

Measuring hesitancy toward childhood vaccines before birth: validation of the Vaccine Hesitancy Scale in pregnant women and its association with health locus of control

Fatma Yağmur Evcil

fyagmuroyedek@gmail.com

Polatlı District Health Directorate, Ankara Provincial Health Directorate, Republic of Turkey Ministry of Health

Esra Çiçek

Konya Provincial Directorate of Health, Republic of Turkey Ministry of Health

Hasan Küçükkendirci

Meram Faculty of Medicine, Necmettin Erbakan University

Orçun Furkan Bayram

Meram Faculty of Medicine, Necmettin Erbakan University

Research Article

Keywords: Vaccination Hesitancy, Pregnancy, Immunization Schedule, Internal-External Control, Psychometrics, Prenatal Care

Posted Date: October 18th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11189365/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Purpose

Decisions about a child's routine vaccinations begin to take shape before birth, yet no psychometrically evaluated instrument measures pregnant women's hesitancy toward the vaccines their unborn child will receive. We evaluated the Vaccine Hesitancy Scale (VHS) adapted for pregnant women and its association with health locus of control.

Methods

In this methodological, cross-sectional study, 330 pregnant women attending an obstetrics outpatient clinic in Turkey were enrolled consecutively. The validated Turkish VHS was reworded to refer to the unborn child and reviewed by ten experts. The sample was randomly split into calibration and validation subsamples for exploratory and confirmatory factor analysis. Known-groups validity, discrimination and a hierarchical regression including the Multidimensional Health Locus of Control Scale were examined.

Results

The two-factor structure was reproduced, explaining 66.51% of the variance. The confirmatory model fitted acceptably after a single residual covariance between two adjacent confidence items (CFI = 0.978, RMSEA = 0.077), supported by WLSMV estimation. Internal consistency was high for the lack of confidence subscale ($\alpha = 0.945$) but low for the two-item risks subscale. Hesitancy was higher in all three prespecified known groups, and the total score discriminated maternal tetanus vaccine refusal (AUC = 0.821). Health locus of control added 9.2% to the explained variance; control attributed to health professionals and to oneself was associated with lower hesitancy.

Conclusion

Hesitancy toward childhood vaccines can be identified during pregnancy, before the first vaccine dose is due, and counseling can be oriented to women's control beliefs.

What is Known – What is New

- **What is Known:** The WHO SAGE Vaccine Hesitancy Scale has been validated in parents of children already born; parents' decisions about childhood vaccination begin during pregnancy.
- **What is New:** Adapted to the unborn child, the scale retained its two-factor structure in 330 pregnant women; hesitancy was measurable before the first vaccine dose and was lower when control was attributed to health professionals or to oneself.

Introduction

Pregnancy involves many decisions about maternal and infant health, among them the unborn child's childhood vaccinations [1, 2]. In Turkey, the childhood immunization schedule begins with a hepatitis B dose at birth [3], in line with the World Health Organization (WHO) recommendation that this dose be given within 24 hours of birth [4]. These decisions must therefore be acted on immediately after birth, and they begin to take shape during pregnancy [1, 2, 5, 6].

Vaccine hesitancy, defined as the delay in acceptance or refusal of vaccination despite the availability of services [7], is recognized as a global threat to childhood immunization [8]. Confidence in the importance of childhood vaccines declined in 52 of 55 countries with available data [9].

Several instruments measure vaccine hesitancy [10–13]; among them, the Vaccine Hesitancy Scale (VHS), developed by the WHO Strategic Advisory Group of Experts (SAGE) Working Group, has been evaluated psychometrically [10, 14], and brief parental instruments continue to be validated in new populations [15]. These instruments assess general vaccination attitudes [11, 12] or hesitancy toward a child already born [13, 14], whereas those used in pregnancy focus on vaccines for the mother herself [16]. To our knowledge, no psychometrically evaluated instrument assesses pregnant women's hesitancy toward the routine childhood vaccines intended for their unborn child.

