

# Informing and public awareness on waste separation: a case study of the City of Niš (Serbia)

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**Abstract** Modern waste management is virtually impossible without public awareness on proper waste handling and the desire to tackle and solve this issue. By adopting the National Waste Management Strategy and the City of Niš Waste Management Strategy (Serbia), the separate disposal of household waste has become a priority. The paper presents the results of a survey conducted among the residents of Niš about how they are informed on waste issues and their willingness to separately collect their household waste. The aim of the research is to obtain data on the dominant source of information about the significance of waste separation and waste disposal, which would help implement the local waste management strategy. The survey included 600 respondents from local urban communities. The results were processed using SPSS software and descriptive and nonparametric analysis. The results revealed that most respondents had accurate information about waste and recycling, regardless of how they received it, that they were prepared to become involved in selective household waste separation, and that their age and education level were relevant factors in obtaining accurate information. The majority of respondents receive their information through television and there is a connection between the respondents' age and dwelling (house, flat)

and how they collect their information. The results show that formal and non-formal education about waste and recycling is essential and that the Public Utility Company “Mediana” and the local TV stations need to be more active in raising public awareness.

**Keywords** Niš (Serbia) · Public awareness · Waste · Waste separation

## Introduction

Environmental pollution by waste (wastewater, solid substances, waste gases, etc.) is one of the causes of distortions in the environmental capacity, with a negative impact on human health and the development of new social challenges. Scientists are trying to reduce or eliminate the unfavourable effects of waste by proposing diverse methods and procedures for detecting and eliminating pollutants. In recent years, electrochemical and other methods have been used intensively to determine environmental pollutants. For example, nanosensors have been used to determine hydrazine, hydroxylamine, phenol and sulphite (Sadeghi et al. 2013; Karimi-Maleh et al. 2014; Golestanifar et al. 2015; Gupta et al. 2015) in water and wastewater samples. Air quality monitoring (Mead et al. 2013; Li et al. 2015; Cavellin et al. 2016) is a measure suggested to control the presence of NO<sub>2</sub>, PM<sub>10</sub>, O<sub>3</sub>, NO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub> and other pollutants which, if found in elevated concentrations, adversely affect human health, as well as flora and fauna. The amount of solid waste is rather difficult to determine (Hoorweg and Bhada-Tata 2012), while its improper disposal is a particular problem. In this sense, waste management is becoming a significant issue worldwide due to the fact that waste generation goes beyond the

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capacities of the living environment. The above-mentioned facts highlight the necessity to introduce an efficient waste management system. Almorza et al. (2002) addressed the problems of growing environmental crisis as a consequence of waste accumulation, reflecting that a possible solution might be adequate waste management resulting from the in-depth study of these issues, and an adequate waste management policy. A significant element of waste management is not only the systematic collection and separation of waste for further treatment or disposal in order to preserve human health and the environment, but also avoidance of the unattractive image of waste on the one hand and making financial savings on the other. The economic importance of integrated waste management is undoubted, which is evidenced by the comparative analysis of the municipal waste management in some European countries (Antonioli and Massarutto 2012).

According to Sujauddin et al. (2008), the amount of waste generated in households depends on family size, the educational level of family members and their monthly income. Attitudes related to household waste separation depend on the active support and financial investment of utility companies (Timlett and Williams 2009), as well as on the fees for the collection service based on the waste volume or weight (Scheinberg et al. 2011). As Ors (2012) points out, gender, peer influence, land size and the household location, as well as membership in environmental protection organizations, influence the degree of recycling and utilization of household waste and the waste separation behaviour of the household members.

The Republic of Serbia, through its development strategy, committed itself to sustainable development targeted at solving one of the biggest environmental problems nowadays—the problem of waste. The Waste Management Strategy for the period 2003–2008 did not produce the desired outcome, despite the fact that two important laws and numerous bylaws were adopted: the Law on Waste Management and the Law on Packaging and Packaging Waste (The Official Gazette of the RS 2009). The latest Waste Management Strategy for the period 2010–2019 reveals that the estimated mean daily generation of municipal waste in urban areas is 1 kg per capita and 0.7 kg per capita in rural areas. It is disappointing to find that only 60% of municipal waste is collected through organized house-to-house collection services, predominantly in urban areas, due to the apparent lack of adequate equipment for proper waste treatment. Regardless of the fact that primary recycling in Serbia is prescribed by law and that the law obliges Serbian citizens to separate paper, glass and metal (cans) in specially marked waste containers, recycling does not work in practice. There is no organized system of separate waste collection, sorting and recycling, and therefore, waste generated in this part of

Europe is underutilized. The Action Plan suggested in the Waste Management Strategy envisages the development of a system for primary waste selection in local governments, highlighting the activities focused on the development of public awareness about the need for source-separated collection (Waste Management Strategy for the period 2010–2019).

According to the Serbian Waste Management Strategy and related laws, municipal waste management is within the jurisdiction of local governments, and they are obliged to adopt the local waste management plan and ensure its implementation. In accordance with this obligation and bearing in mind that one of the problems addressed in the City of Niš Development Strategy is the problem of inadequate solid waste management, the City of Niš has adopted a Local Waste Management Plan (<http://strategije.skgo.org/upload/110310LPUotpad.pdf>). The overall objective of this document is to help improve environmental protection, collection services and the disposal of municipal solid waste, and sanitary and health conditions in Niš.

Similar to other countries in the region, for example Albania (Dhimitri et al. 2012; Kodra and Milios 2013), the majority of the towns and cities in Serbia, including Niš as the second-largest city, are faced with the problem of inadequate waste management. The Public Utility Company Mediana (PUE Mediana) is the only provider of waste management services in Niš and it is in charge of maintaining cleanliness in public spaces, cleaning streets, organizing the collection and disposal of municipal and industrial waste, and maintaining the city's public hygiene. Unfortunately, there is no sanitary landfill in the city. In 2014, 82.93% of waste disposed of at the local landfill (dump) was municipal waste. Although the project of rehabilitation and reclamation has already started, the existing landfill still poses a risk to the environment. In addition to the lack of a sanitary landfill, there is also the problem of the large number of illegal dumps (as many as 71) in the City of Niš (<http://strategije.skgo.org/upload/110310LPUotpad.pdf>).

