

Development and psychometric validation of a Value–Belief–Norm-based scale for household waste separation behavior

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Abstract

Background

Inadequate household waste separation remains a significant environmental and public health challenge, particularly in low- and middle-income countries, where ineffective waste management contributes to environmental pollution and increased health risks. Although the Value–Belief–Norm (VBN) theory has been widely applied to explain pro-environmental behaviors, psychometrically validated instruments specifically designed to assess household waste separation

behavior remain scarce, particularly in non-Western cultural contexts. This study aimed to develop and validate a theory-based instrument grounded in the VBN framework for measuring the psychosocial determinants of household waste separation behavior among Iranian housewives.

Methods

A cross-sectional psychometric study was conducted between August 2024 and February 2025 among 289 housewives in Shoushtar, Iran. Instrument development followed a systematic process involving literature review, expert panel evaluation, and item refinement. Face and content validity were assessed using qualitative evaluation, the Content Validity Ratio (CVR), and the Content Validity Index (CVI). Construct validity was evaluated through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Internal consistency and test–retest reliability were assessed using Cronbach's alpha and the Intraclass Correlation Coefficient (ICC), respectively.

Results

The final questionnaire comprised 41 items representing nine theoretically derived constructs consistent with the VBN framework. The instrument demonstrated good psychometric performance, with satisfactory internal consistency (Cronbach's $\alpha = 0.87$) and acceptable test–retest reliability (ICC = 0.70–0.91). Both exploratory and confirmatory factor analyses supported the proposed multidimensional structure and provided evidence for the construct validity of the scale.

Conclusions

This study provides a psychometrically sound and culturally adapted instrument for assessing household waste separation behavior based on the Value–Belief–Norm (VBN) theory. The questionnaire offers a practical tool for environmental health research, behavioral intervention development, and the evaluation of household waste management programs. Its application may facilitate theory-driven research and support the design of evidence-based interventions in Iran and other socio-culturally comparable low- and middle-income settings.

Keywords: Household waste separation; Value–Belief–Norm theory; Psychometric validation; Environmental health; Questionnaire development; Construct validity

Introduction

Rapid technological advancement, coupled with continued population growth, has substantially increased global resource consumption and intensified the generation of municipal solid waste (MSW), posing serious environmental challenges, including soil and water contamination, greenhouse gas emissions, and adverse effects on both environmental and public health[1]. These challenges are particularly pronounced in developing countries, where inadequate infrastructure, limited financial resources, and governance constraints continue to impede the implementation of sustainable and effective waste management systems[2].

In Iran, the average daily per capita waste generation is approximately 0.63 kg in both urban and rural areas. Organic materials constitute nearly 70% of the total waste stream, while recyclable components such as paper and plastic together account for less than 10% of household waste [3]. By comparison, several developed countries, including Australia and the United Kingdom, have achieved recycling rates ranging from 60% to 80% through well-established household waste

collection systems, source-separation programs, and policies aligned with circular economy principles[4].

Source separation at the household level is widely recognized as a cost-effective strategy that reduces landfill dependency, improves resource recovery, and minimizes environmental pollution. Beyond its environmental benefits, household waste separation also contributes to protecting public health by reducing human exposure to hazardous waste and environmental contaminants[5]. However, the effectiveness of household waste separation programs depends not only on adequate infrastructure and supportive public policies but also on individual willingness to consistently engage in waste separation practices. Behavioral compliance is shaped by several psychosocial determinants, including attitudes, perceived responsibility, moral obligations, and social norms, all of which have been shown to influence individuals' engagement in household waste separation[6].

Among these determinants, personal and social norms are consistently recognized as key predictors of pro-environmental intentions and behaviors[7]. Because household waste separation is primarily a voluntary behavior, understanding the moral and normative processes underlying individuals' decisions is essential for designing effective environmental and public health interventions. Consequently, theoretical frameworks that explicitly incorporate moral and normative dimensions provide valuable insights into the mechanisms that motivate voluntary participation in household waste separation programs [7].

