because these concepts are not yet fully applied to healthcare, as demonstrated by the scarce literature on the topic of environment-friendly practices in healthcare[20,21,25,27,28,43–46] and the complete inexistence of

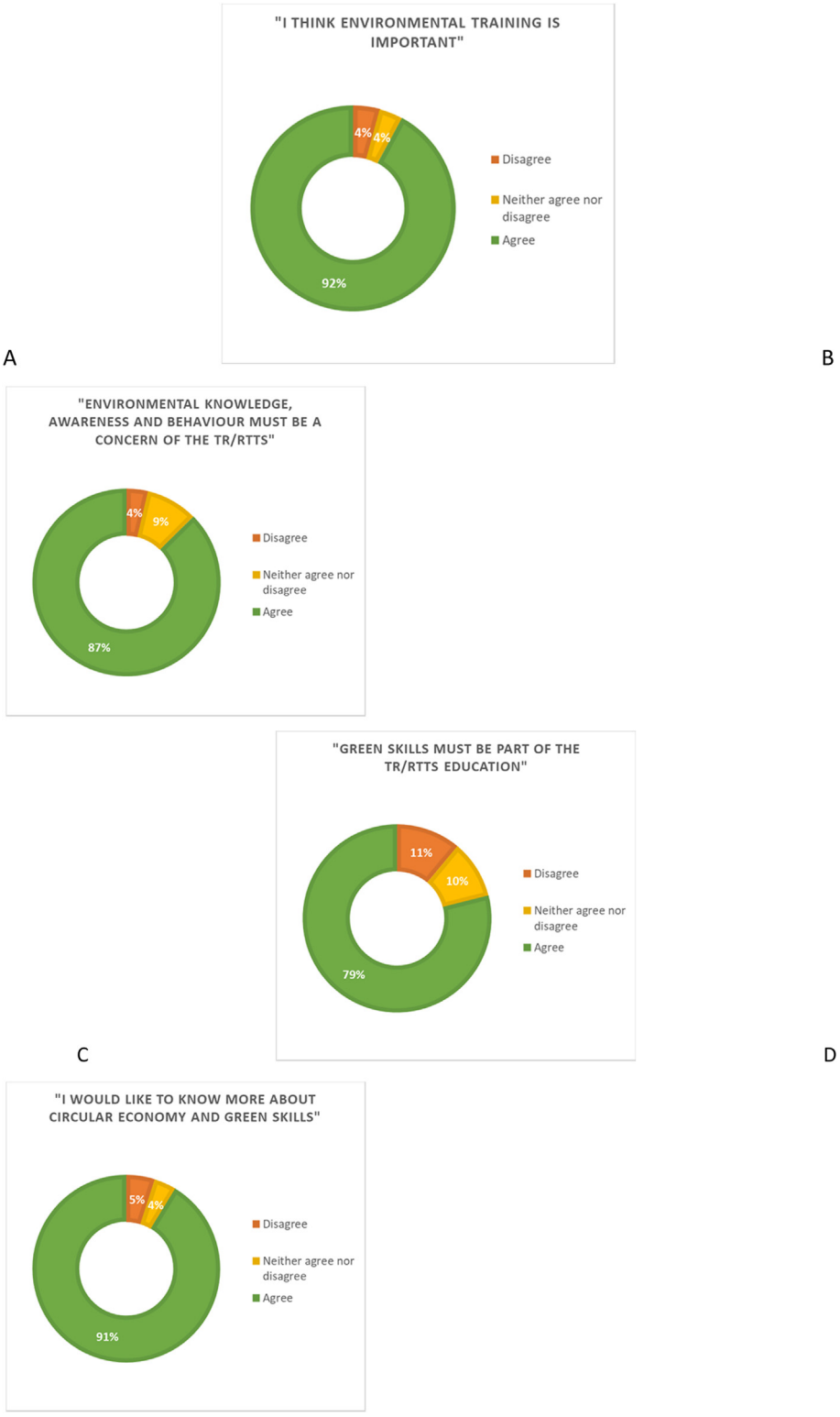

Figure 4. a–d – Levels of agreement with statements regarding the educational needs of TR/RTTs regarding CE and GS.

literature about its application to RT. As such, it is not surprising that these professionals are unaware of these concepts. It can also be hypothesised that professionals who knew about these concepts became familiar with them by searching for information as part of their personal interests rather than through their professional development.