Establishing the prevalence of hesitancy does not explain why it arises. Concerns about vaccine safety, misinformation from social media and the internet, and problems of trust in health professionals play an important role in hesitancy and refusal [17, 18]. Health locus of control theory distinguishes whether individuals attribute control over their health to themselves, to powerful others, or to chance [19]; examining hesitancy along these dimensions may help tailor prenatal counseling [20].

This study evaluated the psychometric properties of the Turkish VHS adapted to measure pregnant women's hesitancy toward their unborn child's routine vaccinations, and examined its relation to the dimensions of health locus of control.

Materials and methods

Design, setting and participants

This methodological, cross-sectional study evaluated the validity and reliability of the Turkish VHS adapted for pregnant women; reporting followed the STROBE checklist [21] (Online Resource 2). Data were collected between April 1 and June 25, 2026, at the obstetrics and gynecology outpatient clinic of a state university hospital in Turkey. Pregnant women aged 18 years or older with sufficient Turkish proficiency and no cognitive impairment preventing completion of the form were enrolled consecutively (n = 330). Sample size considerations are given in Online Resource 1.

Instruments

A 17-item form covered sociodemographic, obstetric and vaccine-related variables; maternal tetanus vaccination was recorded as intention below 20 weeks and actual status thereafter.

The VHS, developed by the SAGE Working Group [10], was psychometrically evaluated in 3,779 Canadian parents [14], yielding a nine-item, two-factor structure (seven-item lack of confidence and two-item risks subscales). Items are rated on a five-point Likert scale (confidence items reverse-scored); total scores range from 9 to 45, higher scores indicating greater hesitancy. The Turkish form was validated in 317 parents of children aged 9–16 years [22]. In the present adaptation, the items referring to the child (1, 3, 7 and 8) were rephrased in the future tense to refer to the unborn child, item 6 was simplified, and the instructions specified the childhood vaccines to be given under the National Immunization Schedule (Online Resource 1, Table S5). Content validity was rated by 10 experts (I-CVI 0.90–1.00; S-CVI/Ave 0.98) [23], a Turkish-language expert reviewed the form, and a pilot with 40 pregnant women identified no comprehension problems.

Health locus of control was measured with Form A of the Multidimensional Health Locus of Control Scale (MHLC) [19], which assesses internal, chance and powerful others dimensions with six items each on a six-point scale (subscale range 6–36); the Turkish version has acceptable fit and reliability [24]. The three subscale scores were used as continuous variables.

Data collection and analysis

Forms were self-administered in the waiting area under researcher supervision. Analyses used IBM SPSS 25, AMOS 24 and R 4.6.1 (lavaan) [25]; significance was set at $p < 0.05$. Full analytical details are given in Online Resource 1.

The sample was randomly split into calibration and validation subsamples ($n = 165$ each). Exploratory factor analysis (EFA; principal axis factoring, direct oblimin) was conducted in the calibration subsample, with the number of factors decided by the eigenvalue criterion, scree plot and parallel analysis [26, 27]. Confirmatory factor analysis (CFA) was conducted in the validation subsample with maximum likelihood estimation; because the items were ordinal and multivariate normality was not met, the Bollen–Stine bootstrap [28] and a sensitivity analysis with WLSMV estimation on polychoric correlations were added. The loadings of the two-item risks factor were constrained to be equal for identification. The unmodified two-factor model, a final model with a residual covariance between items 1 and 2 (also reported in the Turkish parent form [22]) and a one-factor alternative were compared using conventional fit criteria [29, 30]. Reliability was assessed with Cronbach's alpha and, for the two-item subscale, the Spearman–Brown coefficient [31]; composite reliability (CR) and average variance extracted (AVE) [32], item discrimination and floor and ceiling effects [33] were also examined.

Known-groups validity was tested with the a priori hypothesis that VHS scores would be higher among women who refused maternal tetanus vaccination, whose previous child was incompletely vaccinated, and who were not vaccinated against influenza during pregnancy (Welch's t test, Cohen's d [34]; ROC analysis with a data-derived, exploratory cut-off). Comparisons by descriptive characteristics were

hypothesis-generating; variables independently associated with hesitancy were examined with a preplanned four-block hierarchical regression (demographics; vaccination status; information source; locus of control), interpreted as associational given the cross-sectional design.