An analysis of the composition of the waste collected in the city was carried out for the purpose of developing the Local Waste Management Plan. It was observed that the quantities and composition of waste vary depending on the month and season, but also depending on the waste collection location, i.e. housing types (individual or collective). A sample of the waste collected in the parts of the city with predominant individual housing comprised mainly organic waste (54.29%). It is interesting to note that there were more fine elements (17.54%) than garden waste (16.45%), which is not often the case. There was also high volume of plastic bags (6.27%). Unlike in individual housing, in areas with predominant collective dwellings, there was less garden waste and fine elements, but a larger proportion of textile waste (18.69%), of which diapers

made up only 3.67%. The amount of plastic bags disposed of from collective residences was larger than the amount collected from individual housing (11.56%). A large proportion of the unused municipal waste consisted of hard plastic (6.57%) and glass (6.41%).

According to Torretta et al. (2013), intensive campaigns focused on informing the population about the importance of waste collection, especially through providing practical information concerning waste collection locations, as well as promotion of sustainable consumption, can contribute to raising public awareness about the importance of separate waste disposal and waste management. Since integrated waste management implies the involvement of residents in proper waste handling at the source (i.e. in the household), it is crucial to have access to information on waste and its impact on the environment and human health. Tonglet et al. (2004) confirmed that adequate knowledge, opportunities and incentives were the basis for the understanding and perception of recycling among household members, which had a significant influence on their behaviour. In fact, it can be said that public information is one of the main instruments for raising awareness on waste and influencing human habits to reduce, reuse and recycle.

Taking into account the importance of information for shaping residents' behaviour regarding household waste, the quantities of waste in the city and willingness to adequately manage waste, as well as the desire for local people to be involved and interested in waste management, we came up with the subject for our research. From this point on, our research subject can be defined as possible ways to inform the citizens of Niš about the environmental impact of waste and benefits of recycling and waste separation.

The paper starts from a general hypothesis that the lack of information and willingness of the citizens of Niš to dispose of their waste separately are mainly conditioned by the manner of providing information. Two specific hypotheses were set:

1. The demographic characteristics of the population do not influence the level of information on waste, recycling and the willingness to separate household waste.
2. The means of providing information on waste separation do not affect citizens' willingness to collect and separate their household waste.

To prove the hypotheses, the authors conducted a survey in the City of Niš, in the period from 1 April to 1 May, 2015.

## Materials and methods

A random sample of 600 respondents consisted of the representatives of households in individual houses and collective residential buildings in the city area.

Data were collected by the method of examination. The research instrument was a questionnaire, designed specifically for this study, comprising 27 open and closed questions (see Supplementary material). The survey was conducted anonymously. It should be emphasized that the empirical part of the research was conducted during the implementation of the cross-border cooperation project *WASTE*, conducted by PUE "Mediana" in Niš, Serbia, and the Municipality of Pernik from Bulgaria, financed by EU funds. The aim of the project was to strengthen citizens' awareness of recyclable waste. One of the project outcomes was to purchase and distribute 138,000 plastic bin bags and 18,300 plastic bins for recyclable waste to households in the City of Niš.

Descriptive and nonparametric statistics were used for data interpretation using SPSS (Statistical Package for the Social Sciences) software.

## Results and discussion

The survey covered 53.7% male and 46.3% female respondents. The highest percentage of the respondents belongs to the age group of 31–65 (46.2%), a smaller percentage is in the 18–30 age group (41.8%) and the lowest percentage of respondents is older than 66 years of age (12%). In terms of educational attainment, 47.5% of the respondents had completed secondary education, 24.4% university education, 19.6% college education and 8.5% primary education. Of the total number of respondents, 56.7% live in individual while 43.3% live in collective dwellings.

The answers to questions concerning what happens to household waste, how long it takes for food waste to decompose, whether biodegradable material is degradable under the influence of micro-organisms, whether we can obtain fertilizers that improve soil quality after decomposition of organic waste (food, paper, cardboard, garden waste), whether we can use waste disposed of in a landfill for energy production, whether plastic bags pollute the environment, whether illegal dumping has a negative effect on human health and what a sanitary landfill is indicate that a high percentage of respondents, regardless of their gender and dwelling (individual—a house or collective—a flat), have accurate information on waste.

The distribution of responses and the resulting value of Pearson's Chi-square and Asymp. Sig. show an association between age and having accurate information on the time needed for food waste decomposition and the impact of illegal dumps on human health. As shown in Table 1, the oldest respondents provided the fewest correct answers.

The results of standard deviation on the whole sample indicate that there is no significant mean deviation

( $M = 2.03$ ;  $SD = 0.655$ ;  $SE = 0.027$ ), neither are there any deviations in the age groups (under 30:  $M = 2.02$ ;  $SD = 0.639$ ;  $SE = 0.040$ ; from 31 to 65:  $M = 2.08$ ;  $SD = 0.624$ ;  $SE = 0.037$ ; over 65:  $M = 1.93$ ;  $SD = 0.811$ ;  $SE = 0.040$ ). Single-factor analysis of variance (ANOVA) did not determine a statistically significant difference of  $p < 0.05$  while examining the attitudes of respondents about the time necessary for waste decomposition, depending on the age group they belonged to:  $F(2.597) = 1.6$ ;  $p = 0.21$ .

$\eta^2 = 0.005$  by Cohen’s guidelines indicate the insignificant impact of age on statistical differences. Subsequent comparison using Tukey’s HSD test provided information about the differences in mean values (over 65:  $M = 1.93$ ;  $SD = 0.811$ ; from 31 to 65:  $M = 2.08$ ;  $SD = 0.624$  and under 30:  $M = 2.02$ ;  $SD = 0.639$ ). However, the respondents aged between 31 and 65 gave more correct answers than the respondents under 30 and those older than 65 years of age. The group of respondents over 65 has the lowest average value.