About half of the participants stated that they advocate and apply CE practices as part of their individual practice and as a professional group. Importantly, this means that half of the respondents do not consider that they practice CE.

In addition, the open questions showed that their awareness of CE practices is limited to waste management (reuse, reduce,

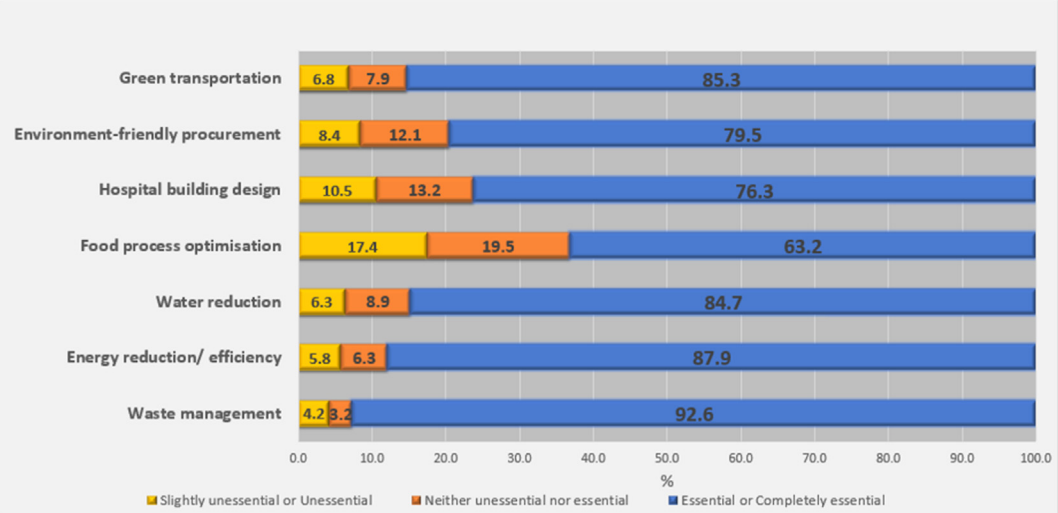

Figure 5. Topics of climate change mitigation in healthcare.

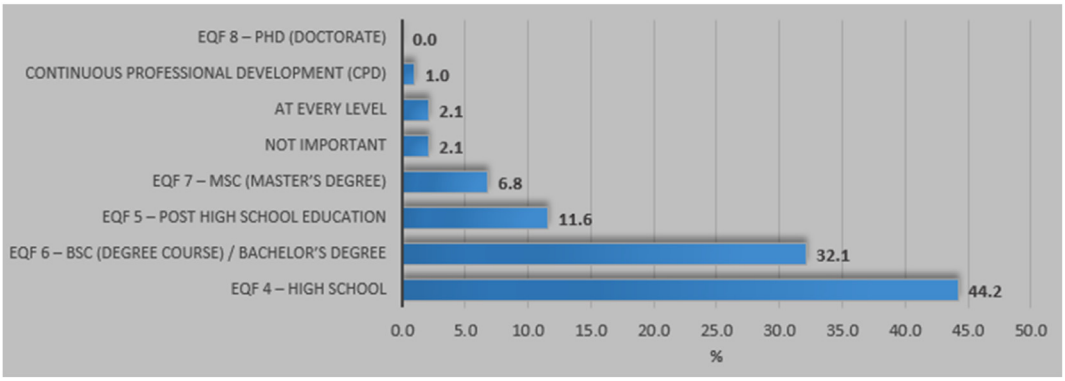

Figure 6. Most appropriate academic level to learn about circular economy and green skills.

recycle). As such, the other dimensions of CE applied to healthcare found in the literature are not well known to these professionals: "green transportation", "environment-friendly procurement", "hospital building design", "food process optimisation", "water reduction", "energy efficiency" and establishment of a "green team".[12,14,47] Also, their practices contradict their perception of their contribution to the environment; for example, most participants use internal combustion cars as their primary transportation mode (the most polluting mode of transportation).