One of the most widely recognized and empirically supported theoretical frameworks for explaining pro-environmental behavior, with important implications for environmental and public health, is the Value–Belief–Norm (VBN) theory[8]. The VBN model proposes a sequential causal

86 pathway in which fundamental value orientations influence environmental beliefs, particularly
87 awareness of consequences (AC) and ascription of responsibility (AR), which subsequently
88 activate personal norms (PN) and motivate pro-environmental behaviors[9]. Within this
89 framework, values are typically categorized into egoistic, altruistic, and biospheric orientations,
90 each representing a distinct motivational basis for environmental decision-making and behavioral
91 engagement[10].

92 Empirical research consistently demonstrates that biospheric and altruistic values are positively
93 associated with pro-environmental behaviors, whereas egoistic values tend to show weaker or even
94 negative associations, highlighting the importance of value-based approaches for promoting
95 environmentally responsible behaviors[11]. Despite the well-established explanatory capacity of
96 the VBN theory, relatively few studies have focused on developing psychometrically robust
97 instruments specifically designed to assess household waste separation behavior. Moreover, most
98 existing VBN-based measurement tools have been developed and validated in Western cultural
99 settings, raising concerns regarding their cross-cultural applicability and their ability to accurately
100 capture context-specific psychosocial determinants in non-Western societies. Consequently,
101 reliable and culturally appropriate measurement instruments remain scarce for populations with
102 different social, cultural, and environmental characteristics. Given the central role of women in
103 household waste management and the lack of a culturally adapted and psychometrically validated
104 VBN-based instrument tailored to this behavioral domain, the development of a context-specific
105 questionnaire is both necessary and timely[12]. Accordingly, this study aimed to develop and
106 psychometrically validate a culturally adapted questionnaire based on the Value–Belief–Norm
107 theory to assess household waste separation behavior among Iranian housewives. In addition to
108 providing a reliable and valid measurement instrument, this study seeks to support future theory-

driven environmental health research, facilitate the design of evidence-based behavioral interventions, and provide a standardized tool for evaluating household waste management programs in Iran and other socio-culturally comparable settings.

Materials and Methods:

A cross-sectional psychometric study was conducted in Shoushtar, Khuzestan Province, Iran, between August 2024 and February 2025. The target population consisted of Iranian housewives aged ≥ 18 years who were literate in Persian and provided written informed consent to participate. Participants with cognitive impairment or severe illness that could interfere with questionnaire completion were excluded from the study.

The sample size ($n = 289$) was calculated using NCSS PASS version 15 based on a significance level of $\alpha = 0.05$, a precision of $d = 0.05$, and an anticipated 10% non-response rate

[13]. A multistage stratified random sampling approach was employed across five Comprehensive Urban Health Service Centers (CUHSCs) in Shoushtar.

Questionnaire development was guided by the Value–Belief–Norm (VBN) theory. Initially, 49 items were generated through an extensive literature review and consultation with experts in health education, environmental health, and psychometrics. The items were organized according to the VBN constructs, including egoistic, altruistic, and biospheric values; the New Environmental Paradigm (NEP); awareness of consequences (AC); ascription of responsibility (AR); personal norms (PN); and injunctive and descriptive norms, to comprehensively assess the psychosocial determinants of household waste separation behavior.

Face validity was assessed using both qualitative evaluation and quantitative item impact **scores**. Content validity was evaluated using the Content Validity Ratio (CVR) and the Content Validity Index (CVI), and items with a CVR > 0.59 and a CVI $\geq$ 0.79 were retained

[14]. The internal consistency of the questionnaire was assessed using Cronbach's alpha coefficient, whereas its stability was evaluated using the test–retest Intraclass Correlation Coefficient (ICC)[15].

