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Consumer willingness to pay for a pharmaceutical disposal program in Serbia: A double hurdle modeling approach

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ABSTRACT

Proper collection and disposal of pharmaceutical waste from households can reduce the negative influence of medicines on the environment. The aim of this paper is to examine the current methods of disposal of unused medicines from households, as well as the willingness of Serbian residents to participate and bear the costs of an organized collection program. Moreover, this research aims to define factors contributing to an individual's willingness to participate and pay for a medicine collection program. The survey included randomly selected patients older than 18 years visiting private pharmacies in the four largest Serbian cities. The questionnaire included information regarding the presence of unwanted medicines within the household, general medicine disposal practices, the likelihood to participate in a medicine take-back program, willingness to pay for a medicine disposal program (per prescription and per visit), importance to the environment, and demographic variables from participants. Approximately 80% of surveyed respondents are very or somewhat likely to participate, however less than half of the respondents are willing to pay for the collection of their unused medicines. The factors that influenced willingness to participate are environmental awareness and income, while the factors affecting willingness to pay, are previously received advice about proper disposal, education level, number of unwanted medicines in the household and gender. The majority of Serbian people dispose unused medicines improperly, mostly into household garbage. Well-organized and easily accessible collection programs are essential in order to enable the general public to return unused medicines for proper disposal.

1. Introduction

The presence of medicines in drinking water, as a result of contaminated groundwater, rivers and lakes is a problem that will continue to grow as the population expands and more medicines are dispensed. However, the environmental importance and human health risk that this represents may not be known for years (Daughton, 2003; Leung et al., 2013).

While medicines can enter the environment during the production process, consumption or disposal, improper disposal of pharmaceutical waste from households is considered one of the most important routes for the entry of medicines into the environment (Daughton, 2003; Schwab et al., 2005; Webb et al., 2003). The current literature data suggests that improper disposal of medicines is a global problem which plays a significant role in environmental contamination (Paut Kusturica et al., 2017; Tong et al., 2011). According to literature, the most common reason reported for not returning medicines to pharmacies or other collection sites is lack of information and awareness on the existence of available unwanted medicine collection schemes in the community (Fenech et al., 2013; Kruopiene and Dvarioniene, 2010; Sasu et al., 2012).

Proper collection and disposal of medicine waste from the household can reduce the negative impact of medicines on the environment (Lubick, 2010). Organized collection programs of unused medicines are being implemented in many countries around the world enabling medicines to be collected at

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pre-designated sites (pharmacies, health centers, etc.) in order to protect public health and the environment (Vogler et al., 2014; Vellinga et al., 2014; Arkaravichien et al., 2014; Glassmeyer et al., 2009). Under the provisions of current European Union legislation (EC, 2004), all the EU Member States have to establish collection programs to safely dispose of unused expired medicines (Directive 2004/27/EC). The methods used for collection differ among countries, but in general, pharmacies play an essential role (Vogler et al., 2014; Persson et al., 2009; Dias-Ferreira et al., 2016). The financial support for drug collection also varies among the countries, as some countries rely only on government funding, while other are supported through the pharmaceutical industry or the pharmacies themselves (Glassmeyer et al., 2009). Nevertheless, several surveys have noted that the implementation of these systems and their efficiency varies widely across the EU Member States (Volmer, 2010) and it is not clear whether all the EU countries have implemented these requirements. For example, for Cyprus, Malta and Bulgaria, no information to clarify the implementation of these collection systems exists (Bungau et al., 2018; Volmer, 2010). The problem is also common in the countries where the management of medicine-based waste is in its infancy, as studies performed in Romania and Croatia both showed that complicated procedures and high cost incurred by pharmacies cause some pharmacies to refuse to collect unused medicines from the population (Bungau et al., 2018; Jonjic and Vitale, 2014). In the US, the safest approach for drug disposal is a local or national drug take-back program on the national Drug Enforcement Administration (DEA) authorized collection site. The DEA has occasionally sponsored the National Prescription Take-Back day to collect unused medicines. Moreover, the DEA has authorized certain entities like retail pharmacies, drug distributors or drug manufacturers, to become the collection sites for unused medicines (Glassmeyer et al., 2009).

