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Preferences for medicines with different environmental impact – A Swedish population-based study

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ABSTRACT

Background: Despite increased insight into the harmful effects medicines have on the environment, research is scarce on how this awareness affect consumer behaviour and how people would react to environmental policies that could influence individual treatment options.
Objectives: To investigate if information about environmental harm would affect people's medicine choices and the support of policies to reduce pharmaceutical pollution.
Methods: A web survey was completed by a representative sample of the Swedish adult population (n=1,583). The survey included a choice task with three disease scenarios (common cold, rheumatoid arthritis, and stroke) and fictitious medicines with different therapeutic effect and environmental harm. There were also items asking for support of possible policies (eco-labelling of over-the-counter (OTC) medicines, higher prices for environmentally harmful medicines, and green prescribing requirements).
Results: The most environmentally friendly and least effective options were preferred by 68% of the participants in the common cold scenario, 36% in the rheumatoid arthritis scenario, and 23% in the stroke scenario. These were rated highest in satisfaction with treatment option for the common cold (large effect) and rheumatoid arthritis (small effect) scenarios. Regarding stroke, the most effective and least environmentally friendly options were most preferred. Reported support of policies were consistently high. The highest was the support of eco-labelling of OTC medicines, followed by higher prices for environmentally harmful medicines, and green prescribing requirements (in that order). Female sex, age $\geq$ 60 years, higher education and having no children were associated with being positively inclined towards the most intrusive regulation (green prescribing requirements).
Conclusion: There is a willingness among people in Sweden to take environmental considerations into account for minor ailments, which gradually disappears when faced with more serious diseases. Swedes support policies that could lead to more environmentally friendly medicine use, including those that affect individual treatment options.

1. Introduction

1.1. Pharmaceuticals in the environment

There is incontestable evidence that pharmaceutical pollution has environmental effects limiting the diversity of nature (Boxall et al., 2012). Emission of pharmaceutical residues presents great environmental harm as they can cause physiological effect on living organisms as well as contribute to antibiotic resistance (Boxall et al., 2012; Larsson, 2014). Hot spots for these emissions are identified in major pharmaceutical-producing countries in Asia where large amounts of residues are emitted from the industrial plants into municipal sewage (Larsson, 2014; Liu and Wong, 2013). However, there is also concern about the problem this represents in regions where pharmaceutical pollution is mainly due to direct consumption (Arnold et al., 2014).

In the European Union (EU) region, it is estimated that about 90% of the pharmaceuticals found in the environment are excreted by people and animals, and come from urban wastewater, sewage sludge and manure (European commission, 2019). Since medicines are only partly absorbed after intake and significant fractions pass through the body

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unchanged, medicinal residues are emitted into sewage. In conventional wastewater treatment plants, the residues are only partly removed (Sörengård et al., 2019); therefore, active pharmaceutical ingredients (APIs) enter water systems, and some of them are detected in concentrations that are expected to cause pharmacological responses in aquatic animals, e.g., fish (Björlenius et al., 2018; Brodin et al., 2013; Cerveny et al., 2020; Fick et al., 2011). Swedish watercourses are no exemption (Larsson, 2012; Fick et al., 2011). Analyses of around 70 pharmaceuticals in water samples from large Swedish lakes (Vänern, Vättern and Mälaren) and ambient rivers detected frequently occurring APIs, including hormones (e.g. 17-β-estradiol) and anti-inflammatory substances (e.g. diclofenac) in concentrations that exceeded the Water Framework Directive's threshold values of environmental quality standard (Malnes et al., 2021; Swedish Agency for Marine and Water Management, 2019).

Besides being a risk to the environment, pharmaceutical discharge and accumulation in the environment constitute a risk to public health. Medicines have been designed to have pharmacological effects and confer significant benefits to society. However, these effects can be highly injurious when occurring due to unintended intake. According to a WHO report from 2012, trace concentrations of pharmaceuticals in drinking-water are unlikely to pose risks to human health, but knowledge gaps about risks associated with long-term exposure and the combined effects of mixtures of pharmaceuticals give cause for concern (World Health Organization, 2012). With an increasing life expectancy in a population where a growing proportion constitutes older people living longer with multiple concurrent diseases (partly due to ever-evolving pharmaceutical innovations), this is not a problem that is going to diminish over time unless more preventive policies are in place.

With current knowledge on hand, it is possible to implement targeted measures to reduce the emissions. Such measures include investment in more advanced and sustainable water treatment plants, but also initiatives to be implemented at source, before medicines reach the environment (Argaluza et al., 2021). In this paper, we focus on how such measures would potentially be received by the population in Sweden, a country which for years has been considered a front-runner in environmental policies (Organisation for Economic Co-operation and Development, 2014).

1.2. Measures to reduce pharmaceuticals in the environment (the case of Sweden)

Since 2011, socio-economically and environmentally sustainable use of medicines has been one of three long-term goals in Sweden's national medicines strategy (Ministry of Health and Social Affairs, 2020). Within the EU, the Swedish government is recognised as a strong advocate of measures to restrict pharmaceutical pollution and for being a driver of legislative change (Nijsingh et al., 2019; Swedish Medical Products Agency, 2018). For instance, the Swedish Medical Products Agency (MPA) has proposed amendments in regulations that would enable requirements for environmental consideration to be a part of the risk-benefit assessment which is included in the documentation for approval of medicines (Swedish Medical Products Agency, 2018). The MPA has also suggested incorporation of requirements regarding environmental management in the principles and guidelines for *Good Manufacturing Practice* (GMP), which could have a positive environmental effect even outside EU borders (Swedish Medical Products Agency, 2018)

