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# Currents in Pharmacy Teaching and Learning

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## Do Swedish universities educate future doctors and pharmacists about the environmental impact of pharmaceuticals?

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### ABSTRACT

**Objectives:** Residues of pharmaceuticals, originating from production, distribution or consumption, reach the environment where they have negative consequences on ecosystems. Educating future physicians and pharmacists could promote more environmentally friendly decisions throughout the life-cycle of pharmaceuticals. The aim of this cross-sectional study was to describe how pharmaceuticals in the environment was integrated into Swedish universities' medicine and pharmacy educations.

**Methods:** The study was conducted November–December 2022 and consisted of two parts; i) a review of program curricula for medicine and pharmacy programs in Sweden and ii) a questionnaire distributed to course managers at pharmacy programs, and to program managers at medicine programs. Multiple-choice questions were analysed with descriptive statistics. Open-ended questions and program curricula were assessed qualitatively with content analysis.

**Results:** Pharmaceuticals in the environment was mentioned in the general learning objectives aligned with the Higher Education Ordinance, but content related to environment was only included in curricula for some courses, mainly regarding sustainable development. A total of 47/100 pharmacy course managers and 6/7 medicine program managers responded to the questionnaire. 19/47 pharmacy course managers and 6/6 medicine program managers indicated that their courses include aspects of pharmaceuticals in the environment. The most common areas in pharmacy courses were sustainable drug use, and sustainable drug manufacturing/development. **Conclusions:** Sweden's medicine and pharmacy programs contain some education about environmental impacts of pharmaceuticals but the curricula could be developed further. There is room for improvement in integrating environmental themes throughout the programs, potentially as an interprofessional education with a life-cycle perspective of pharmaceuticals.

### Background

Pharmaceuticals in the environment is of an emerging global concern with implications for both ecosystems and human health.

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Pharmaceuticals can enter the environment during different stages of their product life-cycle.<sup>1</sup> Already in the 1970s, compounds such as acetylsalicylic acid and its metabolites were detected in effluent water discharged from sewage treatment facilities in Kansas City, USA.<sup>2</sup> A large number of studies have been published since, and in 2022, a study examining pharmaceutical concentrations in 258 rivers across 104 countries revealed that more than 25 % of the examined rivers had concentrations of at least one active pharmaceutical compound exceeding levels considered to be safe for aquatic organisms or in terms of antimicrobial resistance (AMR).<sup>3</sup> The release of pharmaceuticals into the environment can have serious consequences, including antibiotic resistance and disturbances within entire ecosystems. One notable example occurred in the 1990s when vultures in India and Pakistan faced severe population decline due to the ingestion of livestock treated with diclofenac.<sup>4</sup> Another example involves 17 $\alpha$ -ethinyl estradiol, a hormonal contraceptive pharmaceutical, which has been linked to the feminisation of male fish, leading to reduced reproductive capabilities and declined populations.<sup>5,6</sup>

Healthcare professionals can play an active role in mitigating pharmaceutical pollution within their roles in healthcare and within the domains of research, governance and policy. Two of these professions are physicians and pharmacists. Within the healthcare setting, they can contribute to reducing the environmental impact of pharmaceuticals in several ways. Physicians can for instance contribute by considering non-pharmacological management when relevant and by prescribing medicines with a lower environmental impact.<sup>7</sup> In many countries, pharmacists are allowed some prescribing authority, enabling them to contribute in similar ways as physicians by prescribing less environmentally impactful medicines.<sup>8</sup> Pharmacist-led initiatives have also shown to substantially improve antibiotic prescribing practices when included as part of hospital antimicrobial stewardship programs (ASP) and to reduce the overall medicine consumption in deprescribing programs.<sup>9,10</sup> Both professions can thus contribute to reducing waste by optimising volumes prescribed and dispensed, and also by including environmental aspects of medicines in guidelines and procurement decisions.<sup>11,12</sup>

