

Determinants of source waste separation behavior in Iranian high school students: An application of the theory of planned behavior

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Abstract

Background: Nowadays, one of the most serious environmental concerns is the appropriate management and disposal of municipal waste, which can lead to significant environmental consequences. This study aimed to examine the determinants of source waste separation behavior (SWSB) among high school students applying the theory of planned behavior (TPB).

Methods: In this descriptive study that was performed in 2022 via an online survey, 689 questionnaires were completed by students in 10 randomly selected high schools in Abhar, Iran. The data were analyzed by IBM SPSS Amos version 23. To assess the predictive determinants of SWSB, a structural equation model (SEM) was used.

Results: Subjective norm was found to be the best predictor of high school students' source waste separation (SWS) intention. The TPB had a prediction power of 68% and 74% for predicting waste separation from the source intention and behavior, respectively.

Conclusion: According to the results of this study, subjective norm has the greatest impact on separation intentions (regression weight = 0.550; SE = 0.08; CR = 6.863; and $P < 0.0001$). Educational administrators are suggested to pay special attention to the role of significant others, such as teachers, parents, and peers in their planning to improve waste separation behavior at the source in schools.

Keywords: Waste separation, Theory of planned behavior, Students, Iran, Surveys, Questionnaires

Citation: Alimardani Z, Hajimiri K, Jafari F, Sadeghi G. Determinants of source waste separation behavior in Iranian high school students: an application of the theory of planned behavior. Environmental Health Engineering and Management Journal 2024; 11(3): 293-300 doi: [10.34172/EHEM.2024.29](https://doi.org/10.34172/EHEM.2024.29).

Article History:

Received: 28 January 2024

Accepted: 24 June 2024

ePublished: 25 July 2024

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Introduction

The majority of today's environmental issues are primarily the result of people's daily behaviors (1). The management of municipal solid waste (MSW), which is a critical issue facing all countries, particularly developing countries, is one of the environmental concerns (2). Nearly 80% of MSW, which contains the majority of recyclable materials, is disposed in landfills (3). Household solid waste and waste from other sources such as educational and medical institutions, retail, food services, and other services are a major source of MSW generated via routine daily activities (4). The waste separation will enhance the quality of household recycling, and reduce the amount of waste generated by households as well (5). The most obvious advantages of waste recycling management are reduced waste production, improved waste collection and disposal, improved health education, and community

awareness and perception (6). Typically, universities and high schools as educational institutes have a solid waste management system, and how students handle solid waste significantly impacts their subsequent pro-environmental behavior. As a result, universities typically place a high value on environmental education and perform research to encourage recycling behavior (7,8). Because universities are considered as miniature of society and sound places for pilot initiatives, there has been less research in high schools than in universities (9). Whereas, high school students and their participation in environmental health programs is a way not only to nurture environmentally conscious citizens but also to inform youth about the importance of participating in sustainable environmental waste management. It also helps to conserve resources, save money, and stimulate the separation of household waste (9). To discover the effective factors for their source



waste separation behaviors (SWSB), high school students have been selected for this study. Because engaging youth in environmental projects can lead to the creation of responsible citizens who care about the environment and educate them on the importance of participating in sustainable waste management practices. Moreover, adolescents dedicate a significant portion of their time to educational institutions, resulting in a substantial impact on the total waste production. In addition, the research carried out in Iran is focused on elementary and middle school students (10,11). On the other hand, students face specific challenges in waste disposal in school such as the lack of knowledge about proper waste disposal procedures (12) and the lack of awareness about the health impact of improper waste disposal, particularly about solid waste disposal in dump sites near urban areas (13). These challenges highlight the importance of addressing waste management issues in schools and implementing environmental education programs to address these issues.

The theory of planned behavior (TPB) is a behavioral change theory that is used to determine the factors that influence individual decision-making in social psychology. TPB is widely being promoted as a key theory in environmental science to predict and promote a variety

of pro-environmental behaviors such as waste segregation at the source (14,15). Individual intent is primarily influenced by three factors in the TPB, namely attitude, subjective norms (SN), and perceived behavioral control (PBC) (16) (Figure 1). According to the TPB model, intention is the strongest predictor of behavior. In other words, the level of a person's desire to engage in a specific behavior is related to the likelihood of doing so (17). People who have a high intention to recycle are more likely to do so than those who have a low intention. A relationship between intention and behavior has been discovered in research, particularly in pro-environmental behavior (1,9). The attitude of a person is characterized by their evaluation of the outcome of behavior (17). According to the literature, information about the benefits of recycling is a substantial predictor of a positive attitude toward it, which plays a major role in a person's decision-making process (18,19). An SN is characterized as perceived pressure from significant others such as family members, peers, and teachers (16). Subjective norms have shown inconsistent results; although some previous research has shown that SN is a major motivator for recycling (20,21), others have found that it does not predict intention to recycle (22,23). The PBC refers to how easy or difficult an individual thought a given behavior was (24). The results