However, the initial work of incorporating environmental protection in Swedish pharmaceutical policy dates to the beginning of the 2000s when environmental criteria were first used in public procurement of medicines. About the same time, Apoteket AB (the state-owned pharmacy chain, former monopolist) and Stockholm County Council (provider of public health care in the capitol area) began collecting data on environmental risk and hazard of pharmaceuticals for human use on the Swedish market. The systematisation of these data constituted the precursor to an environmental classification system, which was further developed to a voluntary national system by the Swedish Association of the Pharmaceutical Industry in collaboration with MPA and other stakeholders in the healthcare sector (available at www.fass.se since 2005) (Wennmalm and Gunnarsson, 2009, Ramström et al., 2020). It contains information about medicines' environmental hazard and risk (however, not near complete) and has the purpose to make it easier for consumers, prescribers, and pharmacy staff to access the environmental impacts of medicines. It also formed the basis of the *Pharmaceuticals and Environment* database (available at www.janusinfo.se), which is being used as prescribing support and a resource by the Regional Drug and Therapeutics Committees when preparing treatment recommendations (Ramström et al., 2020).

The regulation of the pharmaceutical market is of great importance for the pharmaceutical companies' incentives to work on environmental improvements. In typical "consumer states", which Sweden is an example of, interest in curbing healthcare costs might overshadow the urge to reduce emissions. Thus, these countries make the "production countries" suffer from the pharmaceutical pollution caused by their high consumption levels (Nijsingh et al., 2019). Like the other Nordic countries, Sweden has a comprehensive reimbursement system for pharmaceuticals, which puts pressure on the companies to supply their products at the lowest possible price. Every month, the price regulatory authority invites tenders from the suppliers of generic medicines (i.e. medicines for which the original's patent has expired) and enters into agreements with the suppliers that offer the medicines at the lowest price. In the pharmacies, the personnel are obliged to promote sales of the negotiated medicines through generic substitution (Håkonsen and Andersson Sundell, 2015). Hence, and despite other environmental considerations taken by the authorities, the public reimbursement system in combination with the monthly tenders do not promote environmental initiatives and commitment to sustainable development. If a company on its own initiative invests resources on for instance reduced emission of pharmaceutical residues, it would most likely entail a competitive disadvantage since price is the only competitive means. At the time of writing, the Swedish Government has commissioned central government agencies, including MPA, the Dental and Pharmaceutical Benefits Agency (TLV), and the eHealth Agency, to jointly develop and establish a pilot scheme with an environmental premium in the pharmaceutical reimbursement system (Government Offices of Sweden, 2021). This scheme entails environmental assessment of a selection of reimbursed medicines (i.e. antibiotics, non-steroidal anti-inflammatory drugs (NSAIDs), and sex hormones) and a volume-based financial reward to companies that satisfies criteria related to emission control. Efforts are also being made to promote more sustainability regarding the purchase of medicines in inpatient care through public procurement.

Within the over-the-counter (OTC) segment, measures have been taken by the Swedish Pharmacy Association to increase consumer awareness by voluntary labelling of OTC medicines. Since 2020, manufacturers have the possibility to have their product shelves labelled with a specific symbol (Välvald, meaning well-chosen), if they exhibit an externally audited sustainability report and are a member of the Pharmaceutical Supply Chain Initiative (PSCI) (Swedish Pharmacy Association, 2022).

1.3. Perception of pharmaceuticals' environmental risk

Despite increased insight into the harmful effects of medicines on the environment, research is scarce on how this environmental awareness might affect consumers' choice when faced with various medicines. There is also a paucity of studies of the public's willingness to behavioural change and support of policies to reduce the use of environmentally harmful medicines. An exemption is the US study by Dohle et al., which showed that people might be willing to balance health and environmental considerations when choosing a medicine for a minor ailment (e.g., common cold) but not for a severe disease (e.g., cancer)

(Dohle et al., 2013). This study also found that medicines used in agriculture were perceived as a more severe threat to the environment compared with medicines for human use, probably because people see more personal benefit of human medicines. Psychological studies have shown that perceived benefit and risk are inversely related, i.e., products perceived as having a high benefit tend to be judged low in risk, and vice versa (Finucane et al., 2000). However, prescription medicines have been identified as products for which this negative correlation is relatively low (Alhakami and Slovic, 1994, Slovic et al., 1989, 2007), for instance when compared with medicines sold OTC (Alhakami and Slovic, 1994). When it comes to medicines' relative age, there is evidence for a robust oldness preference among consumers when being informed that older and newer medicines are equally safe and effective (Jie, 2020). Regarding the environmental risk associated with medicines, the general level of knowledge is low, and people tend to base their risk assessments on irrelevant, easily accessible information (e.g. prescription status and disease severity) instead of objective environmental risk factors (Luís et al., 2021). Common perceptions are that prescription medicines are more environmentally risky than prescription-free and that medicines used for treatment of severe diseases are more harmful to the environment than medicines used for less serious conditions (Luís et al., 2021). Another aspect is that lay people tend to perceive lower risk of pharmaceuticals in the environment when compared with experts (Luís et al., 2020), something that is contrastive to peoples' judgment of chemicals. A possible explanation can be that experts to a larger extent base their judgement on population-derived evidence, while lay people are more concerned about their individual level of risk and how they could be affected (Berry, 2004).

The Swedish people have traditionally placed a high value on protecting the environment (Organisation for Economic Co-operation and Development, 2014). In the medical field, this is reflected, for instance, in the high degree of unused medicines being delivered to the pharmacies for safe disposal. It is estimated that about three out of four Swedes return unused medicines to the pharmacy, something they increasingly do due to a will to contribute positively to the environment and unlike before when security was reported as the main reason for this practice (Persson et al., 2009).