A recent study performed in Serbia has shown that unused and expired medicines are often present in households, and that throwing medicines in the garbage is the predominant disposal method among the Serbian population (Paut Kusturica et al., 2012; Paut Kusturica et al., 2016). Although more than half of the participants were aware that medicines may negatively impact the environment, environmental awareness did not necessarily equate with behavior that initiated proper disposal of unused medicines, indicating that other issues, such as the availability of an organized disposal system, play an important role (Paut Kusturica et al., 2012). Although in Serbia the New Rule for Medical Waste Management was established in November 2010, it is not fully applied in everyday practice. This regulation imposes an obligation for pharmacies to accept unused and expired medicines brought in by the public and return them to wholesalers, manufacturers or special operators trained to collect and transport waste for destruction. However, the new legislation has created many problems due to the vagueness of relevant regulations and inadequately defined responsibilities for drug wholesalers and manufacturers. In practice, there are many unresolved issues arising from unclearly identified financial responsibility, which allows both manufacturers and wholesalers to avoid their financial obligations, so that operators who may have an interest in this business do not know who will pay for this service. The operator is obliged to collect these medicines from the pharmacy and transport them to the warehouse, where these medicines are classified and stored as medicine waste until they are exported to some of the EU countries where they are to be properly destroyed (State Gazete, 2010). This problem has not yet been resolved and pharmacies stopped collecting the medicines from public because the warehouse storage capacities were filled.

Therefore, the aim of this paper is to examine the current methods of disposal of unused medicines from households in Serbia, as well as the willingness of Serbian residents to participate and bear the costs of organizing the unused or unwanted medicines collection program. Secondly, this research aims to define factors contributing to an individual's willingness to participate and pay for a medicine collection program.

2. Methods

2.1. Survey design and data collection

The survey was designed to collect information from participants regarding the presence of unwanted medicines within the household, general medicine disposal practices, previous receipt of advice about proper medicine disposal, previous participation in a program for the disposal of unused medicines, likelihood to participate in a medicine take-back program, willingness to pay for a medicine disposal program (per prescription and per visit), perception of the importance of the environment, and demographic variables. The questionnaire used in this survey was based on one previously used (Vielma Delano, 2016). Participants were patients visiting private chain pharmacies in the four largest cities in Serbia: Belgrade, Novi Sad, Niš and Subotica. Data were collected by trained interviewers in private pharmacies during the period from December 2017 to November 2018. The research was approved by the Ethical Committee of the Faculty of Medicine of Novi Sad (approval number: 01-39/104/1).

The sample population included randomly selected patients in private pharmacies. The interviewer asked every third patient to participate until the number of 200 patients in each city was reached. The only criteria for inclusion in the study were that the participants were older than 18 years. Each patient provided written informed consent after receiving all the necessary information regarding the survey. The examiner then recorded the verbal responses of the patients to the questions. The survey participants were asked to establish their willingness to participate, willingness to pay per prescription (WTPP) and willingness to pay per visit (WTPV) for the collection of unused medicines at a pre-defined location (pharmacy or health center). The contingent valuation question was designed assuming a fee had to be paid to drop off medicines at a predesignated collection site, based on either the number of medicines or the number of visits. The hypothetical situation was established in a similar manner to that published by Vielma Delano (2016).

Afterwards, respondents were asked about the average number of medicines likely to dispose of, and their WTP. Given the limitations of the survey to ensure a response to these questions, ranges were provided. The options provided for WTPP ranged from 0 dinars to 50+ RSD (0–48.3 USD), with 10 RSD (0.096 USD) increments, and 0 to 100+ dinars (0–0.97 USD) with 20 RSD (0.19 USD) increments for the WTPV option (conversion rate 1 USD = 103.4 RSD, based on the National Bank of Serbia official middle RSD exchange rate on the 31.12.2018). The data was analyzed by basic descriptive statistics, nonparametric statistical tests and advanced econometric modeling. Categorical variables were summarized by percentages and the crosstab procedure. χ^2 test was employed to test significant relationship between two categorical variables by comparing categories for one variable across categories of the second variable. Relationship between categorical variables was also examined via Spearman correlation. The level of significance in all tests was 0.05. Analyses were performed in software: SmallStata 13, R 3.43 and Excel 2013.

2.2. Econometric model analysis

The double-hurdle model was created to estimate both WTPP and WTPV. The model was proposed by Cragg (1971). The main

assumption was that for each individual there were two decisions making processes with regard to purchasing an item. Each of these processes was determined by a different set of independent variables. More precisely, there were 2 separate hurdles to be passed in order to have nonzero level of expenditure. The general model specification is:

$$y_{i1}^{*} = w_i'\alpha + v_i \text{ Participation decision} \quad (1)$$

$$y_{i2}^{*} = x_i'\beta + u_i \text{ Expenditure decision} \quad (2)$$

$$y_i = x_i'\beta + u_i \text{ if } y_{i1}^{*} > 0 \text{ and } y_{i2}^{*} > 0 \quad (3)$$

$$y_i = 0 \text{ otherwise} \quad (4)$$

where $i = 1, \cdots, n$ and

y_{i1}^{*} is a variable that describes household's decision to participate in WTPP/WTPV
y_{i2}^{*} is variable that describes household's consumption
y_i is the observed dependent variable
w_i, x_i are sets of independent variables explaining the participation, i.e. expenditure decision
v_i, u_i are the i.i.d normal error terms.