Claude (Anthropic) was used to translate the manuscript from Turkish into English; the authors reviewed the translation and take full responsibility for the content.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki (2024 revision) and approved by the Non-Interventional Clinical Research Ethics Committee of Necmettin Erbakan University, Meram Faculty of Medicine (No. 2026/6421, 13 March 2026); institutional permission, written informed consent and permission from the authors of the Turkish forms of both scales were obtained.

Results

Sample characteristics and vaccine hesitancy

The 330 participants had a mean age of 28.61 ± 5.15 years and a mean gestational age of 23.54 ± 9.92 weeks; 58.2% had a previous live birth. Regarding maternal tetanus vaccination, 77.0% had been or would be vaccinated, 12.4% were undecided and 7.9% refused; 4.2% had received influenza vaccination, and healthcare professionals were the most influential information source for 82.7%. The mean VHS total score was 20.48 ± 7.82 (range 9–45).

VHS scores were higher among women with a previous incompletely vaccinated child, those who refused maternal tetanus vaccination, those not vaccinated against influenza, those who believed that neither maternal vaccine protects the baby, and those relying primarily on scientific literature rather than healthcare professionals (all $p < 0.001$); they differed by education ($p < 0.001$) and correlated weakly with gestational week ($r = 0.142$), but not with the remaining characteristics (Table 1).

Table 1 Participant characteristics and comparison of Vaccine Hesitancy Scale (VHS) scores (N = 330)

Variable	Mean $\pm$ SD (range)	Correlation with VHS score (r)	p value
Age (years)	28.61 $\pm$ 5.15 (18–43)	–0.065	0.241
Gestational age (weeks)	23.54 $\pm$ 9.92 (5–41)	0.142	0.010
Number of living children (n = 192)	1.76 $\pm$ 0.79 (1–4)	–0.011	0.875
Variable	n (%)	VHS score (Mean $\pm$ SD)	p value
Education level			<0.001
Primary school or below	31 (9.4)	17.16 $\pm$ 4.58	
Middle school	86 (26.1)	20.19 $\pm$ 7.07	
High school	93 (28.2)	22.68 $\pm$ 8.06	
University or above	120 (36.4)	19.83 $\pm$ 8.40	
Occupation			0.235
Housewife	238 (72.1)	20.79 $\pm$ 7.40	
Employed	92 (27.9)	19.65 $\pm$ 8.81	
Perceived economic status			0.195
Income less than expenses	25 (7.6)	18.40 $\pm$ 6.42	
Income equal to expenses	191 (57.9)	20.94 $\pm$ 8.11	
Income more than expenses	114 (34.5)	20.16 $\pm$ 7.57	
Pre-pregnancy chronic disease			0.798
No	282 (85.5)	20.52 $\pm$ 8.08	
Yes	48 (14.5)	20.21 $\pm$ 6.13	
High-risk pregnancy			0.917
No	210 (63.6)	20.56 $\pm$ 8.20	
Yes	91 (27.6)	20.21 $\pm$ 6.98	
Do not know / not informed	29 (8.8)	20.69 $\pm$ 7.75	
Previous live birth			0.537
Yes	192 (58.2)	20.25 $\pm$ 7.68	
No	138 (41.8)	20.79 $\pm$ 8.03	

Previous child's vaccination status (n = 192)			<0.001
All scheduled vaccinations completed	176 (91.7)	19.22 ± 6.51	
Partially vaccinated or not vaccinated	16 (8.3)	31.62 ± 10.30	
Maternal tetanus vaccination status			<0.001
Vaccinated / will be vaccinated	254 (77.0)	19.24 ± 7.04	
Undecided	41 (12.4)	21.12 ± 7.12	
Refused / will refuse vaccination	26 (7.9)	29.85 ± 9.32	
Previously vaccinated / medical contraindication	9 (2.7)	25.33 ± 7.71	
Influenza vaccination status during pregnancy			<0.01
Not vaccinated	295 (89.4)	20.92 ± 7.52	
Not pregnant during influenza season / undecided	21 (6.4)	18.52 ± 10.41	
Vaccinated	14 (4.2)	14.14 ± 6.89	
Belief in protection of maternal vaccination			<0.001
Both protect	104 (31.5)	16.23 ± 5.65	
Don't know	100 (30.3)	20.90 ± 6.35	
One protects	74 (22.4)	20.57 ± 6.76	
Neither protects	52 (15.8)	28.02 ± 9.56	
Primary source of vaccine information (n = 329)			<0.001
Healthcare professionals	273 (82.7)	19.49 ± 6.92	
Scientific literature / books	37 (11.2)	26.30 ± 10.94	
Other people / social media	19 (5.8)	23.53 ± 7.76	