The question, however, is how far this willingness extends. There are many factors that play a role for people's behaviour in this context, including acquisition of information, communication and understanding of risk (Berry, 2004). There are also basic human values with relevance to health and healthcare, which may be in conflict. For instance, people may face a dilemma of placing the benefit of the population before that of themselves (Berry, 2004). On the societal level, a strict health economic approach will ensure the most rational use of monetary resources for society, while from an environmental angle, the society will benefit from adding other criteria than cost in the procurement process, something that at the end of the day will increase the taxpayers' contribution.

In this study, we seek to gain an understanding of how people in Sweden would choose medicines based on simple information about the medicines' therapeutic effect and environmental harm. As in a previous study (Dohle et al., 2013), we have constructed hypothetical disease scenarios, albeit with the introduction of more nuance regarding severity of the condition to be treated. Based on the reviewed research, there is reason to believe that people in Sweden may be willing to make environmentally friendly choices when it comes to medicines. However, there is little evidence of where a possible limit goes in terms of the severity. The aim of this study is to investigate if information about environmental harm would affect people's medicine choices and the support of environmental policies to reduce pharmaceutical pollution in the Swedish population.

2. Methods

2.1. Study setting and design

A cross-sectional study was conducted with data from a web panel (the Citizen Panel) organised by the Laboratory of Opinion Research (LORE) at the University of Gothenburg, Sweden. The purpose of LORE is to provide an infrastructure for multidisciplinary research and be an efficient facility for collecting data from web questionnaires. The Citizen Panel has approximately 69,000 registered users from all over the country and is a mix of opt-in respondents and respondents recruited by random probability sampling (Martinsson et al., 2020). Participation is voluntary and without payment.

2.2. Study population

A sample of 2,800 persons was selected at random from the Citizen Panel and invited by email to take part in the survey. This sample was stratified by sex, age, and education to be representative of the Swedish adult population (aged ≥18 years). Of the gross sample, 4.5% of the invitations failed to be delivered, which gave a net sample size of 2,674 persons who received the survey invitation. Of these, 1,583 agreed to take part in the survey, giving a net participation rate of 57% (Martinsson et al., 2020).

2.3. Data collection

A questionnaire with two sections was developed. In the first section, participants were asked about their purchase of medicines during the past 12 months, if they had received information about environmental risks of medicines and to what extent they were concerned about the environmental harm of medicines. In the second part, which was partially modelled on the questionnaire used by Dohle et al. (Dohle et al., 2013), the participants were confronted with three medical scenarios related to fictitious medicines used in treatment of humans. The scenarios dealt with medicines used for stroke prevention, treatment of rheumatoid arthritis and relief of symptoms of common cold. A detailed description of the scenarios is to be found in Appendix 1. The scenarios were presented to each participant in random order.

Succeeding each scenario, the participants were shown a table that displayed the relative age, therapeutic effect, and environmental harm of the two medicines that they were asked to consider. There were in

Table 1
A description of the relative age, therapeutic effect and environmental harm of the fictitious medicines.

	Newest medicine	Newer medicine*	Oldest medicine
Scenario 1. Stroke			
Fictitious name	Kalomin	Vitarev	Zolyn
Per cent of patients that are not having a stroke following treatment	90%	70%	50%
Per cent decline in the reproductive rate of rainbow trout	40%	20%	0%
Scenario 2. Rheumatoid arthritis			
Fictitious name	Alocyl	Botorel	Cetozol
Per cent of patients that experience reduced disease progression and pain relief	90%	70%	50%
Per cent decline in stocks of char	40%	20%	0%
Scenario 3. Common cold			
Fictitious name	Fluvenox	Oroflexol	Minohydren
Per cent of patients that are symptom-free after 24 hours	90%	70%	50%
Per cent decline in affected fish fry	40%	20%	0%

* The "newer medicine" was older when compared with the newest, but newer when compared with the oldest.

total three different medicines (as shown in Table 1), but each participant received one version (of the three possible combinations) of a table that described only two of the medicines. In one version, the participants compared the newest medicine (Option 1) with the newer medicine (Option 2). In another version, the participants compared the newest medicine (Option 1) with the oldest medicine (Option 2), and in the last version, the newer medicine (Option 1) was compared with the oldest medicine (Option 2). Hence, there were three versions for all three scenarios, which made a total of 27 different versions of the questionnaire.

The questions being asked were the following:

(1) "Assume that Option 1 [Option 2] is the only medicine available to you. Under these circumstances, how satisfied would you be with this medicine considering its relative age, effectiveness and environmental impact?" (on an ordinal scale from 1 to 7 where 1 = "not at all satisfied", 4 = "moderately satisfied" and 7 = "very satisfied"), and
(2) "Assuming you could choose between the two medicines, which one would you choose?".

The participants were also asked to state how they would respond to the following legislative changes (on an ordinal scale from 1-7 where 1 = "I would be very negative to this policy", 4 = "I would be indifferent to this policy", and 7 = "I would be very positive to this policy"):

(1) "In some countries, doctors may be required by law to prescribe the medicine with the lowest environmental harm. What is your position on the introduction of a similar regulation in Sweden?",
(2) "It has been discussed that the price for environmentally harmful medicines should be higher than for medicines with lower environmental harm. What is your position on paying more for environmentally harmful medicines?", and
(3) "In some countries, it is a legal requirement that medicines sold without a prescription are labelled with a warning of environmental harm. What is your position on implementation of similar labelling requirements in Sweden?"