In order to assess the impact of the independent variable on the dependent variable, we needed to decompose the unconditional mean into probability of participation and the conditional expectation.

The unconditional mean is

$$E(y|x_i) = P(y_i > 0|x)E(y|x_i, y_i > 0), \quad (5)$$

while the conditional mean is given with

$$E(y|y_i > 0, x_i) = x_i\beta + \sigma_i \frac{\phi(\frac{x_i\beta}{\sigma_i})}{\Phi(\frac{x_i\beta}{\sigma_i})}, \quad (6)$$

where ϕ is the standard normal probability distribution function.

The double-hurdle model is estimated using maximum likelihood techniques. In our model the same specification of independent variables in both stages for both WTPP and WTPV is taken. In the first stage the participation decision was defined as:

$$y_{i1}^{*} = Env_i\beta_{Env} + Phar_i\beta_{Phar} + Dem_i\beta_{Dem} + v_i, \quad (7)$$

where $\boldsymbol{Env_i}$is set of independent environmental variables included environmental awareness, i.e. important (*e.imp*) and previously received advice about proper disposal of medicines from households (*advice*); $\boldsymbol{Phar_i}$ is the set of pharmaceutical variables including the presence of unwanted medicines in households over the last 12 months (*unmed*), and a dummy variable to control for respondents that have participated in a medicine collection program before (*envp*) and number of packages likely to drop off at a collection point in the future (*nupack*); $\boldsymbol{Dem_i}$ is the set of socioeconomic variables including number of people in the household (*pple*), average respondent's monthly income (i.e. 0.00–24,000din (*inc0*), 24,001–45,000din (*inc24*), 45,001–60,000din (*inc45*), 60,001–80,000 (*inc60*), 80,001–100,000 (*inc80*) and over 100,000 (*inc100*), college education (*education*), age (i.e. 18–45 years old (*age18*), 46–65 years old (*age46*), and over 65 years old (*age65*), and gender (*male*) (Vielma Delano, 2016).

In the second stage, the following specification of the expenditure decision is taken:

$$y_{i2}^{*} = Env_{(res)i}\beta_{Env} + Phar_{(res)i}\beta_{Phar} + Dem_i\beta_{Dem} + u_i \quad (8)$$

where $\boldsymbol{Env_{(res)i}}$ is advice, $\boldsymbol{Phar_{(res)i}}$ are envp and nupack and $\boldsymbol{Dem_i}$ is set including pple, Inc0, Inc24, Inc45, Inc60, Inc80, education, age18, age46 and gender.

3. Results

Descriptive statistics for the socioeconomic variable are presented in Table 1. The highest level of education was a graduate degree for more than half of the respondents (53%). More than half of the respondents were female (66.4%). The majority of respondents were employed (62.6%). Approximately, a third of the respondents (37.8%) had a monthly income between 24,000 and 45,000 RSD. Compared to the national averages, the sample had higher number of highly educated and employed respondents, while monthly income was similar to the national average.

More than 60% of the respondents reported that they had kept unused medicines in their households in the previous two years, and more than half continue to keep them. The most commonly reported reasons for the presence of unused medicines were not finishing the full therapy (34%) and not knowing what to do with the expired medicines (19.8%). Although most of the respondents believed the most appropriate disposal method for unused medicines was returning them to a pharmacy (81.9%), the most reported disposal method of unused medicines was throwing them into the garbage (59.1%). The majority of respondents had never received advice about the proper disposal of medicines from households nor participated in an organized collection program (Table 2). A significant relationship was found between education and the disposal practice of unused medicines from households ($p < 0.001$), as well as between age and respondent's opinion on the most appropriate method to dispose of unused medicines ($p = 0.003$).

An individual's willingness to participate and pay for the collection of unused medicines from their households is presented as a percentage in Fig. 1. Approximately 80% of surveyed respondents were very or somewhat likely to participate, however, just 46.3% stated they were very likely or somewhat likely to pay for the collection of their unused medicines. There is a statistically significant correlation between willingness to participate and willingness to

Table 1
Descriptive statistics for the socioeconomic variables.