Construct validity was assessed using Exploratory Factor Analysis (EFA) followed by Confirmatory Factor Analysis (CFA). EFA was performed using principal axis factoring with varimax rotation. Sampling adequacy and the suitability of the data for factor analysis were evaluated using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity [16, 17]. CFA was subsequently conducted to examine the fit of the proposed VBN measurement model. Model fit was evaluated using multiple goodness-of-fit indices, including the chi-square/degrees of freedom ratio (χ^2/df), Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI), Incremental Fit Index (IFI), and Root Mean Square Error of Approximation (RMSEA).

All statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA) for descriptive analyses, reliability assessment, and EFA, whereas IBM SPSS AMOS version 26.0 was used to perform CFA.

Ethical Considerations

The study protocol was approved by the Ethics Committee of Shiraz University of Medical Sciences (Approval No. IR. SUMS.SCHEANUTREC.1402.119). Written informed consent was

obtained from all participants prior to data collection, and all study procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki.

Results:

Participant characteristics

A total of 289 housewives participated in the study. The participants had a mean age of 36.10 ± 9.93 years. Regarding educational attainment, 29.1% had completed high school, 38.1% held a diploma, and 32.9% had a university degree. The majority of participants were married and were full-time housewives. Detailed demographic characteristics are presented in **Table 1**.

Table 1. Demographic characteristics of the study participants (N = 289)

Variable	Category	n (%)
Age (years)	Mean $\pm$ SD	36.10 $\pm$ 9.93
Marital status	Single	16 (5.5)
	Married	273 (94.5)
Educational level	Less than diploma	84 (29.1)
	Diploma	110 (38.1)
	University degree	95 (32.9)
Spouse's educational level	Less than diploma	91 (31.5)
	Diploma	96 (33.2)
	University degree	86 (29.8)

Variable	Category	n (%)
	Not applicable (single)	16 (5.5)

158

159 **Content validity and reliability**

160 Following face and content validity assessment, eight items were removed, resulting in a final
 161 questionnaire consisting of 41 items with a mean Content Validity Index (CVI) of 0.81.

162 The questionnaire demonstrated good internal consistency, with an overall Cronbach's alpha of
 163 0.87. Cronbach's alpha coefficients for the individual constructs ranged from 0.67 to 0.87. Test–
 164 retest reliability was also satisfactory, with Intraclass Correlation Coefficient (ICC) values ranging
 165 from 0.699 to 0.907, indicating acceptable to excellent stability. In addition, the Composite
 166 Reliability (CR) values supported the internal consistency of the latent constructs. The
 167 standardized factor loadings, t-values, ICC, CR, and Cronbach's alpha coefficients for each
 168 construct are presented in **Table 2**

169 **Exploratory Factor Analysis**

170 **Table 2. Standardized factor loadings and psychometric properties of the final Value–Belief–**
 171 **Norm (VBN)-based Household Waste Separation Behavior Questionnaire**

Construct	Item	Standardized Factor Loading (λ)	t-value	Cronbach's α	ICC	CR	AVE
Egoistic values	1	0.957	114.83	0.72	0.833	0.745	0.93
	2	0.944	192.19				

Value Belief Norm Waste Separation Scale

Construct	Item	Standardized Loading (λ)	Factor t- value	Cronbach's α	ICC	CR	AVE
	3	0.985	459.39				
	4	0.982	221.12				
	5	0.972	120.92				
Altruistic values	7	0.911	61.53	0.74	0.782	0.877	0.72
	8	0.885	43.21				
	9	0.798	35.36				
Biospheric values	10	0.932	110.07	0.87	0.907	—	0.87
	11	0.924	99.81				
	13	0.937	113.31				
New Environmental Paradigm	14	0.945	136.71	0.67	0.699	0.674	0.75
	16	0.914	137.59				
	18	0.767	24.84				
	19	0.895	46.77				
Awareness of consequences	20	0.945	43.69	0.81	0.829	0.811	0.71
	21	0.784	27.47				
	23	0.807	28.74				
	24	0.817	536.63				
	25	0.826	633.27				
	26	0.855	34.35				
	27	0.837	736.02	0.74	0.721	0.851	0.64