Information on participants' sex, age, education, place of residence, and parental status was collected at the end of the survey. Education was categorised as "lower than high school exam" (ranging from no education to high school without the final exam), "high school exam/post-high school" (including post-high school education without an exam) and "university degree/postgraduate studies".

The web survey was dispatched between the 11th of December 2019 and the 15th of January 2020, during which time two reminders were sent by email.

2.4. Statistical analysis

Median scores were calculated for the participants' stated satisfaction with a given medicine, when compared with an alternative for the same scenario, whereupon Wilcoxon Signed Rank Tests were performed for pairwise comparisons of scores. We used Cohen's criteria to determine effect size ($r = 0.1$: small effect; $r = 0.3$: medium effect; $r = 0.5$: large effect) (Cohen, 1992).

Pearson's chi-square tests (with subsequent post hoc tests) were performed to examine any differences in the choice of medicines for the three disease scenarios, i.e., if there were any significant differences in preferences for a less effective and more environmentally friendly medicine (Option 2) compared with a more effective and less environmentally friendly medicine (Option 1).

We performed a Friedman test (with subsequent post hoc tests) to compare the mean rank of scores for the three environmental policies. Logistic regression was used to investigate the odds ratios (ORs) for being positively inclined towards environmental policies in relation to sex, age, educational level, and parental status. Values 5-7 on the ordinal scale were coded as 'positive' while 1-4 were coded as 'not positive'. Female sex, < 60 years of age, lower than high school exam, and having children were chosen as reference categories in the analyses. The results are presented as ORs with 95% confidence intervals (CIs).

SPSS Statistics, version 25 (SPSS Inc., Chicago, IL, USA) was used in the analyses of the data.

2.5. Ethical consideration

Data collection by LORE was approved by the Regional Ethical Review Board in Gothenburg (Dnr: 189-14). All personal information, including informed consent, was handled by the technical staff at LORE and stored in encrypted files. The data was completely anonymous for the investigators. Ethical approval was not considered necessary for this specific study.

3. Results

3.1. Background information about the participants

There was an almost equal distribution of women and men; 43.4% were 60 years of age or older and 25.0% had higher educational achievements (see Table 2). Two-thirds resided in a larger Swedish city. A total of 91.9% of the participants reported that they had purchased medicines during the past 12 months and 34.7% that they had received information that medicines can have environmental effects. Of the latter, 79.3% stated that media, including social media, were the source of this information, followed by medicines packages, including insert leaflets (45.8%), pharmacy staff (37.2%), friends and family (21.1%), primary healthcare centre or hospital (15.6%) and other (8.8%). More than half (55.7%) reported that they were very or fairly worried about the environmental effects of medicines (Table 2).

3.2. Satisfaction with the medicines

For all three scenarios, the participants stated their satisfaction with the medicines, given this medicine was the only medicine available to

Table 2
Background characteristics of the study population.

		n (%)
Sex (n=1583)		
	Female	785 (49.6)
	Male	798 (50.4)
Age group (n=1583)		
	< 30 years	165 (10.4)
	30-39 years	214 (13.5)
	40-49 years	269 (17.0)
	50-59 years	248 (15.7)
	60-69 years	351 (22.2)
	≥ 70 years	336 (21.2)
Education (n=1575)		
	Lower than high school exam	284 (18.0)
	High school exam/ post-high school	898 (57.0)
	University degree/ postgraduate studies	393 (25.0)
Place of residence (n=1499)		
	Larger city	989 (66.0)
	Medium urban area	312 (20.8)
	Countryside	198 (13.2)
Parental status (n=1503)		
	Children	1041 (69.4)
	No children	458 (30.6)
Worry about the environmental effects of medicines (n=1574)		
	Very worried	169 (10.7)
	Fairly worried	709 (45.0)
	Not particularly worried	616 (39.1)
	Not worried at all	80 (5.1)

them.

For the common cold scenario, the highest median score was 5 of 7, which was obtained for the oldest (least effective and most environmentally friendly) medicine when presented together with the newer (median = 3 of 7) as well as the newest medicine (median = 2 of 7). The median scores for the newer and the newest medicines were 4 and 3 of 7, respectively, when these were presented together. For the medicines described in the two other scenarios, the median score was 4 of 7, regardless of comparator.

A Wilcoxon Signed Rank Test showed that there were significant differences in the distribution of scores not only for the medicines in the common cold scenario but also for those in the rheumatoid arthritis scenario (displayed in Fig. 1). The trend was similar in the two scenarios, i.e., the participants were most satisfied with the least effective and most environmentally friendly (newest/newer) medicine when this medicine was presented together with a more effective and less environmentally friendly (newer/oldest) medicine. For the cold medicines, the effect sizes were overall large ($r^c = 0.47$; $r^d = 0.69$; $r^e = 0.66$) while they were rather small for the medicines for rheumatoid arthritis ($r^a = 0.12$; $r^b = 0.24$).

3.3. Choice of medicine

Figure 2 displays how the participants responded when they were asked to state their choice of medicine when they could choose between two given medicines (Option 1 and Option 2).

In the stroke scenario, 52.8% stated that they would choose the most effective and least environmentally friendly option (Option 1), while the respective percentage for the rheumatoid arthritis and cold scenarios were 40.3 and 14.1. The percentages who stated a preference for the least effective and most environmentally friendly option (Option 2), were 22.9 for the stroke scenario, 36.3 for the rheumatoid arthritis scenario, and 68.2 for the cold scenario. For the three scenarios, respectively, 24.3%, 23.4% and 17.8% did not state a preference for any of the medicines that were compared.