The ubiquity of pharmaceutical residues in our ecosystems, stemming from their manufacturing, widespread use, and improper disposal, demands a comprehensive understanding of the life-cycle of pharmaceuticals, their impact on the environment and how pharmaceutical contamination in the environment can be reduced. It also requires a holistic approach, integrating environmental consideration into decision-making. A few years ago, a revised definition of the rational use of medicines was proposed by Orive et al., describing rational use as providing “medications appropriate to [patients] clinical needs, in doses that meet their own individual requirements for an adequate period of time, at the lowest cost to them and their community, considering the interconnection between people, animals, plants, and their shared environment”.<sup>13</sup> For this shift to happen, healthcare professionals need better understanding of for instance, preventive medicine, ecotoxicology and concepts of rational use of drugs. There is also a need for better access to information available on the environmental hazard and risk of pharmaceuticals. In Sweden, two knowledge support systems provide such information (Janusinfo.se and Fass.se).<sup>14,15</sup> These systems are, e.g., used by the Drug and Therapeutics Committees to consider environmental aspects of pharmaceuticals in their treatment recommendations.<sup>16,17</sup>

Education is instrumental for change by enhancing individuals' knowledge and competence, enabling their participation in decision-making processes, as well as promoting sustainable development.<sup>18</sup> International bodies acknowledge the need for increased training for healthcare professionals on the environmental impact of pharmaceuticals, including AMR. For instance, WHO has created education and training of health workers on AMR and rational use of medicines,<sup>19</sup> and the International Pharmaceutical Federation (FIP) suggests the inclusion of environmental aspects of pharmaceuticals in pharmaceutical education.<sup>20</sup> Furthermore, the European Commission emphasised the need to include environmental aspects of pharmaceuticals in medical training to support the implementation of best practices<sup>21</sup> and acknowledges the importance of universities for promoting green transition.<sup>22</sup>

While education can play a central role in empowering future professionals to mitigate emissions and risks linked to pharmaceutical residues in the environment, there are only a few studies that have examined the extent to which universities have addressed the environmental aspects of pharmaceuticals.<sup>23,24</sup> This study seeks to investigate if the educational programs of medicine and pharmacy offered by Swedish universities include aspects of environmental impact of pharmaceuticals. Recognising knowledge gaps in education could lay a basis for transforming these educations to meet future skills needed, e.g., to develop pharmaceuticals that are more environmentally friendly or to promote rational use of medicines, taking environmental aspects into account when possible. Overall, this could contribute to reducing the environmental footprint associated with pharmaceuticals while ensuring the highest quality of care.

## Methods

This cross-sectional study consisted of two parts; a text analysis of program curricula for medicine and pharmacy programs offered

**Table 1**

Overview of educational programs included in the study and the corresponding Swedish universities that offered them (in second half of 2022).

Educational program	University
Medicine program	Karolinska institutet, Linköpings University, Lunds University, Umeå University, University of Gothenburg, Uppsala University and Örebro University.
Pharmacy program (MSc)	University of Gothenburg, Uppsala University, and Umeå University.
Pharmacy program (BSc)	Linneaus University (Kalmar), University of Gothenburg, Uppsala University, and Umeå University.

at Swedish universities, and a questionnaire distributed to course- and program managers in universities teaching medicine and pharmacy in Sweden (Table 1). This difference in target groups is explained by difficulties in identifying specific courses within medicine programs that could be relevant for the subject of pharmaceuticals in the environment, while within pharmacy programs it was assumed that most courses could be relevant.

### *Review of program curricula*

For the text analysis, official program curricula for the autumn of 2022 were downloaded from the website of each university's medicine program<sup>25–31</sup> and pharmacy program.<sup>32–37</sup>

The program curricula examined were built upon two sources for learning objectives, 1) general learning objectives based on the Swedish Higher Education Ordinance (SFS No. 1993:100),<sup>38</sup> ensuring consistency in higher education programs given in Sweden and 2) local learning objectives at programs that are specific to each university, allowing them to tailor their curricula to address unique objectives and student needs. The review of program curricula focused on examining the program learning objectives at the time of the study with a specific emphasis on identifying content related to the environmental aspects of pharmaceuticals. This process consisted of thoroughly reading through the program curricula documents at least once. As it was not expected to identify specific learning objectives about pharmaceuticals in the environment, a more lenient approach was taken to include objectives that could be deemed relevant. Consequently, the review included a range of terms such as sustainability, sustainable development, ecology, environment, One Health and rational use of drugs, respectively.