Despite the apparent lack of awareness and knowledge, most participants agree that environmental issues are relevant for them as individuals, professionals, and the institutions where they work.

The clear majority of participants agree that TR/RTTs should develop GS. As expected, participants who think environment-friendly practices are important also think that TR/RTTs' education about the topic is essential.

Therefore, it may be concluded that it is essential to address this need for GS and the lack of knowledge and awareness of sustainable practices by upskilling TR/RTTs, providing them with the necessary competencies to apply sustainable strategies in their hospitals and departments. TR/RTTs may benefit from training on sustainable practices in healthcare as well as other sectors. Upskilled TR/RTTs can then develop new ways to reduce the carbon footprint in their departments.

The topics considered most essential were "waste management", "energy efficiency"," green transportation", and "water reduction". "Food process optimisation" was considered the least essential, possibly since TR/RTTs have a minimal role in these procedures inside the hospital. However, 63% of RTTs still considered this essential or completely essential perhaps due to its relevance as part of their personal contribution to the environment. Nevertheless, it seems that the first step is to increase awareness among TR/RTTs regarding the different dimensions where this professional group can improve healthcare contributions to the environment beyond the "waste management" dimension of CE applied to healthcare.

Green skills should be developed at the high-school level (EQF4) (44% of responses) or the Bachelor's level (EQF6) (32% of responses). This split could be explained by the fact that these competencies may need to be developed "at every level", as mentioned in the open questions by four participants. A suggestion is that general GS may be taught during basic mandatory education,[48] and specific healthcare CE practices may be taught during their training as healthcare professionals.

Limitations

Only 31 of 44 European countries are represented, and only 190 valid responses from the vast population of TR/RTTs in Europe were

achieved. RTTs may be unaware of the application of CE and GS in their daily practice and, therefore, not be inclined to answer the survey. Another possible explanation is that despite the best efforts to distribute the survey across all European countries through the SAFE EUROPE partners (including EFRS as a European-wide partner) and social media, not all TR/RTTs had access to the survey. Lastly, online surveys also tend to have a relatively low response rate. However, this method was selected since it efficiently allows data collection across such a large geographic area.

The answers are not equally distributed across European countries. For example, Portugal was over-represented (71 respondents – 37.4%), which may have influenced the results. This uneven distribution of responses is a common weakness of international studies that affects the data analysis; therefore, it should be avoided in future studies.

Convenience sampling was used since only members of the professional organisations or those with access to the SAFE EUROPE consortium media feed could participate in the survey. However, due to the broad dissemination reach and significant European representation (31 countries), there is high confidence that the results reflect the overall picture of European TR/RTTs.

Surveys naturally suffer from respondent bias since people interested in the topic have a greater enthusiasm to participate in the studies, while it is challenging to collect data from the population who are not interested. However, since only 36%–42% of respondents knew what CE and GS are, the survey gathered data from people who may not be knowledgeable about the topic.

The self-designed survey was tested for reliability with this study's population. However, the tool should be revalidated if used in another population.

Conclusions

TR/RTTs' knowledge and awareness of CE and GS are incomplete, but they consider these topics essential to be developed by these professionals. It is crucial to develop an awareness of the application of CE to healthcare beyond “waste management”, so these professionals are aware of how they can improve their practice in other domains: “green transportation”, “environment-friendly procurement”, “hospital building design”, “food process optimisation”, “water reduction”, and “energy efficiency”.

This study was the first step in the research of sustainability in RT, showing that TR/RTTs are ready and motivated to apply, but further research is necessary to identify what aspects of circular economy and other sustainable strategies can be applied in RT. As such, the key recommendation is to keep researching this topic. Specifically, it is imperative to understand how CE and other sustainable strategies apply to RT and the barriers to their application.

TR/RTTs training is a lifelong process. Some underdeveloped skills or competencies can be acquired as part of basic mandatory education, during and after graduation, such as part of Continuous Professional Development (CPD). This education would allow them to adapt their practice to be more sustainable.

Conflict of interest statement

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radi.2022.12.006.

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