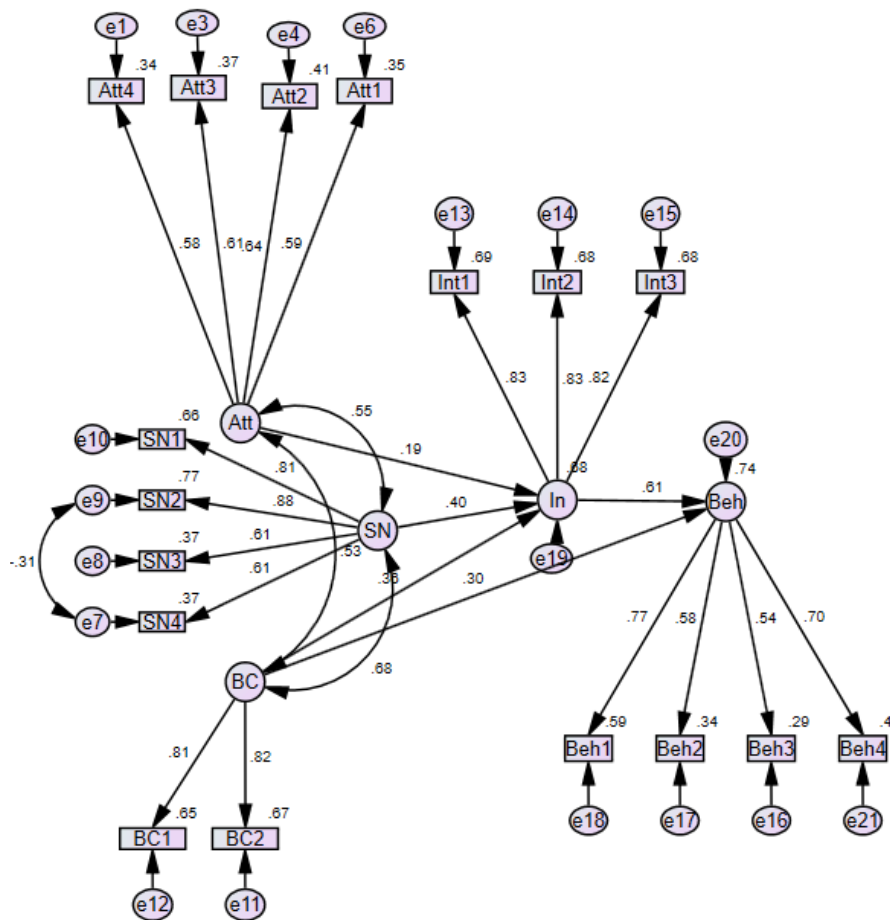


Figure 1. The standardized coefficient regression weights or factor loading for every path in the complete model

of the association between PBC and behavioral intention are mixed, just like the results of SN. The PBC has been reported as the strongest predictor of behavior intent in some studies (2,25). While it has not been found to predict recycling behavior in others (26,27). This study aimed to apply the TPB to analyze the predicted factors of SWSB in high school students.

Materials and Methods

The participants in this cross-sectional study were students from high school in Abhar County, which is located in Zanjan province in northwest Iran. The sample size was calculated using Equation 1, with a standard deviation of 1.24 for the SN (28). The estimate's required accuracy (d) was set at 12%, with a confidence interval of 95%.

$$n = \frac{z^2 \frac{1 - \sigma^2}{2}}{d^2} \quad (1)$$

The sample size was calculated to be 437 using equation 1. After considering the 5% non-response error and the design effect of 1.5, 689 participants were chosen to take part in the study. A self-directed online questionnaire was used to collect the data from February 19 to March 15, 2022.

Abhar county includes Abhar, Hidaj, and Sain Qaleh, with 1827 students enrolled in 42 high schools. The study samples were chosen using a multi-stage cluster sampling method. To do so, a list of high schools in Abhar (N=36), Hidaj (N=3), and Sain Qaleh (N=3) cities was compiled. Then, 10 schools (5 boys and 5 girls) were chosen randomly; eight schools from Abhar city (4 boys and 4 girls), one boys' school from Hidaj city, and one girls' school from Sain Qaleh city. Then, one classroom was randomly selected from different disciplines and levels of each school. Both students and their parents had to consent to participate in the study. This study included both genders (male and female), ages 15 and 19, and high school students in the 10th, 11th, and 12th grades.