Likewise, the oldest respondents gave the fewest correct answers to the question pertaining to the impact of illegal dumps on human health (Table 2), whereas, as with the previous question, the highest number of correct answers was given by the respondents in the 31–65 age group.

The results of standard deviation indicate the absence of a significant mean deviation for the entire sample ( $M = 22.1$ ;  $SD = 0.595$ ;  $SE = 0.024$ ) and in the age

**Table 1** Years of age and answers to the question: How long does it take for food waste to decompose?

	1 day	2 weeks	1 year	Total
<i>Age</i>				
<i>Under 30</i>				
Number of respondents	49	149	53	251
%	19.5	59.4	21.1	100.0
% of Total	8.2	24.8	8.8	41.8
<i>31–65</i>				
Number of respondents	44	168	65	277
%	15.9	60.6	23.5	100.0
% of Total	7.3	28.0	10.8	46.2
<i>Over 65</i>				
Number of respondents	26	25	21	72
%	36.1	34.7	29.2	100.0
% of Total	4.3	4.2	3.5	12.0
<i>Total</i>				
Number of respondents	119	342	139	600
%	19.8	57.0	23.2	100.0
% of Total	19.8	57.0	23.2	100.0

Pearson  $\chi^2 = 20.557$ ,  $df = 4$  Asymp. Sig. (2-sided) = .000

**Table 2** Years of age and answers to the question: Does illegal dumping have a negative impact on human health?

	Yes	No	I don’t know	Total
<i>Age</i>				
<i>Under 30</i>				
Number of respondents	216	14	19	249
%	86.7	5.6	7.6	100.0
% of Total	36.5	2.4	3.2	42.1
<i>31–65</i>				
Number of respondents	247	11	16	274
%	90.1	4.0	5.8	100.0
% of Total	41.7	1.9	2.7	46.3
<i>Over 65</i>				
Number of respondents	49	2	18	69
%	71.0	2.9	26.1	100.0
% of Total	8.3	0.3	3.0	11.7
<i>Total</i>				
Number of respondents	512	27	53	592
%	86.5	4.6	9.0	100.0
% of Total	86.5	4.6	9.0	100.0

Pearson’s  $\chi^2 = 29.628$ ,  $df = 4$  Asymp. Sig. (2-sided) = .000

groups (under 30:  $M = 1.21$ ;  $SD = 0.595$ ;  $SE = 0.024$ ; from 31 to 65:  $M = 1.16$ ;  $SD = 0.500$ ;  $SE = 0.030$ , over 65:  $M = 1.55$ ;  $SD = 0.883$ ;  $SE = 0.106$ ). Based on the results obtained, there is a statistically significant difference of  $p < 0.05$  which points to the influence of the respondents’ age on their views about the impact of illegal dumps on human health:  $F(2.589) = 12.71$ ;  $p = 0.000$ . Statistical significance is supported by Cohen’s  $\eta^2 = 0.04$ , which indicates the mean impact. The comparisons made by Tukey’s HSD test show that the mean in the 31–65 age group ( $M = 1.16$ ;  $SD = 0.50$ ) differs most from the mean value in the oldest respondents’ group ( $M = 1.55$ ;  $SD = 0.88$ ) and marginally from the group of the youngest respondents ( $M = 1.21$ ;  $SD = 0.57$ ). The respondents aged between 31 and 65 provided more correct answers than the respondents under 30 years of age and a significantly higher number of correct answers than those over 65.

Based on the results, we noticed a connection between the level of the respondents’ education and accurate information about the questions concerning what happens to household waste [Pearson’s  $\chi^2 = 108.229$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000], how long it takes food waste to decompose [Pearson’s  $\chi^2 = 66.238$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000], whether biodegradable material becomes degradable under the influence of microorganisms [Pearson’s  $\chi^2 = 21,100$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.002], whether plastic bags pollute the

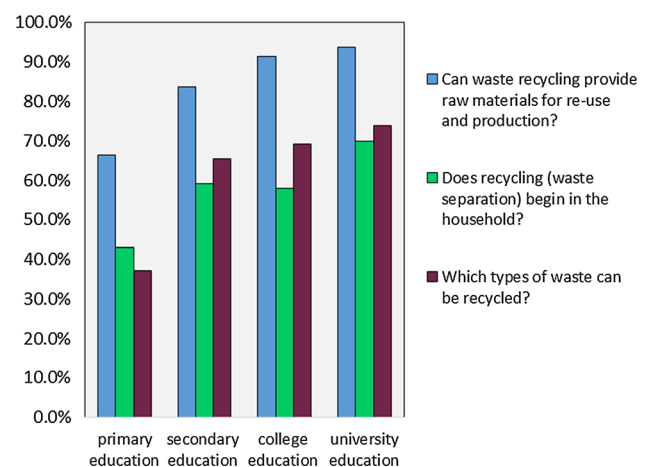


environment [Pearson's  $\chi^2 = 18.518$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.005], whether illegal dumping has a negative impact on human health [Pearson's  $\chi^2 = 39.840$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000] and what a sanitary landfill is [Pearson's  $\chi^2 = 35.997$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000]. As expected, the distribution of correct answers to all the above questions increases with the level of education. The lowest percentage of respondents who answered correctly completed primary education only, whereas the highest percentage of respondents who provided the correct answers had completed university education.