VHS, Vaccine Hesitancy Scale. Percentages are column percentages of the total sample unless otherwise indicated. p values were obtained from Pearson correlation (continuous variables) and from the independent-samples t test, Welch's t test, Welch's ANOVA, or the Kruskal–Wallis test, as appropriate. Within each variable, groups not sharing a superscript letter differed significantly in Games–Howell or Dunn–Bonferroni post hoc comparisons (p < 0.05)

Factor structure

In the calibration subsample (KMO = 0.909; Bartlett's $\chi^2(36) = 1166.77$, $p < 0.001$), EFA reproduced the two-factor structure, explaining 66.51% of the variance; the scree plot (Online Resource 1, Figure S1) and parallel analysis supported two factors. Rotated loadings were 0.652–0.957 for lack of confidence and 0.636 and 0.678 for risks (Table 2). All items discriminated between the lower and upper 27% groups ($p < 0.001$); floor effects were observed for the confidence items (Online Resource 1, Tables S1–S3).

Table 2 Psychometric properties of the Turkish adaptation of the Vaccine Hesitancy Scale for pregnant women

Panel A. Item analysis and exploratory factor analysis (calibration subsample, n = 165)

Factor	Item	Mean $\pm$ SD	Corrected item–total correlation	Cronbach's α if item deleted	Rotated factor loading
Lack of confidence	VHS1	1.87 $\pm$ 1.14	0.911	0.929	0.957
	VHS2	1.91 $\pm$ 1.15	0.886	0.931	0.935
	VHS3	2.15 $\pm$ 1.34	0.806	0.939	0.862
	VHS4	2.15 $\pm$ 1.29	0.823	0.937	0.837
	VHS6	2.21 $\pm$ 1.13	0.655	0.950	0.652
	VHS7	1.94 $\pm$ 1.18	0.846	0.934	0.846
	VHS8	1.77 $\pm$ 1.04	0.818	0.937	0.839
	VHS5	3.12 $\pm$ 1.36	0.436	—	0.636
Risks	VHS9	3.35 $\pm$ 1.33	0.436	—	0.678

Panel B. Construct reliability and validity

Construct	No. of items	Standardized CFA loading range (validation subsample)	α (calibration subsample)	CR (validation subsample)	AVE (validation subsample)
Lack of confidence	7	0.788–0.943	0.945	0.947	0.719
Risks	2	0.521–0.524 $\boxtimes$	0.607 $\boxtimes$	0.429	0.273
Overall scale	9	—	0.885	—	—

EFA and α : calibration subsample (n = 165); CFA loadings, CR and AVE: validation subsample (n = 165). $\boxtimes$ Loadings constrained to be equal. $\boxtimes$ Spearman–Brown coefficient. KMO = 0.909; Bartlett’s $\chi^2(36) = 1166.773$, $p < 0.001$; variance explained = 66.51%. AVE, average variance extracted; CFA, confirmatory factor analysis; CR, composite reliability; EFA, exploratory factor analysis; KMO, Kaiser–Meyer–Olkin

In the validation subsample, the unmodified two-factor model did not fit acceptably (CFI = 0.930; RMSEA = 0.134). With a residual covariance between items 1 and 2, fit was acceptable ($\chi^2(26) = 51.12$; CFI = 0.978; TLI = 0.969; RMSEA = 0.077; SRMR = 0.036; Table 3), and the Bollen–Stine bootstrap did not indicate misfit ($p = 0.100$). Standardized loadings were 0.788–0.943 for lack of confidence and 0.52 for both risks items (Fig. 1); the inter-factor correlation was low ($r = 0.089$, $p = 0.468$). WLSMV estimation supported the same solution (CFI = 0.996; RMSEA = 0.073; SRMR = 0.048; $r = 0.091$), whereas a one-factor model fitted poorly (RMSEA = 0.164) with risks loadings near zero (–0.01 and 0.12).