Data were collected via an anonymous online questionnaire, which was divided into two sections: The first section dealt with the scio-demographic characteristics of the participants. The second section was a TPB-based researcher-made questionnaire about SWSB. This scale had 17 items and five dimensions. SWSB was evaluated through four items. A sample question for SWSB was: "I separate recyclable materials and use them for other useful purposes (e.g., making school crafts, etc.)." The intention was evaluated by three items, for instance, "I am going to separate the garbage I create at home or in the school". The attitude was evaluated through four items (I think the separation of waste produced in the home or the school is a responsible behavior). SN also was evaluated through

four items. SN's sample question was: "Important people in my life (family, friends, teachers, classmates, etc.) ask me to separate the garbage I produce in the home or the school". And PBC was evaluated through two items (I'm sure I can separate the garbage I produce at the home or the school at the beginning). The items were assessed using seven-point Likert scales ranging from 1 to 7.

The students of both genders (n=12) evaluated the validity of the qualitative and quantitative face. They evaluated items for difficulty, appropriateness, and ambiguity; afterward, they made any required adjustments. They also were asked to rate the item's suitability on a 5-point Likert scale (5=It is completely suitable, 1=It is not suitable at all). A score of >1.5 was considered acceptable for the impact score (29). The impact score of all items is higher than 1.50. Ten experts in the fields of psychometry, health education, and environmental health engineering, evaluated the questionnaire's content validity by calculating the content validity ratio (CVR) and content validity index (CVI) for each item. The experts assessed item essentiality using a 3-point Likert scale: "Not essential," "Useful but not essential," and "Essential." Items with CVR values above 0.62 were approved per the Lawshe table. They also evaluated item relevance, determining item-CVI (I-CVI) and scale-level CVI (S-CVI) based on their ratings. Items with I-CVI exceeding 0.79 were deemed acceptable. S-CVI, calculated by averaging I-CVIs, required a value over 0.80 for acceptance (29). In the content validity, CVR and CVI of the questionnaire were calculated and at this stage, no items were deleted. The S-CVI/Ave for the items was 0.940.

In addition, it was piloted with a group of 30 participants, and the internal consistency was assessed using Cronbach's alpha, which was at an acceptable level (>0.70). The test-retest method (with a 2-week interval) was used to examine the questionnaire's stability. The intra-class correlation coefficients (ICCs) were then determined, with an ICC value of >0.8 being considered a stable value (30). The ICC was at an acceptable level (ICC=0.99).

The data were reviewed and cleaned for accuracy before being analyzed with IBM SPSS Amos 23. Kurtosis and skewness were used to determine the data's normality (31). Due to the online format of the questionnaire, there were no missing data in this study. Participants, who responded to almost all of the questions, in the same way, were characterized as indifferent cases by the standard deviation of their responses (values of 0.3 and less) (30).

For descriptive statistics, frequency, mean, and standard deviation were employed. Considering the normality of the data distribution, independent t-test and one-way analysis of variance were used to compare the mean scores of the participants. The structural equation model (SEM) was used to determine the predictive factors of SWSB.

To determine whether the model fits well, chi-square (χ^2), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), goodness-of-fit index (GFI), and adjusted goodness-of-fit index (AGFI) were used. Confirmatory factor analysis (CFA) was used before SEM to ensure that the variables in the model were valid and reliable. Both construct reliability (CR) and average variance extracted (AVE) were calculated for convergent validity after analyzing the fitness level of the model. P-values of less than 0.05 were considered statistically significant.

Results

This study enrolled a total of 689 individuals. Because 54 participants were determined as indifferent cases, the analysis was performed on data from 635 respondents. The respondents aged 15 to 19 years old, with a mean (SD) age of 16.80 (1.04) years. The majority of pupils' mothers were housewives (80%), and their educational level was a high school diploma (30.7%). Their fathers were mostly self-employed (33.7%). Table 1 shows the socio-demographic characteristics of the participants.

The mean score of SWSB of participants and TPB model constructs was compared based on gender, education grade, field of education, and parents' occupation and education (Table 2). The results showed no statistically significant difference between the participants' SWSBs, but the intention of female students to separate waste from the source is significantly higher than that of male students. The results of the study showed that the SWS intentions and behavior of students differ significantly according to their father's occupation so that the mean score of students whose fathers were employees and workers was significantly lower than other occupational groups.