Generally, the respondents possess information and knowledge about recycling. Most citizens responded correctly when asked whether waste recycling can provide raw materials for reuse and production ( $N = 598$ , 86.3%), as well as whether recycling (waste separation) begins in the household ( $N = 598$ , 60.2%) and which types of waste can be recycled ( $N = 598$ , 65.9%), regardless of their gender, place of residence and age. However, the Pearson's Chi-square values and significance level indicate a connection between education level and correct answers to the questions about recycling. The proportion of respondents who answered correctly increases with the level of education, and this particularly refers to the question of whether waste recycling can provide raw materials for reuse and production. Of 51 respondents with primary education, 60.8% gave correct answers, 15.7% incorrect and 23.5% did not know the answer; 68% of respondents with secondary education answered correctly, 14.8% incorrectly and 17.3% did not know the answer ( $N = 284$ ). Of 117 respondents with college education 77.8% answered correctly, while exactly the same percentage of respondents answered incorrectly or did not know the answer (11.1%); of 146 respondents with a university degree 75.3% gave the correct answer, only 7.5% incorrect and 17.1% did not know the answer [Pearson's  $\chi^2 = 36,245$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000]. Also, when asked whether recycling (waste separation) begins in the household, the number of respondents who answered correctly increased as the level of education increased: 43.1% of respondents with primary education gave correct answers, 23.5% incorrect and 33.3% did not know; 59.2% of those with secondary education gave correct answers, while the same percentage gave incorrect ones or did not know the answer—22.5%; in the group of respondents with college education, 59.2% answered correctly, 25.6% incorrectly and 16.2% did not know the answer [Pearson's  $\chi^2 = 18.683$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.005]. To the question of which types of waste can be recycled, the respondents answered as follows: 58.8% of those with primary education claimed all household waste can be recycled, 3.9% only organic waste and 37.3% paper, glass,

plastic and metal; in the group of those with secondary education, 28.2% said all household waste could be recycled, 6.3% said organic waste only and 65.5% opted for paper, glass, plastic and metal; in the group with higher education, 28.2% said all household waste, 2.6% organic waste only and 69.2% paper, glass, plastic and metal; 24% of the respondents with university education claimed all household waste could be recycled, 2.1% only organic waste and 74% paper, glass, plastic and metal [Pearson's  $\chi^2 = 29.692$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000]. The percentage of correct answers depending on the level of education is shown in Fig. 1.

The resulting value of standard deviations 0.578 ( $M = 1.22$ ;  $SE = 0.024$ ) across the sample does not indicate statistical significance in the following groups—respondents with secondary education ( $M = 27.1$ ;  $SD = 0.653$ ;  $SE = 0.039$ ), college education ( $M = 1.14$ ;  $SD = 0.472$ ;  $SE = 0.044$ ) and university education ( $M = 1.09$ ;  $SD = 0.370$ ;  $SE = 0.031$ ). However, significance was observed in respondents with primary education ( $M = 1.47$ ;  $SD = 0.731$ ;  $SE = 0.102$ ). Single-factor analysis of variance (ANOVA) confirmed a statistically significant difference of  $p < 0.05$ , concerning the influence of the respondents' educational level on their opinions about whether recycling can provide raw materials for reuse and production, in the following manner:  $F(3,594) = 7.56$ ;  $p = 0.000$ .  $\eta^2 = 0.03$  indicates the mean impact of education on the respondents' attitudes about whether recycling can provide raw materials for reuse and production. Comparisons by Tukey's HSD test show that the mean value in the group of respondents with university education ( $M = 1.09$ ;  $SD = 0.37$ ) differs the most from the mean of the group with primary education ( $M = 1.47$ ;  $SD = 0.73$ ) and secondary education ( $M = 1.27$ ;  $SD = 0.65$ ), while it slightly differs from the group of respondents with college education ( $M = 1.14$ ;  $SD = 0.47$ ). The respondents with



**Fig. 1** Level of education and correct answers on recycling

university degrees have significantly more information about the possibility of using recycled waste compared to those with lower levels of education.

Similar data were obtained in response to the question on whether waste separation begins in the household.  $SD = 0.780$  ( $M = 1.58$ ;  $SE = 0.032$ ) on the entire sample do not indicate statistical significance in the group with secondary education ( $M = 1.61$ ;  $SD = 0.805$ ;  $SE = 0.048$ ), college education ( $M = 1.58$ ;  $SD = 0.757$ ;  $SE = 0.070$ ) or university education ( $M = 1.40$ ;  $SD = 0.670$ ;  $SE = 0.055$ ). Significance is observed only in the respondents with primary education ( $M = 1.90$ ;  $SD = 0.878$ ;  $SE = 0.123$ ). Data obtained by single-factor analysis of variance (ANOVA),  $F(3,594) = 5.66$ ;  $p = 0.001$  and  $\eta^2 = 0.02$  by Cohen's guidelines point to the low impact of education on the respondents' attitudes about whether recycling begins at home. Comparisons made by Tukey's HSD test indicate that the mean of the group with university education ( $M = 1.40$ ;  $SD = 0.67$ ) differs greatly from the mean of the group with primary ( $M = 1.90$ ;  $SD = 0.88$ ) and secondary school education ( $M = 1.61$ ;  $SD = 0.81$ ), while it slightly differs from the group of respondents with college education ( $M = 1.58$ ;  $SD = 0.76$ ). A higher percentage of university-educated respondents know that recycling begins at home.

As a response to the question about which type of waste can be recycled, the values obtained for the entire sample ( $M = 2.36$ ;  $SD = 0.910$ ;  $SE = 0.037$ ) and the values in the educational groups are as follows: primary ( $M = 1.78$ ;  $SD = 0.966$ ;  $SE = 0.135$ ), secondary ( $M = 2.37$ ;  $SD = 0.894$ ;  $SE = 0.053$ ), college ( $M = 2.41$ ;  $SD = 0.902$ ;  $SE = 0.083$ ) and university education ( $M = 2.50$ ;  $SD = 0.857$ ;  $SE = 0.071$ ). Single-factor analysis of variance (ANOVA) was used to determine the statistically significant difference of  $p < 0.05$  referring to the impact of the respondents' level of education and their knowledge of which types of waste can be recycled— $F(3,594) = 8.40$ ;  $p = 0.000$ , while the eta coefficient of 0.04 indicates the mean impact of the respondents' education on their views about what kind of waste can be recycled. Comparisons using Tukey's HSD test indicate that the mean of the university-educated group of respondents ( $M = 2.50$ ;  $SD = 0.86$ ) differs most from the mean values of the group with primary education ( $M = 1.78$ ;  $SD = 0.97$ ) and secondary education ( $M = 2.37$ ;  $SD = 0.89$ ), while it slightly differs from the group of respondents with college education ( $M = 2.41$ ;  $SD = 0.90$ ). Educated respondents were more likely to be familiar with what type of waste can be recycled, compared to the least educated respondents.