Variable	n (%)
Place of residents	
Belgrade	200 (25)
Novi Sad	200 (25)
Subotica	200(25)
Nis	200(25)
Gender	
Female	531(66.4)
Male	269(33.6)
Age group	
18–25	88(11.0)
26–35	169(21.1)
36–45	181(22.6)
46–55	149(18.6)
56–65	110(13.8)
> 65	103(12.9)
Highest educational level	
Primary education	349(43.6)
Secondary education	420(52.5)
Higher education	31(3.9)
Working status	
Unemployed	142(17.8)
Employed	501(62.6)
Retired	157(19.6)
Monthly income (RSD)*	
<24,000	193(24.1)
24,000–45,000	302(37.8)
45,000–60,000	174(21.8)
60,000–80,000	78(9.8)
>80,000	53(6.6)

* RSD to USD conversion: <24,000 RSD ≈ 232 USD; 24,000–45,000 ≈ 232–435 USD; 45,000–60,000 RSD ≈ 435–580 USD; 60,000–80,000 RSD ≈ 580–773 USD; >80 000 RSD ≈ 773 USD.

Table 2
Unused medicines in households and their disposal practices.

Questions	n (%)
Did you keep any unused medicines (tablets, capsules, creams, syrups...)? in your household, in the last two years?	
Yes	495 (61.9)
No	305 (38.1)
Do you currently keep any unused medicines (tablets, capsules, creams, syrups...) in your household?	
Yes	419 (52.4)
No	381 (47.6)
Why do you keep unused medicines in your household? (choose one or more answers)	
I stopped taking medicines before I finished the therapy	325(34)
I stopped taking medicines because the doctor altered the therapy	128 (13.4)
I do not keep unused medicine in my household	248 (25.9)
Expiration date exceeded and I did not know what to do with them	189 (19.8)
User has passed away	43(4.5)
I hoard them	10(1.0)
Other	13(1.4)
How do you dispose of unused medicines from your household? (choose one answer)	
Throw in the garbage	473 (59.1)
Return to a pharmacy	100 (12.5)
Flush down the toilet or drain	27(3.4)
Burn	6(0.8)
I have never disposed of unused medicines	183 (22.9)
I collect them and wait for the further instructions	5(0.6)
Other	6(0.8)
In your opinion what is the most appropriate method to dispose of unused drugs?	
Return to a pharmacy	655 (81.9)
Flush down the toilet or drain	89 (11.1)
Throw in the garbage	11(1.4)
I do not know	19(2.4)
Organized collection	7(0.9)
Other	19(2.4)
Have you ever been given an advice about proper disposal of medicines from households?	
Yes	192 (24.0)
No	608 (76.0)
Yes	51(6.4)
No	749 (93.6)

pay for the collection of their unused medicines (rho = 0.354, p = 0.000).

When asked to list the specific amount they were willing to pay for prescription or per visit for the disposal of medicines, more than half of the respondents were willing to contribute by paying a fee for collection and disposal of expired medicines per prescription or per visit. The share of the amounts the respondents were willing to pay is presented in Fig. 2.

Almost all the respondents agreed that the environment was very important (64%) or important (33%) to them. The median number of packages respondents would discard per visit is 2 (range 0–20, IQR 2–4, mode 2). Around 40% of respondents were not willing to pay for either prescription or visit. A statistically significant relationship was found between WTPP and household income (p = 0.006), as well as between WTPV and household income

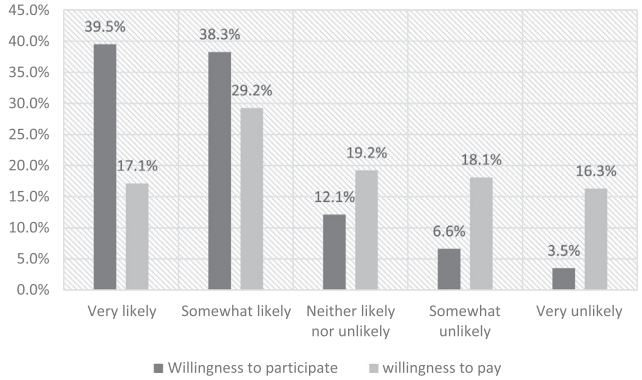

Fig. 1. Willingness to participate and willingness to pay for the collection of unused medicines.

(p = 0.003). Respondents with monthly income 24–45,000 RSD were the most willing to pay for the prescription, while those with income of 45–60,000 RSD were most willing to pay for a visit.

3.1. Econometric models

Double Hurdle models (DHM) (7)-(8) were created and estimations for both WTPP and WTPV were taken as dependent variables according to the procedure described in the Method section. The estimation results for WTPP and WTPV are outlined in Table 3. For both WTPP and WTPV models estimated coefficients for each independent variables in first stage equation (7) are given in columns with name "participation" together with corresponding p values. On the other hand, estimated coefficients figuring in second stage equation (8) and corresponding p values are given in column with name "consumption". The methods were compared using log-likelihood criteria.