Regarding stroke, participants were more likely to choose the newest medicine, which was the most effective and least environmentally friendly medicine (50.5% (Option 1) vs. 24.2% (Option 2) when compared with the newer medicine and 54.6% (Option 1) vs. 18.3% (Option 2) when compared with the oldest medicine). When given the choice between the newer and the oldest medicine, a majority chose the newer (53.2% (Option 1) vs. 25.8% (Option 2)). The post hoc tests showed that participants were least likely to choose the most environmentally friendly medicine when the oldest medicine was compared with the newest.

For rheumatoid arthritis, participants were as likely to choose the newest as the newer medicine (37.7% (Option 1) vs. 38.7% (Option 2)) when these two were compared, and more likely to choose the 'newest' over the 'oldest' (47.1 (Option 1) vs. 29.8% (Option 2)). When given the choice between the 'newer' and the 'oldest', a higher percentage chose the most environmentally friendly medicine over the alternative (40.7% (Option 2) vs. 35.6% (Option 1)). As for the stroke scenario, participants were least likely to choose the most environmentally friendly medicine when the 'oldest' was compared with the 'newest'.

In the last scenario, participants were most likely to choose the most environmentally friendly option regardless of comparator (59.4% (Option 2) vs. 16.9% (Option 1) when 'newer' was compared with 'newest'; 71.8% (Option 2) vs. 12.2% (Option 1) when 'oldest' was compared with 'newest'; 72.9% (Option 2) vs. 13.2% (Option 1) when 'oldest' compared with 'newer').

3.4. Support of environmental policy

Three potential policies aimed at reducing the environmental harm of medicines were presented to the participants. The median scores were 5 of 7 for a law where physicians are obliged to prescribe more environmentally friendly medicines (hereafter: the prescribing regulation) and introduction of higher prices for environmentally harmful drugs (hereafter: the higher price policy) and 7 (maximum score) for labelling OTC medicines with a warning of environmental harm (hereafter: the

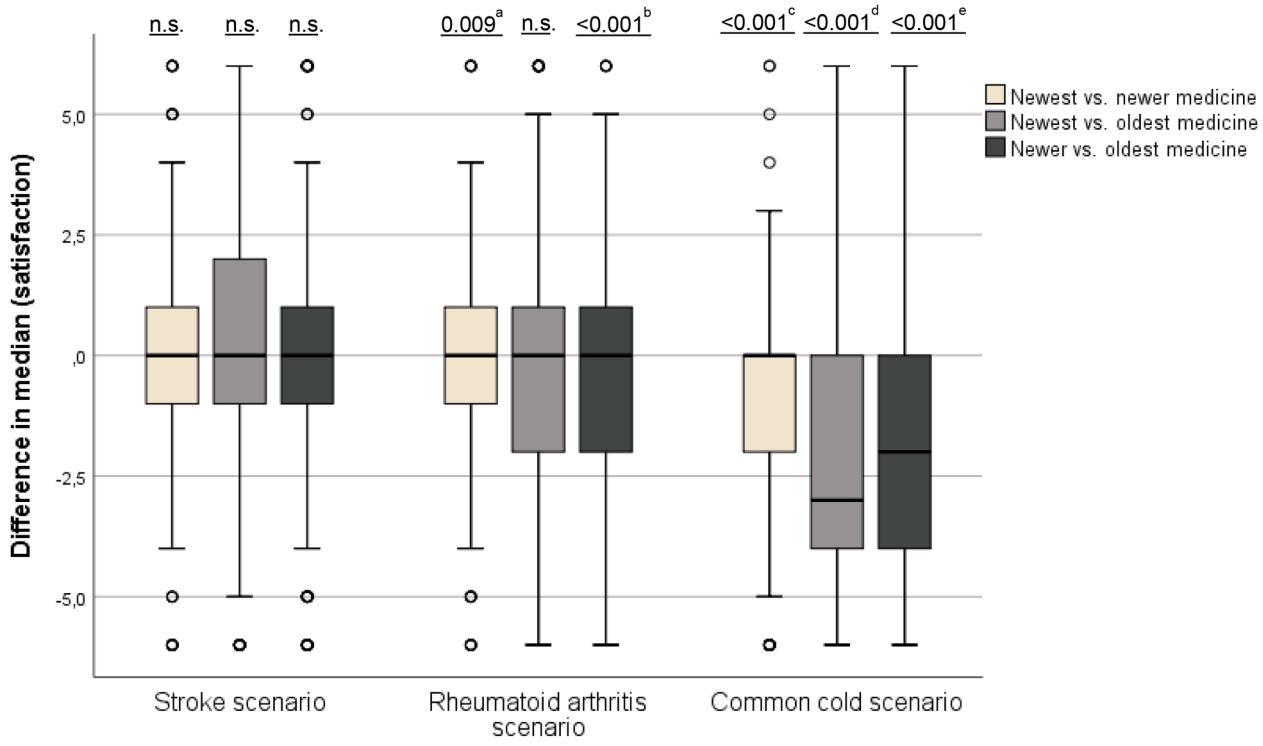

Fig. 1. Boxplots of the difference in satisfaction between the medicines being compared for the three disease scenarios. (In superscripts: *p*-values of effect sizes ([a]$r = 0.12$; [b]$r = 0.24$; [c] $r = 0.47$; [d] $r = 0.69$; [e] $r = 0.66$) from Wilcoxon Signed Rank Tests; n.s. = not statistically significant at a 5% level of significance.)