Value Belief Norm Waste Separation Scale

Construct	Item	Standardized Factor Loading (λ)	t-value	Cronbach's α	ICC	CR	AVE
Ascription of responsibility	28	0.743	27.74				
	29	0.781	542.63				
	30	0.826	39.32				
Personal norms	31	0.838	34.15	0.87	0.851	0.944	0.88
	34	0.985	459.39				
	35	0.982	221.12				
	36	0.972	120.92				
	37	0.981	44.49				
	38	0.911	61.53				
	39	0.885	43.21				
	40	0.798	35.36				
	41	0.932	110.07				
Injunctive norms	42	0.924	99.81	0.78	0.901	0.881	0.63
	43	0.871	92.91				
	44	0.563	17.94				
	45	0.819	542.63				
	46	0.826	633.27				
Descriptive norms	47	0.855	34.35	0.72	0.891	0.832	0.83

Construct	Item	Standardized Factor Loading (λ)	t-value	Cronbach's α	ICC	CR	AVE
	48	0.934	109.07				
	49	0.930	99.72				

172 **Abbreviations:** ICC, Intraclass Correlation Coefficient; CR, Composite Reliability; AVE,
173 Average Variance Extracted.

174 *Items 6, 12, 15, 17, 22, 32, and 33 were removed during psychometric evaluation and are therefore*
175 *not included in the final questionnaire*

176 Exploratory Factor Analysis (EFA) supported the proposed nine-factor structure of the
177 questionnaire, corresponding to the principal constructs of the Value–Belief–Norm (VBN) theory.
178 The extracted factors collectively explained 49.65% of the total variance. Factor loadings ranged
179 from 0.563 to 0.985, indicating satisfactory item–factor relationships.

180 The suitability of the data for factor analysis was confirmed by a Kaiser–Meyer–Olkin (KMO)
181 value of 0.881 and a significant Bartlett's test of sphericity ($\chi^2 = 7245.36$, $df = 820$, $p < 0.001$),
182 demonstrating adequate sampling adequacy and sufficient inter-item correlations for factor
183 extraction. Detailed EFA results are presented in **Table 3**.

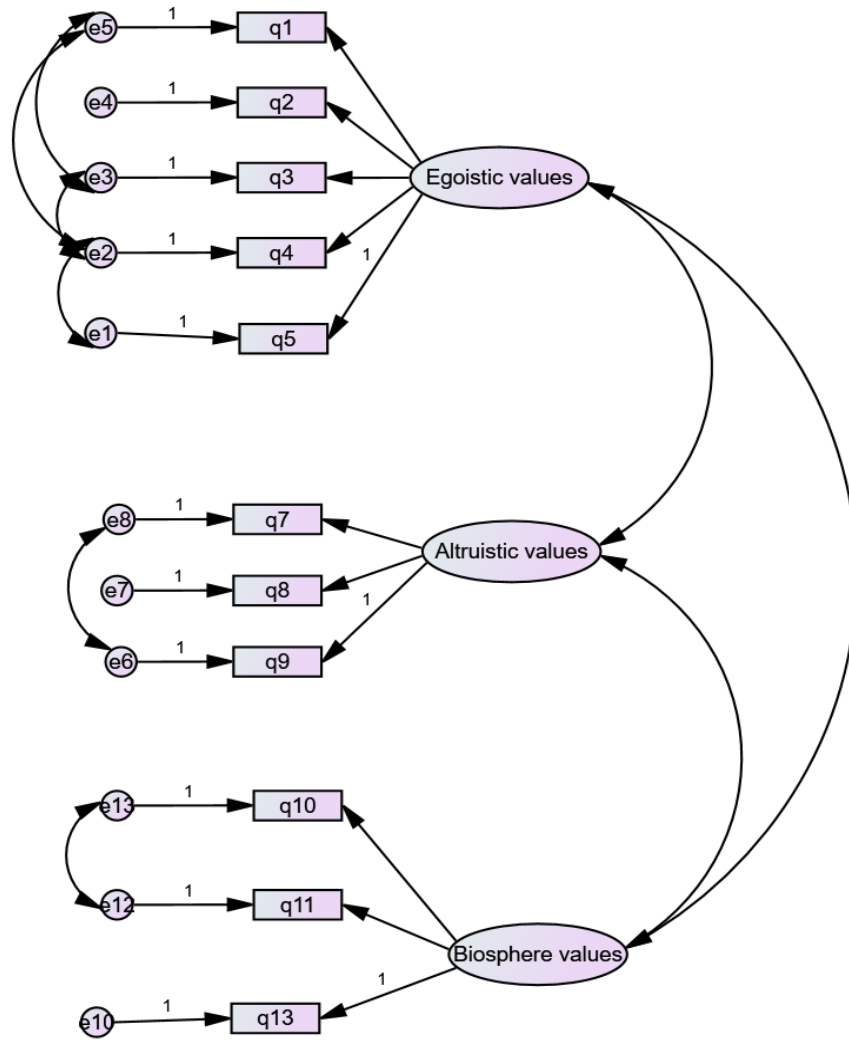
184 Table 3. Sampling adequacy and suitability tests for exploratory factor analysis of the Value–
185 Belief–Norm (VBN)-based Household Waste Separation Behavior Questionnaire (N = 289)