Table 3 Confirmatory factor analysis model fit indices for the Turkish adaptation of the Vaccine Hesitancy Scale for pregnant women (n = 165)

Fit index	Recommended criteria	ML, unmodified two-factor model	ML, final model	WLSMV, final model
χ^2 (df)	—	106.11 (27)	51.12 (26)	48.84 (26)
p	—	<0.001	0.002	0.004
χ^2 /df	< 3	3.93	1.97	1.88
CFI	≥ 0.95	0.930	0.978	0.996
TLI	≥ 0.95	0.906	0.969	0.995
GFI	≥ 0.90	0.880	0.932	N/A
RMSEA (90% CI)	≤ 0.08	0.134 (0.107–0.161)	0.077 (0.045–0.108)	0.073 (0.040–0.104)
SRMR	≤ 0.08	0.043	0.036	0.048
PCLOSE	> 0.05	<0.001	0.079	N/A
Bollen–Stine bootstrap p	> 0.05	—	0.100	N/A

ML, maximum likelihood (AMOS 24); WLSMV, weighted least squares with mean- and variance-adjusted statistics on polychoric correlations (lavaan). N/A, not available. The final model adds a residual covariance between VHS1 and VHS2

Reliability and validity

Lack of confidence showed high internal consistency ($\alpha = 0.945$; CR = 0.947; AVE = 0.719), whereas the risks subscale had a Spearman–Brown coefficient of 0.607 but low CR (0.429) and AVE (0.273); total-scale α was 0.885. The Fornell–Larcker criterion was met (square root of AVE 0.848 and $0.522 > r = 0.089$).

As hypothesized, VHS scores were higher among tetanus vaccine refusers than acceptors ($d = 1.28$), among women whose previous child was incompletely vaccinated ($d = 1.44$) and among women not vaccinated against influenza ($d = 0.94$); all $p < 0.01$ (Table 1). For tetanus refusal, the total score discriminated well (AUC = 0.821, 95% CI 0.730–0.911), as did the lack of confidence subscale (AUC = 0.813), whereas the risks subscale performed poorly (AUC = 0.639) (Fig. 2); the exploratory Youden cut-off was 21 or above (sensitivity 0.846; specificity 0.665). Discrimination was similar for the other two criteria (AUC 0.800–0.830; Online Resource 1, Table S4).

Health locus of control and vaccine hesitancy

The VHS total score correlated negatively with powerful others ($r = -0.334$), internal ($r = -0.261$) and chance ($r = -0.122$) locus of control; the risks subscale correlated only with chance, positively ($r = 0.145$) (Online Resource 1, Table S6). In the hierarchical regression ($n = 329$; Durbin–Watson = 2.18; maximum VIF = 1.59), explained variance rose from 5.7% (demographics) to 22.9% (vaccination status), 26.0% (information source) and 35.2% with the locus of control dimensions ($\Delta R^2 = 0.092$, $p < 0.001$). In the final model, powerful others ($B = -0.25$, 95% CI -0.37 to -0.14 ; $\beta = -0.21$) and internal control ($B = -0.23$, 95% CI -0.37 to -0.08 ; $\beta = -0.15$) were independently and negatively associated with hesitancy, whereas chance was not. Tetanus vaccine refusal showed the largest association ($B = 8.68$; $\beta = 0.30$), followed by influenza non-vaccination, reliance on scientific literature, high school and middle school education versus university, being undecided about tetanus vaccination and gestational week (Table 4)

Table 4 Hierarchical multiple regression of variables associated with the Vaccine Hesitancy Scale (VHS) total score ($n = 329$).