Knowledge about the negative impact of waste and recycling, as the sine qua non, influenced the respondents' opinions on waste separation; the highest percentage

(83.2%) claimed they would separate their household waste (paper, metal, plastic, food) if they were provided the necessary conditions for separate disposal and collection, 12.7% of the respondents declared they might do that, while only 4.2% of the respondents agreed they would not separate their waste. The values obtained show no associations between gender, place of residence and age, and willingness to dispose of household waste separately. The findings are consistent with the research by Schultz et al. (1995) which focused on the lack of association between gender, age and recycling behaviour, while they are contrary to the assertion by Vencatasawmy et al. (2000) who claimed that the elderly were more motivated to get involved in recycling.

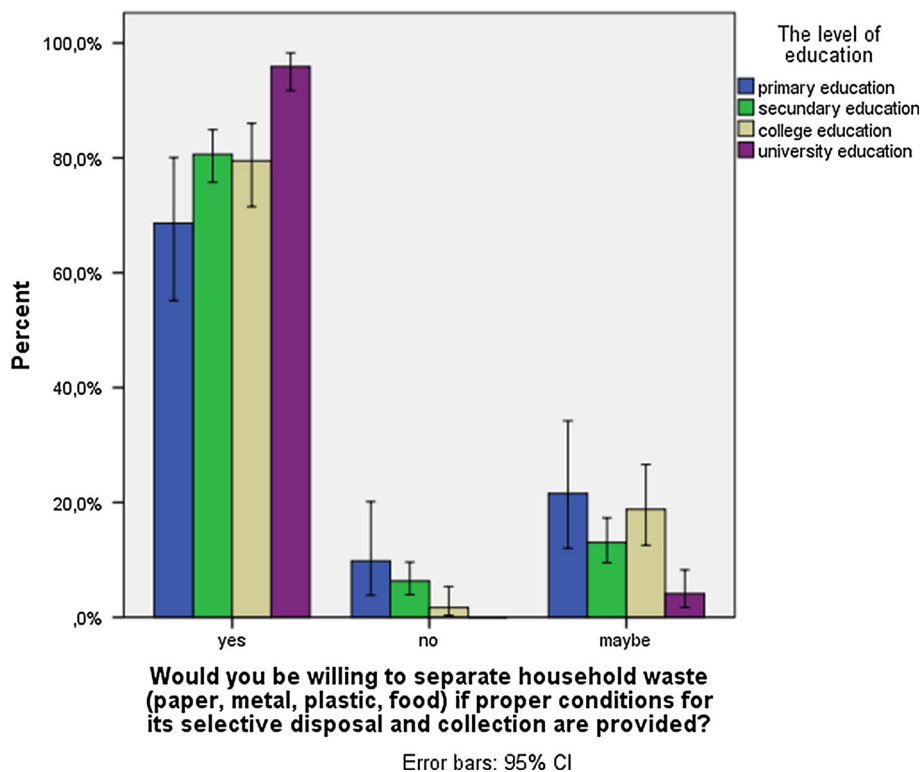
The value of Asymp. Sig. indicates that there is a correlation between the respondents' level of education and willingness to separate waste [Pearson's  $\chi^2 = 34.470$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.000]. The lowest percentage of respondents with primary education said they would separate their household waste, in contrast to the vast majority of their counterparts with university education (96%). The number of respondents who are not willing to separate waste decreases with an increasing level of education; also, none of the respondents with university education would refuse the opportunity to separate their household waste (Fig. 2).

Also, the results of standard deviation indicate that there is no significant mean deviation for the entire sample ( $M = 1.30$ ;  $SD = 0.681$ ;  $SE = 0.028$ ). The values in the age groups are the following: primary education ( $M = 1.53$ ;  $SD = 0.833$ ;  $SE = 0.117$ ), secondary education ( $M = 1.32$ ;  $SD = 0.694$ ;  $SE = 0.041$ ), college education ( $M = 1.39$ ;  $SD = 0.787$ ;  $SE = 0.073$ ) and university education ( $M = 1.08$ ;  $SD = 0.398$ ;  $SE = 0.033$ ). The results of single-factor analysis showed statistical significance of  $p < 0.05$  referring to the impact of respondents' education on their willingness to dispose of waste separately— $F(3,594) = 8.02$ ;  $p = 0.000$ . To confirm this, Cohen's  $\eta^2 = 0.03$  indicates the mean impact of education on the respondents' attitudes towards separate waste disposal. Subsequent comparisons using Tukey's HSD test indicate that the mean of the most educated respondents ( $M = 1.08$ ;  $SD = 0.39$ ) differs greatly from the mean of the least educated ones ( $M = 1.53$ ;  $SD = 0.83$ ) and the group of respondents with college education ( $M = 1.39$ ;  $SD = 0.78$ ), while it insignificantly differs from the group of respondents with secondary education ( $M = 1.32$ ;  $SD = 0.69$ ). University-educated respondents are more willing to engage in separate waste disposal than all other respondents.

The results confirm the findings of earlier studies (Baldassare and Katz 1992; Schultz et al. 1995; Tucker et al. 1998; Vining and Ebreo 1989, 1990) about the importance



**Fig. 2** Education level and willingness to participate in waste separation



of education as a key factor that influences waste disposal habits and the willingness to separately dispose of waste. There is a positive relationship between knowledge about recycling and recycling behaviour, whereas income has only a minor influence on recycling behaviour (Schultz et al. 1995).

Taking into account the difficult economic situation in Niš, it is not surprising that the majority of respondents (82.2%) answered that, with certain financial benefits (e.g. reduction in utility bills), they would opt for separate waste disposal, 14.8% claimed they might do it, whereas 2.3% would not separate their waste. The values of Pearson’s Chi-square and Asymp. Sig. do not indicate any association between the respondents’ gender, age, and educational qualifications and their responses, whereas the place of residence is just at the border line of significance [Pearson’s  $\chi^2 = 10.618$ ,  $df = 6$ ; Asymp. Sig. (2-sided) = 0.005].