The most significant predictors for WTPP were *e.imp, inc24, inc80*. On the other hand, the factors that determined the amount households were willing to pay per prescription were *advice, nupack, educ, gender*. The results showed that the most significant predictors for WTPV were *e.imp and inc24*. On the other hand, the factors that determined the amount households were willing to pay per visit were *advice, nupack, gender* (male) (Table 3).

Based on DHM results presented in Table 3, the mean WTPP and WTPV were estimated and presented in Table 4. The estimated unconditional mean WTPP was 15.39 RSD and the mean WTPP for those who have a positive WTP per prescription was 14.76 RSD. For WTP per visit, the mean value for all respondents was 27.37 RSD, while for those who indicated the amount, the value was 26.06 RSD.

4. Discussion

This paper presents the results from the survey of 800 randomly selected patients visiting private chain pharmacies in the four biggest cities in Serbia. The main contribution of the present study comes from the assessment of the willingness of Serbian people to participate and bear the cost for the establishment of a medicine disposal program for unwanted or unused medicines from households, using 'double hurdle modeling approach'. Although many results referring to general waste management awareness and disposal practices were reported both for Balkan countries (Bungau et al., 2018; Tit et al., 2016 Paut Kusturica et al., 2012) and worldwide (Rogowska et al., 2019; Chung and Brooks, 2019; Zorpas et al., 2017; Paut Kusturica et al., 2017; Dias-Ferreira et al., 2016), to the best of our knowledge no study in Europe explored willingness of

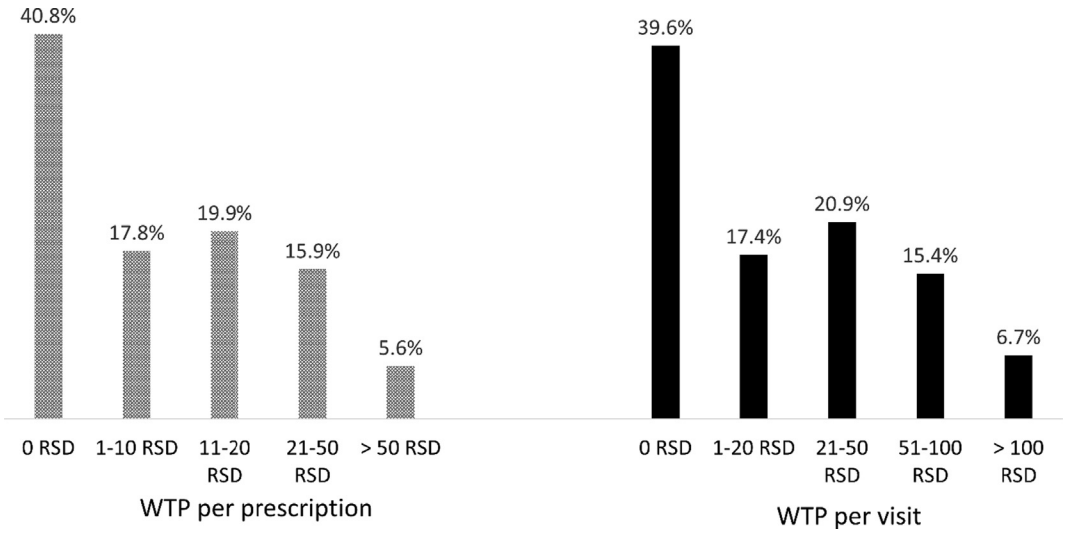

Fig. 2. Willingness to pay per package (WTPP) and Willingness to pay per visit (WTPV) in RSD.

Table 3
Double Hurdle Model estimations for WTPP and WTPV.