The review of program curricula and text analysis was conducted by the first author and was discussed with the other authors to determine the relevance of the identified content to the subject of pharmaceuticals in the environment.

### *Questionnaire development and data collection*

Two different questionnaires, for the programs within medicine and pharmacy, respectively, were developed specifically for this study. Initial in-depth interviews were held with five individuals as a sounding board when developing the structure and content of the survey. These individuals represented different universities or regional health care governance, and had extensive experience of higher education, toxicology, pharmacology, and sustainable development. Furthermore, both questionnaires were pilot tested by three lecturers employed at Uppsala University. The pilot respondents were provided with links to the questionnaires along with questions that addressed the introduction to the questionnaires; the time it took to complete; the intelligibility of the questions; the order and number of close-ended vs. open-ended; and any other comments.

The target group for the questionnaires included program managers for the medicine programs and course managers within the pharmacy programs. Contact information was obtained through the official websites for each program. To identify course managers at the pharmacy programs, electronic mail was sent to pharmacy program managers or to request a list of the course managers. It is worth noting that some pharmacy course managers were responsible for multiple courses within the same university.

The final questionnaires consisted of a brief introduction and 15 questions for medicine program managers and 16 questions for pharmacy course managers (translated questions are available in Supplement 1). A mix of multiple-choice, close-ended, and open-ended questions were used to gather insights into whether aspects of pharmaceuticals in the environment were included in the program/course and if so, gather a brief description of what was taught in them. The questionnaire to the program managers included a question on what courses included aspects on pharmaceuticals in the environment and the questionnaire to the course managers at the pharmacy program included a question inquiring about the specific course(s) for which the course managers were responsible for. The objective was to investigate which aspects related to the environmental impact of pharmaceuticals were incorporated into different subjects.

To compile attitudes from program and course managers regarding whether they were interested in strengthening the teaching about pharmaceuticals in the environment within their program/course curriculum, Likert scale questions were employed. Web questionnaires were distributed using Kurt® – a software for conducting surveys constructed by Uppsala University.<sup>39</sup>

The main respondents for the questionnaires were notified through electronic mail and two reminders. The questionnaires were distributed between the 15th of November 2022 and the 4th of December 2022.

### *Questionnaire data analysis*

A descriptive analysis was conducted on data originating from the questionnaire, stratified by pharmacy and medicine program. Results for multiple-choice questions and likert scales were presented as proportions or numbers of respondents. The question inquiring about the specific course(s) that course managers in pharmacy were responsible for was categorised into different subject areas according to Aktinson, 2014.<sup>40</sup> All data was compiled using Microsoft Office 365 Excel® version 2212.

The analysis of the free-text statements in the questionnaire was completed using a simplified qualitative content analysis.<sup>41</sup> First, we deductively defined preliminary categories based on the aspects covered by the standardised questionnaire. Following, free-text statements regarding what students were taught about were summarised in codes that were allocated to the categories. Lastly, the main overarching themes were defined. Additionally, the emerging themes were compared to one another to avoid overlapping or duplication of responses.

## Results

### Text analysis of program curricula

#### Medicine programs

All program curricula of the seven medicine programs in Sweden were publicly accessible through the internet, published by each university. Two general learning objectives based on the Higher Education Ordinance were related to the environmental aspects of pharmaceuticals; societal determinants of health at individual and population levels, nationally and globally, and health-oriented and disease prevention. In addition, three out of the seven medicine programs' curricula (University of Gothenburg, Karolinska Institutet and Linköping University) had local learning objectives relating to environmental aspects of pharmaceuticals, see Table 2. No local learning objectives related to pharmaceuticals in the environment were identified in the medicine programs of the four remaining universities.

#### Pharmacy programs (MSc, BSc)

All program curricula of the pharmacy Master of Science and Bachelor of Science programs in Sweden except one were published by the universities and publicly accessible on the internet. The remaining curriculum was requested through email, but sufficient documentation for text analysis was not provided.

Out of the general learning objectives based on the Higher Education Ordinance, only one was related to environmental aspects of pharmaceuticals focusing on the rational and optimal use of pharmaceuticals (Table 3). In addition, two universities had local learning objectives related to environmental aspects of pharmaceuticals; 1) sustainability in drug development, production, sale, and use in the master's program at the University of Gothenburg and 2) sustainable development in the field of pharmaceuticals in both pharmacy programs at Uppsala University, see Table 3. No local learning objectives related to pharmaceuticals in the environment were included in the pharmacy programs of the two remaining universities.