Most respondents are exposed to some form of media. Out of the total number, 77.8% have information on selective waste disposal. The highest percentage of respondents obtained information through mass media such as television programmes (53.3%), the Internet (17.3%), print media (13.5%), radio programmes (9%) and the public utility company in charge of waste management, PUE “Mediana” (2.6%) from Niš.

These results did not show any statistically significant correlation between gender and education level on the one

hand and sources of information on waste separation on the other. However, the results indicate a relationship between the residents’ age and dominant source of information, as well as place of residence (individual or collective housing).

It was discovered that the dominant information source depends on the respondents’ age [Pearson’s  $\chi^2 = 30.220^a$ ,  $df = 10$  Asymp. Sig. (2-sided) = 0.001]. The highest percentage of young respondents (under 30 years of age) is well informed through TV programmes, whereas the lowest percentage of respondents is informed by PUE “Mediana”. The prevailing information sources in the second age group (31–65) are TV programmes, while the lowest percentage of respondents in this group reported they received information about waste at school or college. As with the other age groups, TV programmes are the main form of information for the oldest respondents, while the lowest percentage answered that they received information on waste at school or college. These results are not surprising due to the fact that television has become the dominant form of mass media in Serbia, and environmental issues, including the importance of waste separation and waste management, have not been given adequate attention in the education system until fairly recently (Table 3).

When examining the predominant source of information about separate waste disposal, the values for the entire sample were ( $M = 2.31$ ;  $SD = 1.650$ ;  $SE = 0.076$ ), whereas the values at the level of age groups were (under

**Table 3** Years of age and dominant source of information on separate waste disposal

	Through TV programmes	Over the radio	Through newspapers	At school/college	Over the Internet	By PUE “Mediana”	Total
<i>Age</i>							
<i>Under 30</i>							
Number of respondents	90	16	20	12	44	2	184
%	48.9	8.7	10.9	6.5	23.9	1.1	100.0
% of Total	19.3	3.4	4.3	2.6	9.4	0.4	39.4
<i>31–65</i>							
Number of respondents	134	15	31	4	27	8	219
%	61.2	6.8	14.2	1.8	12.3	3.7	100.0
% of Total	28.7	3.2	6.6	0.9	5.8	1.7	46.9
<i>Over 65</i>							
Number of respondents	25	11	12	4	10	2	64
%	39.1	17.2	18.8	6.2	15.6	3.1	100.0
% of Total	5.4	2.4	2.6	0.9	2.1	0.4	13.7
<i>Total</i>							
Number of respondents	249	42	63	20	81	12	467
%	53.3	9.0	13.5	4.3	17.3	2.6	100.0
% of Total	53.3	9.0	13.5	4.3	17.3	2.6	100.0

30:  $M = 2.51$ ;  $SD = 1.715$ ;  $SE = 0.128$ ; from 31 to 65:  $M = 2.08$ ;  $SD = 1.589$ ;  $SE = 0.107$ , over 65:  $M = 2.52$ ;  $SD = 1.584$ ;  $SE = 0.198$ ). Single-factor analysis of variance (ANOVA) investigated the influence of the respondents' age on their information about separate disposal. The results confirmed a statistically significant difference of  $p < 0.05$  referring to the impact of the respondents' age on obtaining information about separating waste in three age groups:  $F(2,464) = 4.001$ ;  $p = 0.01$ . Cohen's  $\eta^2 = 0.01$  indicates small impact. Subsequent comparisons by Tukey's HSD test indicated that the mean of the oldest group of respondents ( $M = 2.52$ ;  $SD = 1.58$ ) differs most from the mean of the youngest ones ( $M = 2.51$ ;  $SD = 1.71$ ) and slightly from the respondents in the middle age group ( $M = 2.08$ ;  $SD = 1.59$ ).

The resulting value of Asymp. Sig. 0.001 indicates a statistically significant relationship between age and the predominant information source on waste separation, which is apparent if we take a look at the distribution of responses regarding the information source and age (Table 4). Among the respondents who claimed their sources of information were TV, newspapers and PUE “Mediana”, the largest proportion were the respondents in the 31–65 age group ( $N = 249$ , 53.8%;  $N = 63$ , 49.2%, and  $N = 12$ , 66.7%, respectively). Out of the respondents who reported radio programmes, school/college and the Internet to be the main ways to get information, the highest

percentage of respondents were under 30 years of age ( $N = 42$ , 38.1%;  $N = 20$ , 60%,  $N = 81$ , 54.3%, respectively).

Based on the values obtained [Pearson's  $\chi^2 = 19.485^a$ ,  $df = 5$  Asymp. Sig. (2-sided) = 0.002], a statistical relationship between the information source and the place of residence (individual and collective housing) was noticed. As shown in Fig. 3, out of the total number of respondents, the highest percentage of respondents who live in individual housing units (houses) gathered information through TV programmes, the Internet, and PUE “Mediana”, while the highest percentage of respondents who live in collective dwellings (apartments) obtained the information through radio programmes, newspapers and school/university.

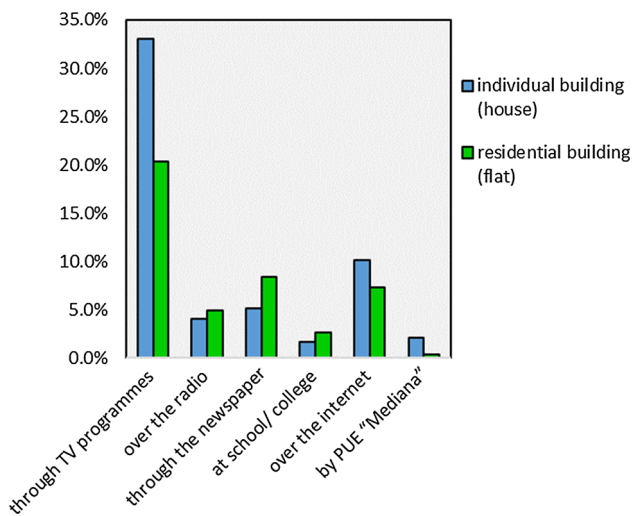
The  $T$  test was used to compare the results of the relationship between the sources of information regarding separate waste disposal in Niš and the respondents' places of residence (in a house/in a residential building). The data indicate that there is a slight difference of arithmetic means and standard deviations regarding information sources about separate waste disposal in Niš, depending on the place of residence: in a house ( $M = 2.26$ ;  $SD = 1.72$ ), in a flat ( $M = 2.38$ ;  $SD = 1.55$ );  $T(465) = -0.811$ ;  $p = 0.41 > 0.05$ .