Variable		WTPP		WTPV	
		Participation	Consumption	Participation	Consumption
ENV	e.imp	0.5062936		0.4858251	
		0.000‡		0.000‡	
	advice	0.065653	−0.298712	0.0176588	−0.3396434
		0.762	0.015†	0.335	0.011†
PHAR	unmed	−0.1294498		−0.1132362	
		0.204		0.292	
	envp	−0.0464784	0.0123888	0.1382481	−0.085489
		0.829	0.956	0.634	0.767
	nupack	−0.0244877	−0.0580891	0.0187034	−0.0681205
		0.603	0.003†	0.611	0.002†
DEM	pple	−0.0078444	0.0573774	−0.0555226	0.0630244
		0.894	0.142	0.364	0.128
	inc0	−0.3220949	−0.3005917	−0.2002542	−0.2316959
		0.342	0.248	0.538	0.381
	inc24	−0.6107793	0.0745075	−0.6728715	0.1347923
		0.018†	0.767	0.023†	0.605
	inc45	−0.3352882	−0.0608076	−0.3723709	−0.0226361
		0.201	0.812	0.213	0.931
	inc60	−0.1971844	0.1431853	−0.3484291	0.2210071
		0.492	0.616	0.283	0.449
	inc80	−0.9281305	0.4677103	−0.7950276	0.5472835
		0.079*	0.307	0.186	0.334
	educ	−0.1922686	0.1673494	−0.1719617	0.1489921
		0.182	0.077*	0.164	0.124
	age18	0.112685	0.022613	0.1065835	0.0401774
		0.495	0.888	0.577	0.808
	age46	−0.214448	−0.0175098	−0.0190972	−0.002999
		0.230	0.917	0.926	0.986
	gender	0.0837301	−0.2095947	0.0954509	−0.195064
		0.627	0.043†	0.523	0.067*
	_cons	1.954	1.642	1.954	1.642
		0.000	0.006	0.000	0.006
	N	800			
	/sigma		1.0000	0.523	1.000
	/covariance		−0.298		−0.7517516
			0.780		0.196

* $p < 0.1$.
† $p < 0.05$.
‡ $p < 0.01$.

residents to bear the costs of establishing reverse distribution network for unwanted and unused medicine.

Results referring to unused medicines in households and their disposal practices are mainly in line with those of previous studies. The present results showed that more than 60% of the respondents maintained unused medicines in their households in the previous two years, and more than half still keep them. This is in accordance with the results of study conducted in Serbia in 2012, which

Table 4
Estimated mean WTP from DHM.

Dependent Variable	Conditional Expectation	Observations	Mean ± SE (RSD)
WTPP	WTP E(y)	800	14.77 ± 0.31*
	WTP E(y|y > 0)	465	15.39 ± 0.29
WTPV	WTP E(y)	800	26.06 ± 0.34
	WTP E(y|y > 0)	473	27.37 ± 0.33

* RSD to USD conversion: 14.77 RSD ≈ 0.14 USD; 15.39 RSD ≈ 0.15 USD; 26.06 RSD≈0.25 USD; 27.37 RSD ≈ 0.26 USD.

showed that unused medicines were often maintained in households and represented approximately a tenth of the total number of household medicines (Paut Kusturica et al., 2012). For more than third of the respondents, the most common reason given for keeping unused medicines were not finishing the full course, followed by not knowing what to do with the unwanted or expired medicines. However, the results of other studies identified resolution of patient's condition, medicine change due to misdiagnosis or side effects, forgetfulness, death of the patient and oversupply due to automatic refills and over-prescription by physicians as main reasons why medicines go unused (Zorpas et al., 2017; Ruhoy and Daughton, 2007; Seehusen and Edwards, 2006). In line with our results, the results from the survey in the USA demonstrated that the main reasons for accumulation of unused medicines were also stopping the therapy before the supply ran out or not knowing what to do with unused medicines (Vielma Delano, 2016). Respondents' lack of knowledge of what to do with unused medicines was expected as few of the respondents had previously received advice about proper disposal of household medicines. Similarly, the results of the study performed in Romania, a neighboring country, identified lack of legislation with clear and simple procedures that can be applied to both pharmacists and citizens as main shortcoming of organised medicine waste collection service (Bungau et al., 2018). Lack of the adequate information and clear instructions on proper manners of drug disposal was also reported in other countries (Braund et al., 2009; Fenech et al., 2013; Vellinga et al., 2014). Although most of the respondents believed the most appropriate disposal method for unused medicines was returning them to a pharmacy, the most reported disposal method was discarding into the garbage. Based on the literature, incorrect disposal of unused medicines represents a worldwide phenomen as studies carried out both in Europe (Bungau et al., 2018; Zorpas et al., 2017; Tit et al., 2016; Rogowska et al., 2019; Bound et al., 2006; Fenech et al., 2013; Kruopiene and Dvarioniene, 2010; Paut Kusturica et al., 2012) and globally (Abahussain and Ball, 2007; Kheir et al., 2011; et al., 2014; Braund et al., 2009; Auta et al., 2011; Shaaban et al., 2018; Chung and Brooks, 2019) all reported the domestic rubbish bin as the predominant method of disposal for unwanted medicines. The recent study performed in the neighbouring Balkan country revealed that even 95% of the population thrown the medicines in the garbage imposing the urgent need of public awareness campaigns (Tit et al., 2016). Other studies showed that gap between the possession of environmental awareness, and displaying proper disposal behavior is not exclusively connected to the Serbian setting (Abahussain and Ball, 2007; Bound et al., 2006). In addition, a U.S. study showed that most respondents believed that disposing of medicines in a secured lockbox located in a pharmacy or physician's office was the best method, nevertheless less than 10% used it as the actual mean of disposal (Law et al., 2014). Finally, while environmental awareness may impact the choice of what is considered the safest mean of disposal, actual behavior does not always equate with awareness, especially where no well-organized collection of unused medicines exists. This is not exclusively a Serbian issue, as there are some EU countries where medicine waste management faces with numerous problems such as incomplete legislation, operators exceeding their contracting costs, high cost of collecting expired medicines (Bungau et al., 2018). Furthermore, in Croatia, country with similar health care system, a model where pharmacies are responsible for financing unused medicines disposal without any kind of reimbursement proved to be quite inefficient (Jonjic and Vitale, 2014).