Next, SEM analysis was used to evaluate the study hypotheses; the standardized estimate for the SEM is shown in Figure 1.

The R^2 value in the model was the most important output of the standardized regression weight. The R^2 value of the model was 0.74, indicating that exogenous constructs (Att, SN, BC, and Int) contributed 0.74% of the variance in estimating the endogenous construct of SWSB, as shown in Figure 1. Meanwhile, the R^2 for the intention to SWS was 0.68, indicating that 68% of the variance in the intention to SWS could be predicted using three latent constructs: attitude, SN, and PBC.

The regression path coefficient and its significance based on $P < 0.05$ are shown in Table 3. All construct pathways were significant. Table 3 describes the interpretation of these findings for the hypotheses developed.

Discussion

Using a TPB model, this study looked at the predictors of high school students' SWSB. The findings indicate that

Table 1. Socio-demographic characteristics of the participants (n = 635)

Variables	n	%	
Education grade	Grade 10	230	36.2
	Grade 11	195	30.7
	Grade 12	210	33.1
Field of education	Mathematical	63	9.9
	Experimental sciences	252	39.7
	Humanities	145	22.8
	Technical and professional	66	10.4
	Work and knowledge	109	17.2
Father's education level	Primary	97	15.3
	Middle school	132	20.8
	High school	42	6.6
	High school diploma	159	25
	Associate degree	46	7.2
	Bachelor's degree and higher	159	25
Mother's education level	Primary	101	15.9
	Middle school	120	18.9
	High school	39	6.1
	High school diploma	195	30.7
	Associate degree	39	6.1
Father's job	Bachelor's degree and higher	141	22.2
	Employee	123	19.4
	worker	89	14
	Self-employed	214	33.7
	Retired	85	13.4
	Farmer and gardener	46	7.2
Mother's job	Other	78	12.3
	Housewife	508	80
Town	Employed	127	20
	Abhar	486	75.6
	Sain Qaleh	83	13.1
	Hidaj	66	10.4

attitude, SN, and PBC explained 68% of the variance in intention to SWS, which is consistent with the results of other research. A study by Strydom in South Africa reported that the TPB could account for 46.4% of the variation in behavioral intention towards SWS among housewives (32). Similarly, the study by Aikowe and Mazancová also revealed that the TPB could clarify 77% of the participants' intention to segregate plastic waste (33). In this regard, the meta-analysis findings show a wide range of predictive power for TPB in environmentally friendly behaviors. Intention predictive power ranges from 2 to 81% (Mean = 44.3, Sd = 19.28) (14).

Meanwhile, the SN had a stronger predictive power than PBC and attitude in predicting the intention to separate waste. Other researchers have reported similar results (25,34). This outcome was not surprising given

Table 2. Mean and standard deviation of source waste separation behavior (SWAB) and theory of planned behavior (TPB) constructs score in the participants