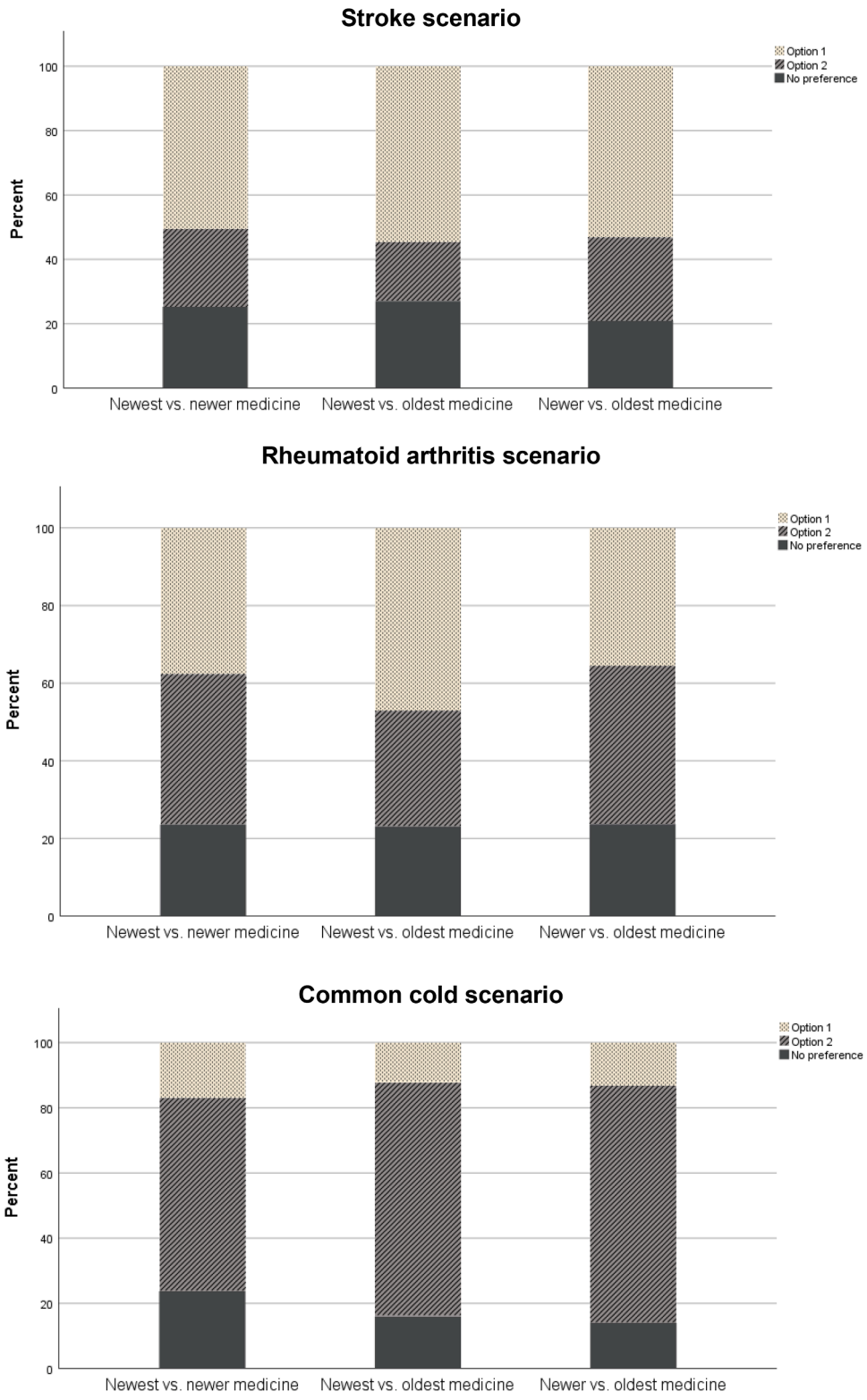

Fig. 2. Choice of medicines for the three disease scenarios. Option 1 was always relatively new and hence more effective and less environmentally friendly compared with Option 2.

labelling requirement). A Friedman Test indicated that there was a statistically significant difference in the distribution of scores across the policies (χ^2 (2, $n = 1473$) = 1211.57, $p < 0.001$). As can be seen from Figure 3, the distribution of scores for the prescribing regulation is skewed towards lower values when compared with the higher price policy. Post hoc tests indicated that there were also differences between the scores when compared pairwise, i.e., the participants were more positive towards the higher price policy compared with the prescribing regulation ($p < 0.001$), and similar for the labelling requirements compared with the prescribing regulation ($p < 0.001$), and for the labelling requirements compared with the higher price policy ($p < 0.001$).

After dichotomising the responses into positive or not positive (= indifferent or negative) about the environmental policies, 49.9% of the participants were categorised as positive towards the prescribing regulation, 55.2% as positive towards the higher price policy and 83.2% as positive towards labelling requirements of OTC medicines.

As shown in Table 3, the likelihood of being positive towards the prescribing regulation was higher for women than men, for those 60 years or older than those who were younger, for people with a university degree/postgraduate studies than those with lower educational achievements and for those without children than those who had children. The results were similar for the higher price policy in terms of sex and there was an increasing support of this policy with higher education. The proposed labelling requirements of OTC medicines were overall well supported but more so in a higher proportion of women compared with men.

4. Discussion

4.1. Discussion of results

In Sweden, multiple measures have been introduced to reduce the environmentally harmful effects of medicine use. Besides the well-established system for safe disposal of medicines in pharmacies (Persson et al., 2009), measures have primarily involved making information about medicines' environmental impact more accessible to stakeholders (Ramström et al., 2020; Swedish Medical Products Agency, 2018; Wennmalm and Gunnarsson, 2009). By analysing choice decisions of medicines in different disease scenarios, we explored to what extent, if at all, a representative sample of the Swedish population would balance therapeutic effect and environmental harm when this information was made available to them.