Variable	Model 1 B (SE)	β	Model 2 B (SE)	β	Model 3 B (SE)	β	Model 4 B (SE)	β
Constant	18.24 (2.80)***		9.99 (3.15)**		8.52 (3.14)**		21.25 (3.58)***	
Age	-0.01 (0.09)	-0.01	-0.01 (0.08)	-0.01	0.00 (0.08)	0.00	0.00 (0.07)	0.00
Gestational week	0.10 (0.04)*	0.12	0.12 (0.05)**	0.16	0.12 (0.04)**	0.16	0.12 (0.04)**	0.15
Education (Ref: University or above)								
High school	2.36 (1.11)*	0.14	2.59 (1.03)*	0.15	3.25 (1.04)**	0.19	3.02 (0.98)**	0.17
Middle school	-0.01 (1.11)	0.00	0.34 (1.03)	0.02	1.41 (1.06)	0.08	2.13 (1.02)*	0.12
Primary school or less	-2.85 (1.56)	-0.11	-2.17 (1.44)	-0.08	-1.12 (1.44)	-0.04	0.20 (1.40)	0.01
Tetanus vaccination status (Ref: Vaccinated / will be vaccinated)								
Undecided			3.47 (1.33)**	0.15	2.89 (1.32)*	0.12	2.99 (1.25)*	0.13
Refused			10.50 (1.45)***	0.36	8.46 (1.53)***	0.29	8.68 (1.45)***	0.30
Other (previously vaccinated / medical contraindication)			4.91 (2.39)*	0.10	4.46 (2.36)	0.09	3.89 (2.22)	0.08
Influenza vaccination status (Ref: Vaccinated)								
Not vaccinated			6.15 (1.93)**	0.16	6.29 (1.90)**	0.16	5.68 (1.79)**	0.15
Information source (Ref: Healthcare professionals)								
Scientific literature / books					4.90 (1.37)***	0.20	3.95 (1.30)**	0.16

Variable	Model 1 B (SE)	β	Model 2 B (SE)	β	Model 3 B (SE)	β	Model 4 B (SE)	β
Other people / social media					1.98 (1.69)	0.06	1.24 (1.60)	0.04
Health locus of control								
Internal							-0.23 (0.07)**	-0.15
Powerful others							-0.25 (0.06)***	-0.21
Chance							-0.04 (0.06)	-0.04
R²	0.057		0.229		0.260		0.352	
Adjusted R²	0.042		0.207		0.235		0.323	
ΔR^2	0.057**		0.173***		0.031**		0.092***	
ΔF	3.87**		17.86***		6.66**		14.81***	

B, unstandardized coefficient; β , standardized coefficient; SE, standard error. ☐ 'Not vaccinated' and 'not pregnant during the influenza season / undecided' combined. *p < 0.05; **p < 0.01; ***p < 0.001

Discussion

This study provides supporting evidence for the construct validity and internal consistency of the Turkish VHS adapted for pregnant women. The scale has been examined in parent and caregiver samples in Canada [14], the United States [35] and China [36], in a measles-specific version in Sudan [37] and, in Turkish, in parents of children aged 9–16 years [22]. Decisions about childhood vaccination begin to take shape before birth [5, 6], yet no validated instrument was available for pregnant women; a study of postpartum women likewise noted the need for an instrument capturing pregnancy-specific concerns [16]. To our knowledge, this is the first validated form measuring hesitancy during pregnancy toward the routine childhood vaccines intended for the unborn child, so that hesitancy becomes measurable before the first dose is due.

EFA, in a subsample independent of the confirmatory analysis, reproduced the original two-factor structure [14]. In the CFA the unmodified model did not fit acceptably; the criteria were met once a residual covariance was specified between items 1 and 2, which express the same confidence construct and are adjacent in the scale. That this covariance has also been reported in the Turkish parent form [22] suggests it is not specific to the present sample. The Bollen–Stine bootstrap and WLSMV estimation yielded the same two-factor solution, and the risks loadings fell to zero in the one-factor model, so these items are not represented by a single confidence dimension.