Measure	Value
Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy	0.881
Bartlett's Test of Sphericity (χ^2)	7245.36
Degrees of freedom (df)	820
<i>P</i> -value	< 0.001
Number of extracted factors	9
Total variance explained (%)	49.65
Factor loading range	0.563–0.985

• **Confirmatory Factor Analysis**

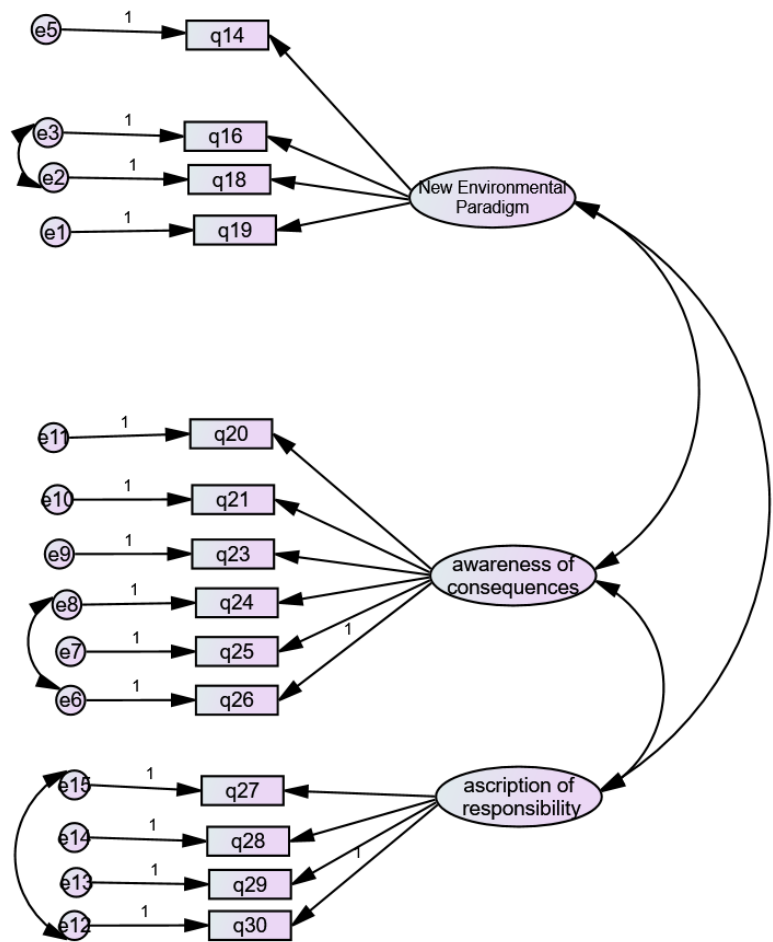
Confirmatory Factor Analysis (CFA) was performed to evaluate the theoretical structure of the VBN-based questionnaire. The CFA results demonstrated an acceptable model fit across all three higher-order domains of the instrument.