The study shows quite clearly that there is a willingness in the Swedish population to take environmental considerations into account despite prospects of reduced therapeutic effect when asked about their choice of OTC medicines for a minor ailment. When faced with the choice between medication for treatment of more serious diseases, the effect was considerably weaker. Although there turned out to be a preference for more environmentally friendly medicines in the scenario with rheumatoid arthritis, the effect, while statistically significant, was weak and probably not transferrable to a real-life setting. In the scenario with the most serious disease (i.e., stroke), we did not see this effect at all. These results coincide with the findings of Dohle et al. (Dohle et al., 2013) where medicine choices for common cold and cancer were compared. A novel contribution of our study is the introduction of nuance regarding disease severity by investigating disease states that are perceived less serious than cancer and more serious than common cold. This study shows that people might be willing to take environmental considerations into account also for more serious conditions, although this effect, as beforementioned, was rather weak.

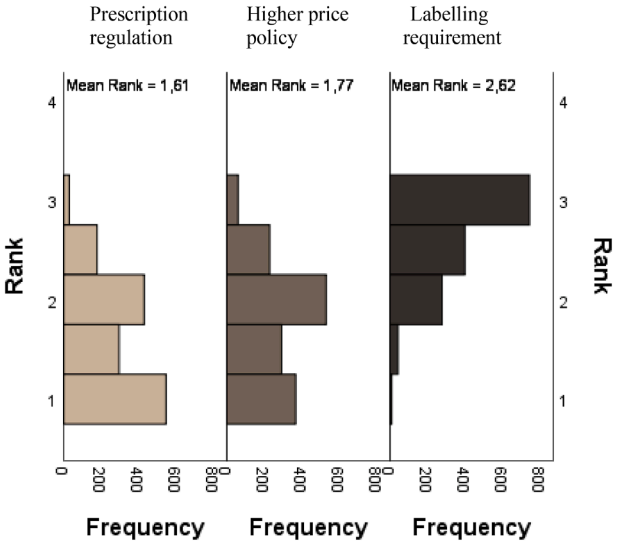

Fig. 3. Distribution of rank scores for the three policies.

A noteworthy percentage of the participants stated that they could not take a position when presented with the choices related to the different scenarios. Possible explanations for this may be that they needed additional data to make an informed choice or felt compelled to choose between two undesirable treatment options. The proportion of undecided was considerably smaller for the scenario with the OTC medicines compared with the two other scenarios. Contrastively, the proportions of respondents that opted out in the study by Dohle et al. were considerably higher for the common cold scenario than for the cancer scenario (Dohle et al., 2013), suggesting that a "no treatment" option was relevant for many. The explanation may be that medical treatment is not considered necessary for this minor ailment, or that OTC medicines, in themselves, are not considered to be particularly effective, or even necessary when regards transient ailments, especially if they are associated with side effects.

The current study documents solid public support of additional environmental policies. Of the proposed policies, the highest score was given to the one with the least intrusive effect, i.e., the labelling of OTC medicines with a warning of environmental harm. This kind of labelling implies product labelling, which is not allowed according to current EU regulations. A labelling of shelves, like what pharmacies in Sweden do today, is, however, a step in this direction. A policy that entails imposing an additional cost on environmentally harmful medicines was also quite well received by the participants. To ask if someone would support a policy that implies an additional payment for environmentally harmful medicines, might appear contra-intuitive. The rationale is that introducing a kind of "penalty fee" for medicines with a negative environmental profile would possibly change the economic incentives in favour of more environmentally friendly medicines. Unsurprisingly, a contingent valuation experiment showed that people who reported being concerned about the environment would be willing to pay more for measures aimed at reducing the release of pharmaceuticals into the environment, compared with those who did not report any concern (Wang et al., 2016).

Interestingly, the support was also quite strong for a law that would demand physicians to prescribe more environmentally friendly medicines, so-called "green prescribing", which is a policy that might influence individual treatment options. By comparison, the participants in the study by Dohle et al. were rather opposed to the idea of restricting the physicians' freedom to prescribe (possibly partly explained by the presented scenario being cancer) (Dohle et al., 2013). Swedes appear to be far more positive to this also when compared with people in Southwestern Europe (Luís et al., 2020). In a study by Luis et al (2020), both lay people and experts assessed different types of measures to reduce the presence of pharmaceuticals in the environment. Health area changes such as changing prescribing behaviour were not well received. In fact, lay people, in a certain contrast to experts, considered the benefits of pharmaceuticals as much more relevant than possible environmental harm, especially when asked about prescription medicines (Luís et al., 2020).

Since it is women who most often visit pharmacies and who also accounts for the largest use of medicines also as age increases (National Board of Health and Welfare, 2022), it is worth noting that those who seemed to be most positively inclined towards the environmental policies were women, as well as those aged 60 or more. This concur with the findings of Dohle et al., where men and younger participants (20-39 years) perceived the environmental risks of medicines as less severe than women and older participants (40-60 years), respectively (Dohle et al., 2013). Higher education and not having children were other variables that were associated with being positive to a greener prescribing policy,

Table 3
Adjusted odds ratios (ORs) for being positively inclined towards environmental policies in relation to sociodemographic and -economic variables.