The difference between the source of information and the place of residence is even more apparent if we compare



**Table 4** Sources of information on separate waste disposal and years of age

	Under 30	31–65	Over 65	Total
<i>Which is the prevalent source of information about selective waste separation in Niš?</i>				
Through TV programmes				
Number of respondents	90	134	25	249
%	36.1	53.8	10.0	100.0
Over the radio				
Number of respondents	16	15	11	42
%	38.1	35.7	26.2	100.0
Through newspapers				
Number of respondents %	20	31	12	63
	31.7	49.2	19.0	100.0
At school/college				
Number of respondents	12	4	4	20
%	60.0	20.0	20.0	100.0
Over the Internet				
Number of respondents	44	27	10	81
%	54.3	33.3	12.3	100.0
By PUE “Mediana”				
Number of respondents	2	8	2	12
%	16.7	66.7	16.7	100.0
<i>Total</i>				
Number of respondents	184	219	64	467
%	39.4	46.9	13.7	100.0



**Fig. 3** Place of residence and sources of information regarding selective waste disposal at the sample level

the data shown in Fig. 4. Out of a total of 249 respondents who answered that they obtained information through TV programmes, 61.8% live in houses; out of 81 respondents who use the Internet as a source of information, 58% live in houses, and out of 12 respondents to whom information was provided by PUE “Mediana”, 83.3% live in houses.

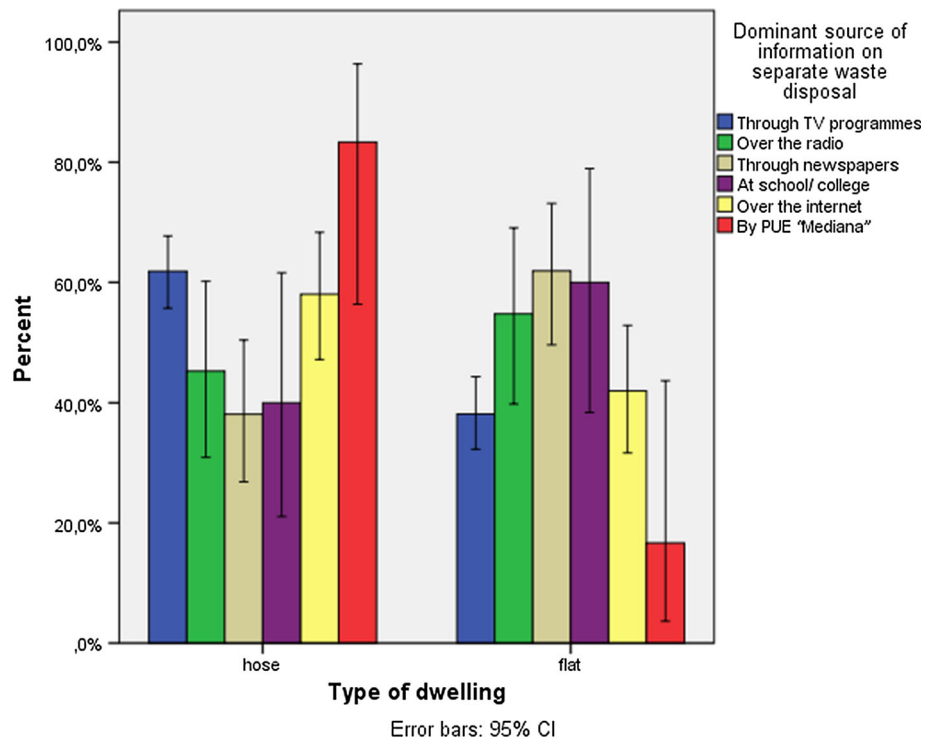
Statistical significance was found between the forms of communicating information and willingness to separate

household waste if the respondents had the necessary conditions [Pearson’s  $\chi^2 = 41.941^a$ ,  $df = 10$  Asymp. Sig. (2-sided) = 0.000]. Of all respondents who learned about selective waste collection through the mass media, the largest percentage agreed they would separate it (83.7%), 4.9% responded that they would not, and 11.3% answered they might participate in waste separation. The highest percentage of respondents in the undecided category includes those who received information over the TV, and there were no undecided respondents who had obtained their information from PUE “Mediana”. The majority of small number of citizens who said they would not separate their household waste were informed by means of newspapers (Table 5).

The data shown in Fig. 5 even more clearly depict the impact of information sources on the respondents’ decision to separate their household waste. Although only 12 respondents said they were informed by PUE “Mediana”, all of them agreed on the waste separation idea. The respondents’ willingness is also influenced by the Internet, TV programmes, radio programmes, newspapers and school/college.

Single-factor analysis of variance (ANOVA) was used to investigate the influence of sources of information about separate waste disposal on the respondents’ willingness to dispose of their waste separately. Sources of information on separate waste disposal were divided into six groups