- For the **Values** domain, the model showed $\chi^2/df = 2.78$, CFI = 0.961, and RMSEA = 0.079 (Figure 1).



-
- Figure 1: The CFA results of the value structure extracted during the EFA

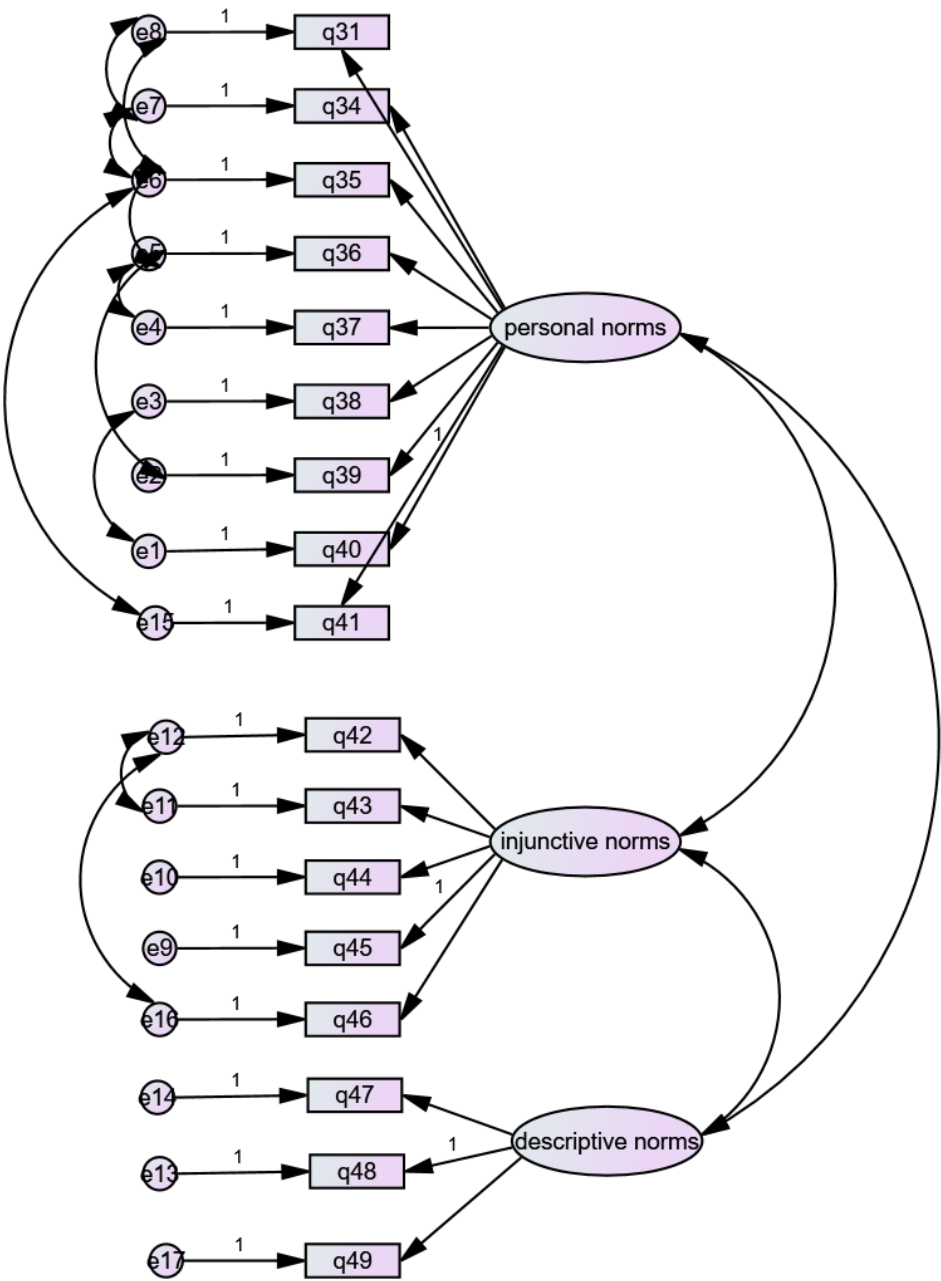
- The **Beliefs** domain also demonstrated a satisfactory fit ($\chi^2/\text{df} = 2.24$, CFI = 0.926, RMSEA = 0.057) (Figure 2).