		Physicians obliged by law to prescribe the medicine with the lowest environmental harm		Higher prices for environmentally harmful medicines		Labelling of OTC medicines with a warning of environmental harm	
		n (%)	OR (95% CI)	*n* (%)	OR (95% CI)	*n* (%)	OR (95% CI)
Sex	Female	447 (56.9)	1.0	483 (61.5)	1.0	688 (87.6)	1.0
	Men	343 (43.0)	**0.6 (0.49, 0.74)**	391 (49.0)	**0.6 (0.51, 0.78)**	629 (78.8)	**0.5 (0.39, 0.72)**
Age group	< 60 years		1.0		1.0		1.0
	≥ 60 years		**1.7 (1.35, 2.12)**		1.1 (0.84, 1.33)		1.1 (0.81, 1.56)
Education	Lower than high school exam	135 (47.5)	1.0	134 (47.2)	1.0	232 (81.7)	1.0
	High school exam/ post-high school	437 (48.7)	1.2 (0.90, 1.58)	487 (54.2)	**1.4 (1.05, 1.85)**	733 (81.6)	1.0 (0.68, 1.49)
	University degree/ postgraduate studies	213 (54.2)	**1.5 (1.05, 2.02)**	247 (62.8)	**1.9 (1.33, 2.57)**	345 (87.8)	1.6 (0.98, 2.60)
Parental status	Children	583 (56.0)	1.0	612 (58.8)	1.0	910 (87.4)	1.0
	No children	200 (43.7)	**1.3 (1.06, 1.70)**	248 (54.1)	1.2 (0.92, 1.49)	383 (83.6)	1.2 (0.90, 1.74)

while education was the variable that had the greatest impact on support of the higher price policy.

4.2. Methodological consideration

The results must be interpreted in light of some methodological limitations. This kind of study design presents a simplified model of real-world decision making. In this study, participants were presented with a brief description of various disease scenarios for which they were asked to state what would be their preferred treatment. We included three variables, i.e., disease, therapeutic effect, and environmental harm, and stated that the risk of side effects was equal across all scenarios. A potential issue is that other variables might have influenced the responses. In general, people's assessments of health benefits and risks are influenced by individual characteristics as well as cognitive and emotional factors, and values (Berry, 2004). Additional factors such as previous knowledge, own experiences, and family health history might have contributed to different perceptions of the severity of the diseases among the participants. Consumers' preferences for older medicines could also have skewed the results in favour of the more environmentally friendly option.

Neutrality was sought in the descriptions of the scenarios to avoid a framing effect, but we cannot rule out that if someone felt stronger for fish fry than for trout, the environmental stakes could have been perceived higher in the cold scenario compared with the two others. There is also always the possibility that people's responses in a hypothetical setting do not reflect actual behaviour. The intention-behaviour gap is well-researched and there are reviews of the available evidence that show that intentions get translated into action about half of the times (Sheeran and Webb, 2016). What people report that they will do is nevertheless a valuable predictor of behaviour (Sheeran and Webb, 2016). When regards environmental measures, findings by Wang and Mangmeechai (2021) indicate that increasing peoples' perception of policies' effectiveness can enhance their pro-environmental intentions and behaviours and reduce the intention-behaviour gap (Wang and Mangmeechai, 2021). However, how applicable this is in terms of illness and health should be the subject of future research.

We also sought to prevent an order effect, i.e., that people may be sensitive to the order in which the scenarios were presented and what two medicines they were comparing for the different scenarios. We tried to counteract this by creating different versions of the questionnaire that differed by the order and combination of medicine choices and randomly assigning participants to different versions. This was easily made possible due to the web-based design.

Another advantage of using a web questionnaire is that they are less prone to social desirability bias than other subjective methods of data collection (Gelder et al., 2010). This makes them suitable for research on sensitive topics and matters associated with "political correctness". Since the environmental interest in Sweden has been stably high over the last decennium, it might be socially desirable to report an engagement in environmental issues and a concern about pharmaceuticals' negative effects on aquatic life (Roos, 2020). A web questionnaire also makes it possible to reach a large number of participants. When web questionnaires first became used in epidemiology research, selection bias was highlighted as a drawback. However, since Internet access rapidly increased it has turned out that subjects responding to web-based questionnaires are comparable to those responding to traditional modes of data collection in terms of age, gender, income, education, and health status (Gelder et al., 2010). In Sweden today, Internet is widely accessible and only 6% of the population are considered nonusers of the Internet (The Swedish Internet Foundation, 2021). Other sources of selection bias are the net participation rate of 57% and the use of panel data. Analyses of the non-responses in the recruitment to the Citizen Panel show that there is an underrepresentation of persons who are young, unmarried/divorced, born outside of Sweden or live in less urbanised areas far away from Gothenburg (Riedel, 2014). In this study, the sample was stratified on age, sex, and education to be representative of the Swedish population, which makes us assume that responders did not differ systematically from non-responders. However, there is an inherent risk that people who agrees to take part in panels might not be representative in other respects and that, in this case, people with an engagement in environmental issues were particularly interested in answering these questions.

5. Conclusion

The severity of the disease seems to affect how people in Sweden are balancing therapeutical effect against environmental harm. This study shows that there is a willingness to take environmental considerations into account for minor ailments, which gradually disappears when faced with more serious conditions. Furthermore, the Swedish population showed support to policies that could directly lead to more environmentally friendly medicine use, preferably in the OTC segment. However, there was also support for measures towards more environmentally friendly prescribing and higher prices for environmentally harmful medicines, regardless of prescription status.

Authors' contribution

H.H. was responsible for study design, data curation, formal analysis and writing the original draft. S.D., H.R. and T.H. contributed with design of the study, interpretation of results and revision of the manuscript.

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Declaration of Competing Interest

The authors declare that they have no competing interests.

Data availability

Data will be made available on request.

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Supplementary materials

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