Variables	N	Attitude		Subjective norms		Behavioral control		Intention		Behavior		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Gender	Mail	312	25.38	2.17	23.98	3.55	12.20	1.85	18.01	2.75	23.98	3.67
	Female	323	26.07	2.00	24.45	3.64	12.32	1.80	18.85	2.62	24.50	3.42
	<i>P</i> value ^a		0.0001		0.098		0.423		0.007		0.067	
Education grade	10	230	25.86	1.99	23.56	4.11	12.09	2.11	18.05	3.15	23.96	3.91
	11	195	25.61	2.13	24.54	3.23	12.34	1.72	18.28	2.48	24.30	3.46
	12	210	25.63	2.11	24.64	3.24	12.39	1.57	18.62	2.30	24.51	3.20
	<i>P</i> value ^b		0.405		0.002		0.182		0.084		0.262	
Field of education	Mathematical	63	25.79	2.01	23.65	3.86	12.15	2.00	18.31	2.62	24.06	3.77
	Experimental	252	25.78	2.16	23.69	4.17	12.07	1.91	18.11	3.05	23.94	3.90
	Humanities	145	25.73	1.92	24.84	3.02	12.48	1.84	18.27	2.62	24.48	3.14
	Technical and professional	66	25.30	2.47	24.7	2.27	12.22	1.76	18.45	2.18	24.25	3.08
	Work and knowledge	109	25.70	2.04	24.67	3.23	12.50	1.50	18.72	2.22	24.75	3.31
	<i>P</i> value ^b		0.567		0.006		0.137		0.395		0.296	
Father's education level	Primary	97	25.52	2.18	24.21	3.40	12.35	1.55	18.24	2.54	24.00	3.70
	Middle school	132	25.81	1.99	24.78	2.80	12.35	1.78	18.47	2.60	24.47	3.45
	High school	42	25.10	2.24	24.14	3.95	12.24	1.41	17.86	2.91	24.17	3.09
	High school diploma	159	25.70	2.00	24.60	3.32	12.31	1.85	18.32	2.75	24.66	3.35
	Associate Degree	46	25.39	2.24	22.98	4.47	12.30	1.63	18.28	3.09	24.00	3.88
	Bachelor's degree and higher	159	26.01	2.18	23.78	4.12	12.10	2.16	18.35	2.69	23.91	3.76
	<i>P</i> value ^b		0.108		0.025		0.863		0.884		0.436	
Mother's education level	Primary	101	25.51	1.96	24.44	2.97	12.17	1.67	18.25	2.48	24.08	3.21
	Middle school	120	25.62	2.12	24.25	3.02	12.23	1.72	18.15	2.71	24.15	3.44
	High school	39	25.36	2.16	23.92	3.69	12.36	1.40	18.36	3.00	24.33	3.11
	High school diploma	195	25.71	2.16	24.31	4.03	12.38	1.94	18.36	2.83	24.73	3.51
	Associate Degree	39	25.97	1.93	24.46	3.47	12.31	1.79	17.97	2.92	24.46	3.94
	Bachelor's degree and higher	141	25.96	2.17	23.95	3.92	12.17	2.01	18.51	2.56	23.72	3.91
	<i>P</i> value ^b		0.437		0.887		0.896		0.860		0.206	
Father's job	Employee	123	25.54	2.35	23.47	3.85	11.81	2.26	17.77	2.76	23.37	3.42
	Worker	89	25.81	2.22	24.61	3.57	12.45	1.98	18.65	2.74	24.74	3.54
	Self-employed	214	25.81	1.93	24.59	3.17	12.43	1.58	18.47	2.38	24.45	3.45
	Retired	85	25.49	2.10	23.18	4.34	11.96	1.81	17.81	3.21	23.56	4.42
	Farmer and gardener	46	25.39	1.91	24.37	3.27	12.37	1.68	18.26	2.99	24.78	3.05
	Other	78	26.03	2.16	25.03	3.37	12.59	1.52	18.91	2.49	24.96	2.94
	<i>P</i> value ^b		0.391		0.001		0.01		0.016		0.004	
Mother's job	Housewife	508	25.70	2.05	24.29	3.51	12.30	1.80	18.35	2.57	24.34	3.43
	Employed	127	25.75	2.33	23.96	4.00	12.14	1.95	18.15	3.19	23.90	4.00
	<i>P</i> value ^a		0.829		0.356		0.387		0.450		0.211	

^a *P* value derived from t-test.^b *P* value derived from one-way ANOVA.**Table 3.** The regression path coefficient and its significance based on $P < 0.05$ for the complete model and hypotheses testing for the respective path

Path of the Constructs		Estimate	S.E.	C.R.	P-value	Decision	
In	<---	Att	0.417	0.105	3.973	0.0001	Supported
In	<---	SN	0.550	0.080	6.863	0.0001	Supported
In	<---	BC	0.368	0.057	6.410	0.0001	Supported
Beh	<---	BC	0.202	0.045	4.535	0.0001	Supported
Beh	<---	In	0.399	0.049	8.217	0.0001	Supported

SE: Standard error; CR: Critical ratio; SWSB: Source waste separation behaviors; SWS: Source waste separation.

that pupils are in their teens and are influenced by key individuals in their lives. Parents and friends are important during adolescence and early youth and they are regarded as “significant others” during this age, and their approval or disapproval establishes SN regarding that behavior (35). Modeling and lifelong involvement help parents influence their children’s social behavior (36,37). Two main institutions in internalizing values and standards through socialization are the home and the school. Miller-Slough and Dunsmore discovered that close friends in adolescence have a lot of influence over each other; also, parents and friends in adolescence act in socialization in a similar way (38). In adult studies, however, the SN does not have a strong predictive effect in predicting the intention to SWS. Adults’ intentions for particular acts seem to be less impacted by others (2,39).