### Questionnaire to program and course managers

#### Medicine programs

**Response rate and participants.** Six of seven program managers completed the questionnaire, which resulted in a response rate of 86 %. Two program managers, upon receiving the questionnaire, forwarded it to individuals within the program with greater knowledge about the program curriculum.

**Responses to the main questions.** All six participants indicated that their medicine programs included education about the environmental impacts of pharmaceuticals. Three universities claimed that they included environment in two or more courses. When asked how the students were taught about environmental impacts of pharmaceuticals, 1/6 was unsure, 5/6 indicated that the students were given lectures, and 4/6 indicated that the students were also given case studies, seminars, workshops or did own research on a topic. When asked if students were taught what they, in their future professional role as physicians, could do to reduce the environmental impacts of pharmaceuticals, four program managers answered yes and two indicated that they did not know. When asked about knowledge support systems containing environmental information, five out of six indicated their medicine program included education about them, and one program manager was unsure.

**Exploring attitudes of program managers.** Half of the participants ( $n = 3$ ) had a high or considerable interest in further developing the

**Table 2**

Identified learning objectives during text analysis (translated from Swedish) in the **medicine** programs curricula related to environmental aspects of pharmaceuticals.

University	General learning objectives	Local learning objectives
All programs <sup>a</sup>	Demonstrate knowledge of and understanding for societal conditions that influence the health of individuals and groups from a national and global perspective	
	Demonstrate the ability to initiate and undertake health promotion and preventive measures in the healthcare services	
University of Gothenburg		Show knowledge of <b>sustainable development</b> from a health perspective, connect to <b>planetary health</b> , and identify health synergies sustainability work in healthcare
Linköping University		Work for <b>sustainable</b> , health-promoting development for current and future generations
Karolinska Institutet		Emphasises a paramount <b>global health</b> perspective

<sup>a</sup> Karolinska institutet, Linköpings University, Lunds University, Umeå University, University of Gothenburg, Uppsala University and Örebro University.

**Table 3**

Identified learning objectives during text analysis (translated from Swedish) in the **pharmacy** programs (MSc and BSc) curricula related to environmental aspects of pharmaceuticals.

University	General learning objectives	Local learning objectives
All programs <sup>a</sup>	Show in-depth knowledge of drug information, drug counselling, and drug evaluation for <b>rational and optimal</b> drug use	
University of Gothenburg Uppsala University		Master's program: Account for, reflect on, and propose measures for <b>sustainability</b> in drug development, production, sale, and use Both programs: Demonstrate knowledge of <b>sustainable development</b> in the field of pharmaceuticals

<sup>a</sup> Linneaus University (Kalmar), University of Gothenburg, Uppsala University, and Umeå University.

subject of pharmaceuticals in the environment within their respective medicine programs, while the remaining three were either less interested or unsure. Similarly, when asked about their interest in participating in a workshop focused on the environmental impacts of pharmaceuticals, the responses were split in the same manner (Fig. 1A).

*What were students taught about and in which courses?* There was some variation between medicine programs regarding which courses included content on the environmental impacts of pharmaceuticals. Three universities incorporated this into either the pharmacology course or into the clinical pharmacology course. Other courses that were mentioned were a course in occupational medicine, two basic sciences courses [e.g. pharmacology and infectious diseases], clinical introduction and professional development. One university did not mention any specific courses. Topics mentioned included different drug groups with known environmental impacts such as Non-Steroidal Anti-inflammatory drugs (NSAIDs) and estrogens, education on negative environmental effects associated with manufacturing processes and drug residues and how to reduce pharmaceuticals entering the environment, antibiotic stewardship to reduce AMR, and practical training of using knowledge support systems containing environmental information of pharmaceuticals. Additionally, the importance of healthcare professionals' awareness of the problem was emphasised.