According to our results, approximately 40% of surveyed respondents were not interested in paying any amount for disposal of their unused medicines, although almost all of them considered environmental quality important. Similarly, the study performed in Texas indicated that all users of medicine take back programs considered the medicine take-back program as a valuable service, while more than half of respondents positively viewed paying for the service on a per weight basis (Thach et al., 2013). However, our results showed higher willingness to pay in comparison to the results of the study performed in the USA where 60% of the respondents were not willing to pay to take their unwanted medicines to a permanent collection center (Vielma Delano, 2016). Nevertheless, the percentage of respondents who are interested in being involved and bearing the cost for organized collection program for unused medicines is substantial as environmental programs are not common in the Serbian setting and almost all of the respondents reported they have never participated in one.

In the present study, the factors influencing an individual's decision to participate in medicine take-back programs were perceived environmental importance and income. In a similar study, the WTP per prescription was determined by the number of packages likely to be disposed of, the presence of unwanted medicines in the households, annual income between 60 and 75,000 and above 75,000 dollars, age and number of people living in households, with income being the only factor influencing the WTP per prescription in both studies (Vielma Delano, 2016). Despite the assumption of household size having a positive effect on the participation decision in WTP, due to higher risk of accidental poisoning or medicine abuse in larger households, number of people in households did not influence WTP per prescription. Furthermore, the results of the US study suggested expenses in larger households limiting the proportion of the budget used for pro-environmental activities as responsible for the observed negative association between household size and WTP (Vielma Delano, 2016).

The factors influencing the decision to participate in a medicine collection program differ from the factors that determine WTP per prescription or per visit, which is in agreement with the results of a similar study conducted in the US (Vielma Delano, 2016). In the present study, factors influencing the WTP were previously received advice about proper disposal of medicines from households, number of packages likely to be disposed of, education and gender. Though it is difficult to make a comparison with the study performed in the USA due to differences in legislation on medicine disposal practices, monthly incomes and general standards of the population, some similarities were observed. For the US residents, the factor influencing their WTP were the number of prescriptions, the number of environmental programs households were engaged with, age, gender (male) and income level (Vielma Delano, 2016). In the present study household income did not influence the WTP amount which is contrary to literature findings of a positive relationship between household income and willingness to pay for an environmental program (Ferreira and Moro, 2013; Klineberg et al., 1998). As for education level, present results support the findings that years of education correlate with pro-environmental behavior and that citizens with a higher education will most likely have more knowledge about environmental issues (Blocker and Eckberg, 1997; Klineberg et al., 1998).

As number of packages positively influenced both the WTPP and WTPV, it is probable that the number of medicines a person is likely to dispose of reflects the number of unused medicines in their households. According to the present results, except for monthly income and male gender, no sociodemographic characteristic influenced the respondents' WTPP and WTPV. For gender, the expectation following other studies was that women have a stronger preference to participate in environmental programs than men (Ferreira and Moro, 2013; Kotchen et al., 2009). The difference with earlier studies might be explained by the fact that, although women tend to express more environmental concern, this does not essentially imply they are more likely to actually become involved in environmental actions compared to men (Blocker and Eckberg, 1997).