The TPB model constructs explain 74% of the variance in SWSB in the present study. While, in Strydom’s study, the findings indicated that the TPB could account for 26.4% of the variation in behavior towards SWS among housewives (32). Regarding this matter, the meta-analysis results reveal a broad spectrum of predictive efficacy for TPB in pro-environmental behaviors. The predictive efficacy of behavior varies from 6 to 81% (Mean = 34.2, Sd = 19.23) (14).

The findings demonstrate that the first construct is the intention, and the SN is the second strongest predictor of SWSB, which is similar to the findings of other studies in this field (40,41). According to the study by Zhang et al, perceived attitude, SN, and PBC have a positive effect on citizens’ intention to participate in waste management activities, and residents’ intention is a direct predictor of waste management behavior (41).

The students’ attitudes have the least predictive value of SWSB in this study. In the study conducted by Aikowe and Mazancová, students’ attitudes did not affect their intention to separate plastic waste. Even if students had a positive attitude toward SWS as a result of improved environmental health, this did not always translate into an increased tendency to classify waste (33). This may be attributed to the fact that even if we know something is good for the environment, we may forget it or not prioritize it in our daily routines.

In addition, Ahmad et al proposed that students in underdeveloped countries be taught about the necessity of recycling activities to enhance their attitudes about recycling in general (42). Integrating waste management education into the school curriculum, which teaches children about the causes and consequences of waste disposal as well as the importance of waste prevention and recycling through fun activities, is a particularly effective way to improve attitudes toward waste reuse and recycling (4).

Our finding indicates that the intention of female students to separate waste from the source is significantly

higher than that of male students. It seems that women have a more favorable attitude towards the environment compared to men due to socialization and the difference in social roles (43). Studies have shown that women are more active in pro-environmental behaviors (44,45). Compared to other students, in the humanities field of education, the mean score of subjective norms is significantly higher. The views of those who matter to them, like teachers, family, and friends, it is more prominent in these students.

The findings of the research indicated that 12th-grade students are more affected by the perspectives of significant individuals compared to other demographics. This could be attributed to the enhanced maturity level of these students, improved interaction with their social circle, and fulfillment of their requirements, consequently enhancing the esteem and honor of those in their vicinity and embracing their viewpoints (46).

The results of the present study showed that the SWS intentions and behavior of students differ significantly according to their father’s occupation. However, this relationship was not observed with mother’s occupation and parents’ education. In contrast to the results of the present study, Evans et al found evidence of a positive correlation between children’s pro-environmental behaviors and their parents’ education level (47). Therefore, more study in this regard is needed.

Conclusion

In this study, the SN had the greatest predictive power on recycling intentions. Hence, it is anticipated that our findings might aid school planners in addressing environmental concerns and offering accurate guidance on properly segregating recyclable waste. Therefore, it is emphasized to pay attention to educating parents and teachers and making them aware of their vital role in their children’s decision-making. It has been proposed that preparation for peer education can improve student behavior. As a result, training students to be health ambassadors could be a beneficial option.

TPB’s efficacy in predicting intention and behavior has been noted. To influence the intention and SWSB in schools, it is suggested that factors such as situational factors, moral components or religious ethics, environmental concerns, and knowledge as well as legislation be evaluated in combination with the TPB constructs in future studies.

However, there are certain limitations to the study that must be addressed in future research. First, the sample was limited to high school students, which may have influenced the outcome due to the students’ different educational stages. The second point to consider is the limitations of cross-sectional and the risk of non-generalizability to different populations. Third, self-report surveys have limits (time and place of completing the questionnaire, general physical and mental condition at the time of

completing the questionnaire, over-reporting, and under-reporting, etc). Fourth, only the self-report method was used to investigate behavior in this study. As a result, future studies should focus on investigating students' real behavior through interviews and observation.

Acknowledgments

The authors would like to thank all the students and teachers and education officials of Abhar City in Zanjan, who made this study possible. They would also like to thank the Vice-Chancellor for Research and Technology and the SDH Research Center of Zanjan University of Medical Sciences for supporting them in conducting this project.

Authors' contributions

Conceptualization: Khadijeh Hajimiri, Fatemeh Jafari, and Golamreza Sadeghi.

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Competing interests

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.

Ethical issues

The Ethics Committee of Zanjan University of Medical Sciences (ID code: IR.ZUMS.1399.241) approved the study design. At the start of the online questionnaire, participants submitted their informed consent to participate in the study. Students were automatically led to the informed consent page with sufficient information about the study after getting the questionnaire link, and then, to the study questions.

Funding

This study was financially supported by Zanjan University of Medical Sciences.

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