*What support did program managers suggest to further develop their educations?* Program managers were asked to suggest what would support further developing the topic of pharmaceuticals in the environment. Of the participants, 4/6 did not answer, were unsure or did not provide a clear answer. The following suggestions were given by the remaining two respondents:

- See examples on how others do
- Recorded short lecture on how Swedish authorities and regional healthcare work to minimise climate and environmental impact linked to pharmaceuticals, nationally and globally

### Pharmacy programs

*Response rate and participants.* Contact was established with three out of four universities providing pharmacy education. Consequently, no information about the number of courses was received for one university and the analysis was therefore based on the remaining three universities. In total, 100 course managers received the questionnaire and 47 of them responded, resulting in a response rate of 47 %. These course managers represented a total of 76 individual courses. Close to half of the participants (22/47) were course managers for courses only within the MSc programs. The remaining participants consisted of 16 course managers for courses only within the BSc program from three universities and 9 were course managers for courses within both programs.

*Responses to the main questions.* A total of 19/47 (40 %) of all managers stated that their courses included education on environmental aspects. These program managers represented all pharmacy programs at the universities where contact was established. Furthermore, 13 of these 19 indicated that the students were taught in their course(s) about what pharmacists could do in their future professional roles to reduce the environmental impacts of pharmaceuticals (Fig. 1B).

Among the 19 participants who responded that their courses included education on environmental aspects, a majority (12/19) indicated that their courses did not include content about knowledge databases containing environmental information (Fig. 1B). When asked how the students were taught about environmental impacts of pharmaceuticals, 16/19 indicated that the students were given lectures, and 10/19 indicated that the students were offered for instance seminars, workshops or a written assignment.

*Exploring attitudes of course managers.* 46 out of the 47 participating course managers answered questions exploring their attitudes. Half of them ( $n = 23$ ) expressed a high or considerable interest in further developing the existing education about the subject or including education for the first time in their course content (Fig. 1C). However, 18 managers indicated low or no interest and five were unsure. Additionally, when asked whether the participants would be interested in attending a workshop focused on pharmaceuticals in the environment, a majority of 26 out of 45 course managers that answered the question indicated high or considerable interest, while 11 indicated little to no interest and eight were unsure.

*What were students taught about and in which courses?* Participants whose courses included education about the environmental impacts