- Figure 2: The CFA results of the beliefs structure extracted during the EFA

- Likewise, the **Norms** domain exhibited acceptable goodness-of-fit indices ($\chi^2/\text{df} = 2.58$, CFI = 0.931, RMSEA = 0.074) (Figure 3).

202 •



215

216 Figure 3: The CFA results of the norms structure extracted during the EFA

217 Standardized factor loadings were all significant ($p < 0.001$), confirming construct validity.

218 **Discussion:**

219 This study developed and psychometrically validated a 41-item questionnaire based on the Value–
 220 Belief–Norm (VBN) theory to assess household waste separation behavior among Iranian
 221 housewives. The instrument demonstrated satisfactory psychometric performance, including good
 222 internal consistency, test–retest reliability, and construct validity, supporting its suitability for
 223 assessing psychosocial determinants of household waste separation behavior in the Iranian context.
 224 The overall Cronbach's alpha coefficient (0.87) indicates good internal consistency, which is
 225 comparable to those reported in previous VBN-based studies. For example,[6] reported a
 226 Cronbach's alpha coefficient of 0.74, whereas[18] reported a value of 0.92, suggesting that the
 227 reliability of the present instrument is consistent with previously validated VBN-based measures
 228 across different populations and cultural settings.

229 Content validity was confirmed through expert evaluation, with all retained items exceeding the
 230 recommended Content Validity Index (CVI) threshold, indicating that the questionnaire
 231 adequately represents the conceptual domains of the VBN framework. These findings are
 232 consistent with those reported by Choi et al. Both Exploratory Factor Analysis (EFA) and
 233 Confirmatory Factor Analysis (CFA) provided empirical support for the proposed theoretical
 234 structure of the instrument. EFA identified a nine-factor solution corresponding to the principal
 235 components of the VBN theory, whereas CFA confirmed that the proposed measurement model
 236 demonstrated an acceptable fit to the observed data. Furthermore, all retained constructs—
 237 including egoistic, altruistic, and biospheric values; the New Environmental Paradigm (NEP);
 238 awareness of consequences (AC); ascription of responsibility (AR); personal norms (PN); and
 239 injunctive and descriptive norms—showed statistically significant standardized factor loadings

and satisfactory model fit indices ($GFI = 0.902\text{--}0.925$), providing additional evidence for the construct validity of the instrument[11, 19].

An important strength of the present questionnaire is the inclusion of both injunctive and descriptive social norms in addition to the core VBN constructs. Although these normative dimensions are not consistently incorporated into existing VBN-based measurement tools, their inclusion may improve the instrument's ability to capture social influences on household waste separation behavior, particularly in collectivist societies where social expectations and community practices strongly influence individual environmental behaviors. Consequently, the questionnaire may provide a more comprehensive assessment of the psychosocial determinants of household waste separation behavior than instruments focusing solely on the traditional VBN constructs.

From a practical perspective, the validated questionnaire provides a useful tool for environmental health researchers, public health practitioners, environmental educators, and municipal waste management authorities. The instrument can be used to identify behavioral determinants, evaluate educational interventions, monitor behavioral change, and guide evidence-based waste management policies. Considering that women particularly housewives play a central role in household waste management, improving waste separation practices within this population may contribute to increased recycling rates, reduced landfill disposal, and lower environmental pollution[20].