The results of our study indicated a substantial willingness to pay both per medicine prescription and per visit. A simple approach to estimate the annual benefits of establishing a collection of unused medicines from households is to multiply the estimated mean WTP by the average number of prescriptions per year, as it was done in the study based on a telephone survey of 1005 residents in southern California (Kotchen et al., 2009). Nevertheless, this approach does not affect the population equitably, as imposing a surcharge on every prescription would place an unequal burden on older residents whose prescriptions tend to increase with age. However, these results indicated a substantial willingness to pay a surcharge on prescriptions to support the establishment of a medicine disposal program, as estimated mean willingness to pay was $US1.53 per prescription, which translated into an average annual willingness to pay of approximately $14. These results suggested ample scope for establishing a medicine disposal program that would yield positive net social benefits, even if the surcharge was applied to only one prescription per year (Kotchen et al., 2009). Based on the number of households in Serbia according to the 2011 census (2.5 million), corrected according to the proportion of persons with WTP > 0 (58.1%), mean conditional WTP per prescription of 15.39 RSD and a median of 2 packages of unwanted medicine disposed per visit, total annual benefits of a medicine take-back program of 44.3 mil RSD (0.43 mil USD) were calculated, assuming a single annual visit. Although information about the cost for establishing a medicine collection program in Serbia is missing, present results are starting points to better inform researchers, policymakers, program providers and other interested parties on the value of these collection programs and to mitigate the introduction of medicine compounds in the environment. The concept of paying a fee relative to the amount of generated waste instead of fixed fee is well accepted among general public. According to the report of European Commission on attitudes of population on general waste management, paying in proportion to the quantity of unsorted waste generated is the preferred approach in all but four EU Member States, and is supported by the highest percentages of people in Italy (58%), Belgium (54%) and Finland (54%) (EU Open Data Portal, 2015).

In our opinion, targeted public educational campaigns should be organized continuously, but advice on proper medicine disposal must routinely follow medicine dispensing. Educating general public about environmental concerns is an essential step in altering disposal practices, however to result in more pro-environmental behavior it is necessary to make the action easy and use the familiar locations such as pharmacies as collection locations. According to the literature, the model where pharmacies take financial responsibility for the disposal of unused medicines without some kind of reimbursement is not recommended (Jonjic and Vitale, 2014; Bungau et al., 2018). In the most European countries, medicine waste disposal costs are paid or funded by pharmaceutical industry, local authorities, health insurance companies, or the government. Furthermore, in Great Britain and Denmark, pharmacies are even recompensed for providing the collections of unused medicines. In case that the cost is borne by the pharmacy, then it is reimbursed such as in Czech Republic or calculated within the pharmacy margin like in Sweden (Jonjic and Vitale, 2014). One of the valuable solutions is an implementation of the Extended Producer Responsibility (EPR) laws which require that pharmaceutical manufacturers manage their products in all phases of their life cycle, including end of life treatment and waste management. To comply with this legislation pharmaceutical manufacturers and others involved in the product chain should plan, manage and fund take-back programs to securely collect unwanted medicines from the public and ensure the collected medicines are properly managed. European waste legislation currently gives a global framework for the implementation of EPR in Europe and EPR policies have been designed and implemented in a very heterogeneous manner across Europe. In Belgium, the Pharmaceutical EPR Program is organized through a partnership of wholesalers, manufacturers and pharmacies. The program is funded by wholesalers, who pay for collection, storage and transportation, while manufacturers pay for incineration of the collected materials based on market share. In France, Spain and Hungary, funding is fully provided by the pharmaceutical industry and all pharmacies are mandated to take back medicines. In Portugal, funding is provided by pharmaceutical manufacturers and distributors as well as the national pharmacy association. Even though participation is voluntary, almost all pharmacies acted as take-back locations in 2011 (California Product Stewardship Council, 2019).

While our study is important in providing new information in this area of research and in influencing program providers and policymakers for future decision-making, some limitations need to be mentioned. Firstly, this study was undertaken in the four biggest cities in Serbia with a large proportion of higher educated people, making it difficult to extrapolate the results to the general population and to the national level. However, these areas with the highest population will have the greatest impact on any future disposal program. Also, answers to the questions regarding disposal habits and attitudes are self-reported and some respondents may have been reticent to tell the truth.

5. Conclusions

The current results suggest that improper disposal of medicines is still prevalent among Serbian people, as unused medicines are mostly disposed of improperly, via the domestic garbage. The majority of people demonstrated strong willingness to participate in medicine collection programs and more than half of them were even willing to make a financial contribution towards an organized collection program. The factors that influenced willingness to participate were environmental awareness and income, while the factors affecting willingness to pay were prior advice received about proper disposal of medicines from households, education level, number of packages likely to be dropped off at a collection point and gender (male). To increase participation and willingness to pay for a disposal program, education and awareness campaigns advising the general public on proper medicine disposal are necessary. Well-organized, cost-effective and easily accessible collection programs are essential in order to enable the general public to return unused medicines to collection schemes for proper disposal. However, it needs to be emphasized that once collection programs are implemented, it may take years of active educational campaigns before any significant improvements are discernible, so prompt action is required.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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