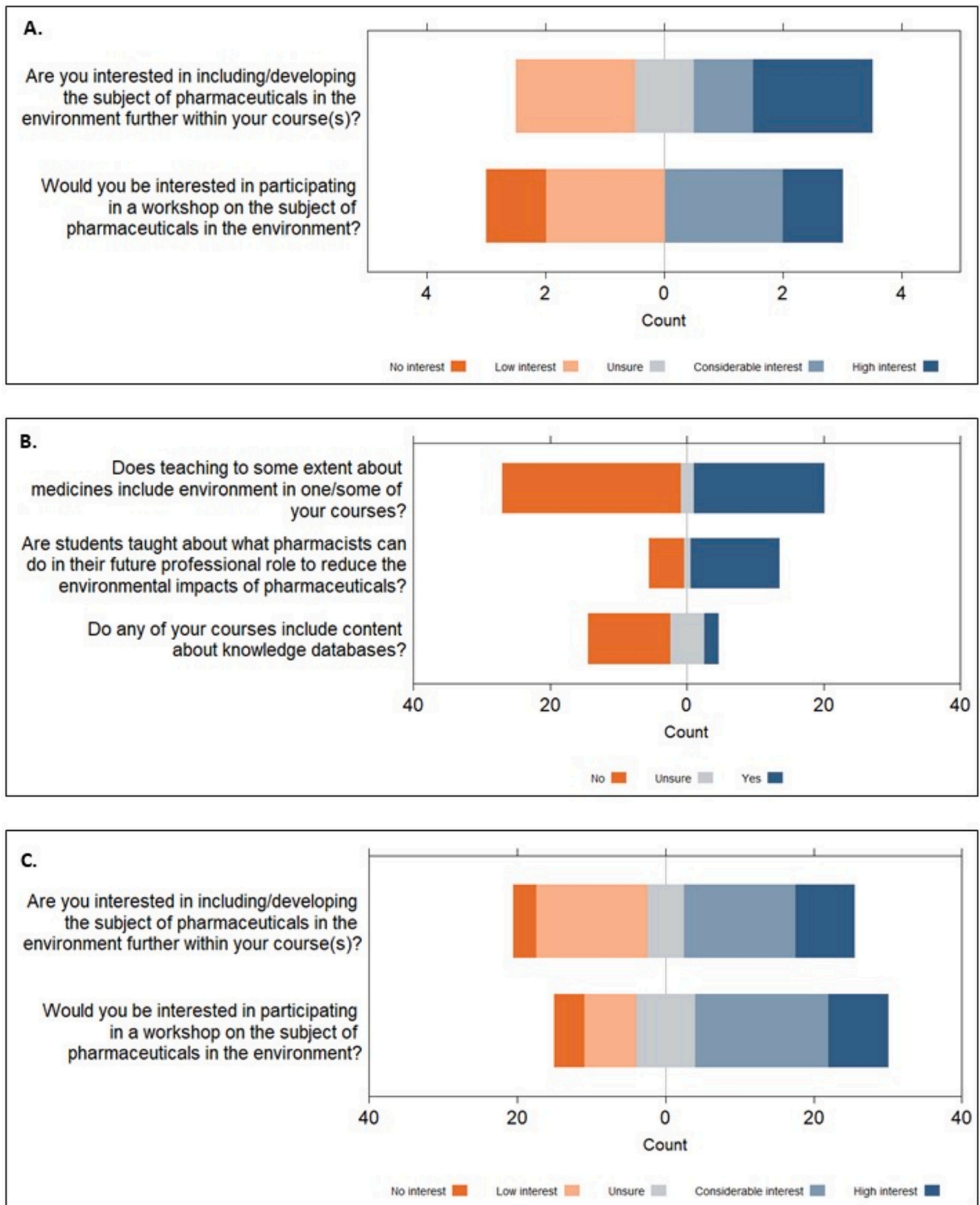


Fig. 1. A The responses from program managers within medicine programs on interest of developing the subject and increasing knowledge; B Responses from course managers within pharmacy programs to questions on inclusion of environmental aspects; C Responses from course managers within pharmacy programs on interest of developing the subject and increasing knowledge.

of pharmaceuticals (19/47) were asked to specify the content and nature of this education. The main themes mentioned were AMR, ecological consequences of pharmaceuticals in the environment and sustainable drug manufacturing. Other topics mentioned were sustainable drug use, sustainable development and waste management and disposal. In addition, one course manager who answered “unsure” as to whether their course(s) did include education, proceeded to answer this question by indicating that their course(s) did include education about waste management and disposal.

A total of 76 courses were specified by the participants as containing information about pharmaceuticals in the environment. These courses were categorised into subject areas (Table 4) based on the classification in Atkinsons 2014 (30). Courses that included environmental aspects of pharmaceuticals ( $n = 24$ ) were found within all subject areas except in “Physics, Mathematics, Computing & Statistics”. The subject area with the most courses were “Medicine, pharmacology & toxicology” ( $n = 9$ ), where all 4 mentioned courses on hematology/immunology covered aspects such as monoclonal antibodies and AMR and more than half of the courses within pharmacotherapy (4/6) included at least one of the aspects of environmental information on pharmaceuticals, antimicrobials resistance or disposal of unused pharmaceuticals. Among the six pharmacology courses specified, none included education about the environmental impacts of pharmaceuticals.

*What kind of support did course managers need in incorporating education on the environment?* Course managers interested in incorporating more education on the environment were asked to specify what support they would need for this. A wide range of answers was received, including:

- Practical examples/case studies: a need for real-life examples of the impact of pharmaceuticals on the environment, preferably aligned with course content.
- External speakers: inviting expert lecturers.
- Collaboration and coordination within the programs: a need for a mapping of what is already being taught within the pharmacy programs.
- Professional development: opportunities for course managers to learn more about the subject.
- Course content: including learning objectives related to the environmental aspects of pharmaceuticals.
- Time and resources: making time for this subject within already condensed courses.
- Discussions with colleagues to provide continuity: Information on what other courses include is needed to be able to build on the information that the students have received/will receive during their training.