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference and limits the assessment of temporal changes in behavioral determinants. Second, although CFA confirmed the measurement structure of the questionnaire, a full Structural Equation Modeling (SEM) analysis was not conducted to evaluate the causal pathways proposed by the

VBN theory. Future longitudinal studies incorporating SEM are therefore recommended to examine the relationships among VBN constructs and to establish predictive validity. In addition, further model refinement, including sensitivity analyses and evaluation of alternative model specifications, may improve overall model fit.

Overall, the present study provides a theoretically grounded, psychometrically sound, and culturally adapted instrument for assessing household waste separation behavior among Iranian housewives. The questionnaire offers a reliable foundation for future behavioral research and intervention studies based on the Value–Belief–Norm theory. Interventions designed using this instrument should emphasize strengthening biospheric values, increasing awareness of environmental consequences, reinforcing personal responsibility, and promoting supportive social norms in order to encourage sustainable household waste separation behavior.

Conclusion:

This study successfully developed and psychometrically validated a 41-item Value–Belief–Norm (VBN)-based questionnaire for assessing household waste separation behavior among Iranian housewives. The instrument demonstrated satisfactory reliability, internal consistency, content validity, and construct validity, indicating that it is an appropriate measure for assessing the psychosocial determinants of household waste separation behavior.

By providing a culturally adapted and theory-based measurement instrument, this study addresses an important gap in environmental health research in non-Western settings. The questionnaire may facilitate future behavioral research, intervention design, program evaluation, and policy development related to household waste management. Although the cross-sectional design and the

absence of a full structural equation model limit causal interpretation, future longitudinal studies conducted in diverse cultural settings will further strengthen the generalizability and predictive validity of the instrument.

Overall, this questionnaire represents a robust and practical tool for promoting theory-driven environmental health research and supporting sustainable household waste management initiatives in Iran and other socio-culturally comparable settings.

Limitations:

- The cross-sectional design limits causal inference; therefore, longitudinal studies are recommended to evaluate temporal stability and predictive validity.
- Although confirmatory factor analyses supported the measurement model, a full Structural Equation Modeling (SEM) analysis of the causal pathways proposed by the VBN theory was not performed.
- Additional sensitivity analyses and alternative model specifications may further improve model fit.
- Because the study was conducted in a single city (Shoushtar), further validation in geographically and culturally diverse populations is recommended before nationwide application.

Recommendations:

Future research should apply this questionnaire in different regions of Iran and other Middle Eastern countries to evaluate its cross-cultural applicability. Theory-based interventions should focus on strengthening biospheric and altruistic values, increasing awareness of environmental

304 consequences, enhancing personal responsibility, and reinforcing supportive social norms.
305 Furthermore, municipal authorities and environmental health policymakers may use this validated
306 instrument to monitor behavioral outcomes and evaluate the effectiveness of household waste
307 management and recycling programs.

308 **Declarations**

309 **Funding:** Not applicable.

310 **Ethical approval and consent to participate:**

311 Ethical approval for this cross-sectional study was obtained from the Ethics Committee of Shiraz
312 University of Medical Sciences (IR. SUMS.SCHEANUTREC.1402.119). Written informed
313 consent was obtained from all participants prior to their inclusion in the study.

314 **Clinical trial number**

315 Not applicable.

316 **Data availability:**

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

319 **Reference:**

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Table 1: Frequency distribution of the participants' demographic characteristics.

Table 2: Factor loading values, External reliability (ICC), and combined reliability of the constructs of a questionnaire on waste separation behavior based on the theory of value, belief-norm.

Table 3. Results of Exploratory Factor Analysis (EFA) for the Waste Separation Behavior Questionnaire (N = 289).

- Figure 1: The CFA results of the value structure extracted during the EFA
- Figure 2: The CFA results of the beliefs structure extracted during the EFA
- Figure 3: The CFA results of the norms structure extracted during the EFA

Supplementary Files

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