**Fig. 4** Dominant information source and place of residence



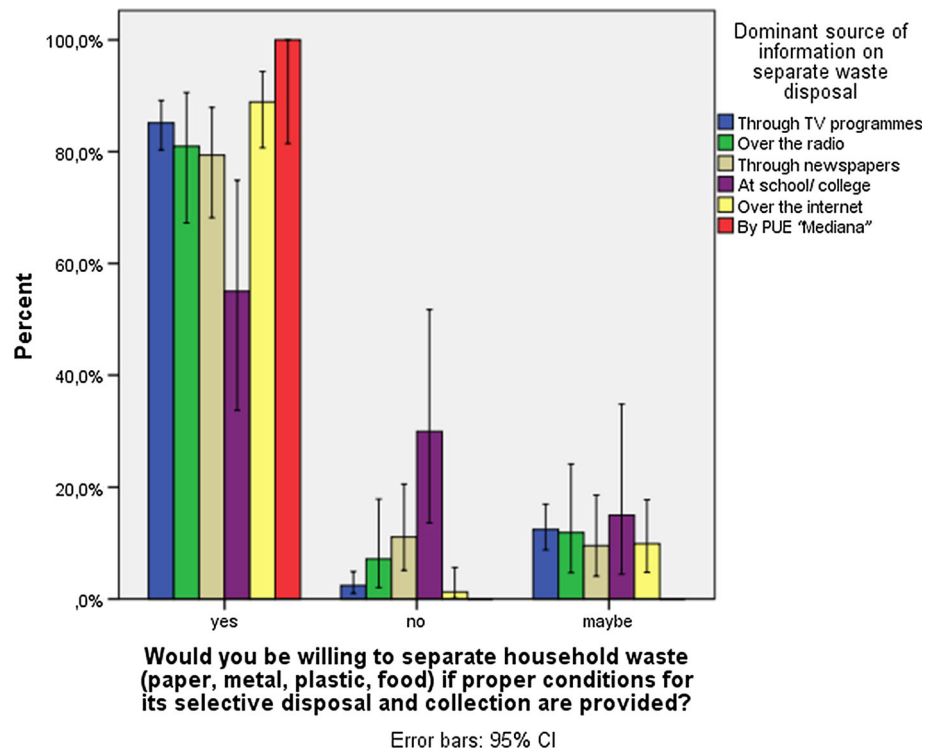
**Table 5** Willingness to separate waste and ways to obtain information

	Through TV programmes	Over the radio	Through newspapers	At school/college	Over the Internet	By PUE "Mediana"	Total
<i>Would you be willing to separate household waste?</i>							
<b>Yes</b>							
Number of respondents	212	34	50	11	72	12	391
%	54.2	8.7	12.8	2.8	18.4	3.1	100.0
% of Total	45.4	7.3	10.7	2.4	15.4	2.6	83.7
<b>No</b>							
Number of respondents	6	3	7	6	1	0	23
%	26.1	13.0	30.4	26.1	4.3	0.0	100.0
% of Total	1.3	0.6	1.5	1.3	0.2	0.0	4.9
<b>Maybe</b>							
Number of respondents	31	5	6	3	8	0	53
%	58.5	9.4	11.3	5.7	15.1	0.0	100.0
% of Total	6.6	1.1	1.3	0.6	1.7	0.0	11.3
<b>Total</b>							
Number of respondents	249	42	63	20	81	12	467
%	53.3	9.0	13.5	4.3	17.3	2.6	100.0
% of Total	53.3	9.0	13.5	4.3	17.3	2.6	100.0

(group 1: TV programmes; group 2: over the radio; group 3: through newspapers; group 4: at school/college; group 5: over the Internet and group 6: by PUE "Mediana"). The

results showed no statistically significant difference of  $p < 0.05$  regarding the impact of information sources on the respondents' willingness to dispose of waste separately

**Fig. 5** Dominant source of information and willingness to separate waste



$F(461) = 1.63$ ;  $p = 0.15$ . Weak statistical significance is accompanied by Cohen's  $\eta^2(0:02)$ , which indicates the extremely weak influence of some sources of information about separate waste disposal on the respondent's willingness to dispose of waste separately. Further comparisons using Tukey's HSD test indicated that the mean value of group 6: ( $M = 1.00$ ;  $SD = 0.00$ ) significantly differs from the mean values of all other groups in the following manner: 1: ( $M = 1.27$ ;  $SD = 0.67$ ); 2: ( $M = 1.31$ ;  $SD = 0.68$ ); 3: ( $M = 1.30$ ;  $SD = 0.63$ ); 4: ( $M = 1.60$ ;  $SD = 0.75$ ); 5: ( $M = 1.21$ ;  $SD = 0.61$ ), while the difference between the mean values of other groups remains insignificant. According to the data obtained, we can conclude that the respondents who were informed on separate waste disposal by PUE "Mediana" were most willing to dispose of their waste separately.

## Conclusion

The research results helped us conclude that the general and specific hypotheses have been partially proved since the greatest number of respondents had accurate information on waste and recycling and they were willing to separate their household waste, regardless of the way they were informed. However, the results revealed that certain demographic characteristics and age influenced the possession of accurate information on waste, as shown in Tables 1 and 2, indicating the necessity to provide

adequate information, especially to the group of the oldest respondents. Likewise, it was observed that the respondents with university education had the most accurate information about recycling and were consequently more willing to separate their waste. Moreover, this points to the necessity of introducing waste issue content in both formal and non-formal education in the national system of primary and secondary education.

The results also showed that the dominant means of obtaining information was television. However, there is a correlation between age and place of residence (house, flat) and the source of information. The results displayed in Fig. 5 seem to be of particular importance due to the fact that they show the form of obtaining information and willingness to separate waste. These data clearly indicate the lack of educational content on the importance of waste management, in particular the need for waste separation at source in schools (if we take into account that 30% of respondents who received information at school said they would not separate waste at home and 15% were undecided). Although some studies have shown that the Internet has a tremendous impact on increasing information and participation (Kenski and Stroud 2006), and bearing in mind the percentage of respondents who are informed on waste issues over the Internet, we believe that in our case, it is necessary to support the cooperation between the competent institutions for waste management, such as PUE "Mediana", and local TV stations.

Simultaneously, the data from Fig. 5 show the need for the proactive involvement of PUE "Mediana" in raising



public awareness, because all respondents who received information from this enterprise agreed they would separate their household waste. Taking into consideration that the survey was conducted during the implementation of the cross-border cooperation project WASTE realized by PUE “Mediana” in Niš and the Municipality of Pernik from Bulgaria, more specifically at the project phase which involved distribution of free plastic bins and bin bags for recyclable waste, our opinion is that this company missed a good opportunity to raise public awareness in the area of waste management. Bearing in mind the results obtained, the focus of an awareness-raising campaign on recycling should be schools and the local and regional media.

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