**Table 4**

Distribution of pharmacy courses including education on environmental aspects of pharmaceuticals ( $n = 76$ ) in Swedish Universities Nov-Dec 2022. The specified course were divided into subject areas based on Atkinson 2014.<sup>40</sup>

Subject area	Main theme of courses specified by the participants within the subject area	Courses including education on (E) environmental aspects	
		Includes E/ total	Unclear or unknown E/ total
Chemistry (CHEMSCI)	Chemistry	2/8	0/8
Physics, Mathematics, Computing, Statistics (PHYSMATH)	Experimental design/Statistical analysis	0/2	0/2
Biology, Biochemistry, Pharmacognosy (BIOLSCI)	Pharmacognosy	2/2	0/2
	Biochemistry	0/2	0/2
	Cell biology	0/4	0/4
Pharmaceutics / Technology (PHARMTECH)	Pharmaceutics	3/3	0/3
	Pharmaceutical technology	0/1	1/1
	Quality assurance	0/3	0/3
	Finished medicinal products	0/1	0/1
	Pharmacokinetics	0/5	0/5
	Hematology/Immunology/infection biology	4/4	0/4
	Pharmacotherapy	4/6	1/6
	Toxicology	1/3	0/3
Medicine / Pharmacology / Toxicology (MEDSCI)	Anatomy and/or Physiology	0/2	0/2
	Pharmacology	0/6	0/6
	Legislation	1/3	0/3
	Social Pharmacy	1/2	0/2
Law / Social Aspects of Pharmacy (LAWSOC)	Pharmacoepidemiology/		
	Pharmacoeconomics	2/2	0/2
	Practical skills (Clinical placement)	2/4	0/4
Generic Competences (GENERIC)	Communication	1/3	0/3
	Academic literacy	0/2	0/2
Not possible to categorise	Subject not given in response	0/3	0/3
	Degree thesis work	1/5	0/5

## Discussion

In this study assessing teaching on pharmaceuticals in the environment in medicine and pharmacy programs at Swedish universities, we found few learning objectives related to the environmental impact of pharmaceuticals in the program curricula. However, all universities incorporated the topic into some courses and there was interest in further developing education around pharmaceuticals in the environment.

General learning objectives related to pharmaceuticals in the environment were found in all reviewed program curricula, in line with the Higher Education Ordinance (1993:100).<sup>38</sup> However, only some of the universities had further developed local learning objectives related to the environmental impact of pharmaceuticals into their program curricula. These learning objectives indicated that some attention is dedicated to the topic, but they were not specifically addressing how pharmaceuticals can affect the environment. As the general learning objectives are based on the Higher Education Ordinance (1993:100), it could be an appropriate starting point to be more specific within this ordinance to harmonise education and to ensure that medicine/pharmacy graduates are given a general understanding regarding this issue. This could prompt more universities to enhance this education.

Pharmaceuticals will continue to be one of the most important tools for physicians to cure, relieve and prevent diseases. Rational prescribing has been suggested to maximise effectiveness, minimise risks, minimise costs and respect the patients' choices.<sup>42</sup> However, environmental aspects have traditionally not been seen as a part of rational prescribing, and many physicians are not aware of the environmental risks and what they can do in their profession.<sup>43</sup> This gap could be reduced by education and training.<sup>43,44</sup> In this study, medicine program managers confirmed they had some teaching on pharmaceutical environmental impact within their programs where three of these incorporated it into a pharmacology course. To further support student learning and skills, we suggest that the theme recur during the entire medicine program. Examples of potential areas where environmental aspects could be added in education and training could e.g. be evidence-based medicine, prevention, medicines management, patient involvement in the prescribing process, non-pharmacological interventions and waste and disposal.<sup>43</sup>

Pharmacists could also play a key role in promoting sustainable development. A previous Australian study have showed low awareness but high interest among pharmacy students.<sup>45</sup> In another study, Domingo-Echaburu et al. found that pharmacy students in Basque, Spain had poor knowledge about pharmaceuticals in the environment, but thought that the issue was important and relevant to pharmacy practice.<sup>46</sup> In a recent study, more than half of pharmacy students at the University of Gothenburg, Sweden, were aware that pharmaceuticals can affect the environment negatively but were less likely to reference their education as the source of information when compared to students of other fields such as medicine.<sup>47</sup>

We found that there was interest in incorporating more education about the topic, as half of the program managers and half of the course managers indicated high or considerable interest. This is in line with other studies conducted. For example, among faculty and researchers within the Faculty of Pharmacy at the University of Helsinki in Finland, slightly less than half of the respondents surveyed thought that actions were needed in their discipline regarding environmentally conscious teaching.<sup>23</sup> In our study, students were not included, but some interest would be expected among students at Swedish universities. Among the pharmacy students surveyed within the Faculty of Pharmacy at the University of Helsinki, 75 % thought that environmental issues were not addressed enough in their pharmacy education and among the medical students, most thought that environmental aspects should play a greater role in their curriculum.<sup>23</sup> This interest should be supported to accelerate the incorporation of more education on environment and sustainability into the programs. Therefore, it is important to support course managers with education about the subject. An international overview of current best practices and some further guidance on how to best integrate environment into medical education could facilitate a more cohesive education and avoidance of redundancy.

We suggest that the environmental theme should recur throughout the programs, preferably as interprofessional education. This has also been suggested in Canada as a way to increase awareness among pharmacists.<sup>24</sup> A similar set-up has been launched by the Generation Green task force at University of Helsinki where physicians and pharmacists are educated about the environmental impact of their professions throughout the program.<sup>23</sup> Pharmaceuticals in the environment is a complex issue requiring collaboration between different professions, why interprofessional education is crucial to promote behavioral change and innovation.<sup>48</sup> To inspire and increase knowledge in the topic, we also suggest that a joint forum is initiated, preferably by the universities where course managers, teachers and/or other stakeholders shaping the education of healthcare professionals are given a forum for knowledge sharing and discussion.

The present study has several strengths. By encompassing both medicine and pharmacy programs across Sweden, the study ensures a comprehensive sample, capturing diverse perspectives and approaches to environmental education within healthcare curricula. The study had a combination of both questionnaires and program curriculum review, allowing for a thorough understanding of the educational landscape regarding pharmaceuticals in the environment in Swedish universities. Furthermore, the study targeted program and course managers actively working with the contents of these educations.

We also acknowledge some important limitations. This study was cross-sectional assessing the situation at the time of the study and some course contents may have changed over the time since data were collected. While the study achieved a rather good response rate, there is a possibility of response bias. Participating teachers may overrepresent those with pre-existing initiatives or interest in environmental education. In addition, the study only reviewed compulsory courses within the medicine and pharmacy programs in Sweden. For instance, in September 2021, Uppsala University introduced a new elective course called "Drugs in the Environment", which was not included in the study.<sup>49</sup> The course covers the consequences of pharmaceuticals in the environment, environmental aspects of the development, production, prescription, and use of pharmaceuticals as well as wastewater treatment and disposal of unused pharmaceuticals. Similar initiatives may exist at other universities and such courses or content could in the future be included in the compulsory curricula. Finally, we acknowledge that the study focuses on Swedish universities which may restrict the

generalisability of findings to other educational contexts with differing educational priorities.

## Conclusion

This study shows an interest in education on environmental impact of pharmaceuticals within medicine and pharmacy programs at Swedish universities and that all universities have, at least to some extent, incorporated the topic into their programs. Further developing the environmental content of these programs could provide future physicians and pharmacists with the skills needed to reduce the environmental impact of pharmaceuticals, as a part of a broader approach for medicines optimisation. A life-cycle perspective of pharmaceuticals should be included covering different aspects from drug discovery and development to production, choice of treatment options and waste management. This issue is complex, and interprofessional education may facilitate behavioral change and innovation.

## Ethics approval and consent to participate

The study was conducted in accordance with the principles of Good Clinical Practice and the Helsinki Declaration. According to Swedish Law on ethical review regarding research involving humans [Lag (2003: 460) om etikprövning av forskning som avser människor], ethical approval of this study was not required since it targeted professionals on non-sensitive issues related to their work. A cover letter was sent along with the link to the survey explaining the study's purpose and highlighting the anonymity of the results. Participants were informed that their participation was voluntary, and informed consent was obtained if respondents finalised the questionnaire. This study did not involve the processing of personal data. However, since information about course managers and program managers is publicly accessible via the university's websites, it was possible to indirectly identify individuals based on their responses.

## Availability of data and materials

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

## Declaration of competing interest

The authors report no conflicts of interest in this work.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cptl.2025.102386>.

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