The two-item risks subscale is a structural feature of the scale: the nine-item structure was defined by removing the tenth item, which loaded similarly on both factors [14]. Its weakness is not specific to this sample, with internal consistency reported as 0.64 in the original study [14], 0.62 in Chinese caregivers [36] and 0.47 in the Turkish parent form [22]; the small number of items and their being the only negatively worded items have been proposed as reasons [14, 35]. Here the two-item factor could not be empirically identified when unrelated to the other factor, so its loadings were constrained to be equal; the resulting loadings (0.52), CR (0.43) and AVE (0.27) fell markedly below recommended thresholds [32]. The inter-factor correlation ($r = 0.09$) was lower than in the original study ($r = 0.44$ [14]), which may reflect a concern independent of confidence in pregnant women or the limited reliability of the subscale. The low correlation poses no problem for discriminant validity, but the low CR and AVE indicate that this subscale should not be used on its own. Because the scale was developed for cross-context comparison [10], the original structure and total score were retained.

Known-groups validity was supported in all three prespecified comparisons, with acceptable discrimination for the total score (AUC 0.800–0.830). The largest difference was observed for the previous child's vaccination status, probably because this criterion rests on actual vaccination behavior rather than reported intention. Discrimination was close to that of the total score for the lack of confidence subscale and low for the risks subscale, so this evidence derives largely from the confidence dimension.

The health locus of control dimensions added 9.2% to the explained variance after demographics, vaccination status and information source were controlled for, with powerful others and internal control independently and negatively associated with hesitancy. Unlike diet or exercise, vaccination can only be administered by health personnel, so the powerful others dimension, reflecting the belief that health is determined by such persons [19], is theoretically expected to show the strongest association. In Israeli parents this dimension was directly associated with completion of the childhood schedule, whereas internal control and chance showed only indirect effects [38]; a scoping review reported trust in health professionals to be the principal predictor of compliance [20], and similar associations have been reported in Southern Italy [39], Italian parents [40], Czech students [41] and rural Namibia [42]. That 82.7% named health professionals as the most influential source indicates a context of high professional trust; counseling should therefore attend to trust in the health professional as well as to information content.

Findings on internal locus of control differ across studies: it is generally associated with lower hesitancy, but parents with a high internal locus have also approached vaccination more critically [20], those who regarded themselves as the principal determinant of their health were more skeptical [42], and groups strongly supporting and rejecting vaccination did not differ on a general locus of control measure but were distinguished by conspiracy beliefs and intolerance of uncertainty [43]. Chance made no significant contribution in the multivariable model, yet the risks subscale was associated only with this dimension, positively. Comparable associations have been reported for chance with lower childhood vaccination [20, 38], fate and divine will with higher hesitancy [39, 40], chance with lower COVID-19 vaccination intention [44], and health fatalism in vaccine-resistant adults [45]. This pattern suggests that information alone may not be sufficient.

Hesitancy scores were on average 8.7 points higher in women who refused maternal tetanus vaccination and 5.7 points higher in women not vaccinated against influenza, suggesting continuity between vaccination behavior in pregnancy and attitudes toward the unborn child's vaccines [5]. The relationship with education was not linear: hesitancy was highest in high school and middle school graduates, whereas women with primary education or less did not differ from university graduates, consistent with earlier reports that more highly educated parents have shown greater safety concerns and that refusal of all childhood vaccines has been more common among university graduates [17].

Strengths and limitations

Construct validity was tested in independent subsamples, the number of factors was supported by parallel analysis, the confirmatory model was re-evaluated with a bootstrap procedure and an ordinal estimator, and known-groups validity was tested against three criteria, one reflecting actual vaccination behavior. Data were collected by consecutive sampling in a single university hospital and vaccination information was self-reported, so generalizability is limited. Given the cross-sectional design, causality cannot be attributed to the associations between locus of control and hesitancy, and the vaccination variables in the regression overlap with the known-groups comparisons, so those coefficients are not independent evidence. Only internal consistency was evaluated; test–retest reliability, concurrent validity and measurement invariance were not examined, and the known-groups comparisons rested on small groups. Whether hesitancy measured in pregnancy predicts the child's vaccination status in the first year should be examined prospectively.

Implications for pediatric immunization practice

Childhood vaccination is usually first raised at the maternity ward or later visits, whereas nine items completed at a routine antenatal contact identified hesitancy at a level that distinguished women whose previous child was incompletely vaccinated. Hesitancy identified before birth can be communicated to the teams administering the first hepatitis B dose and the subsequent schedule, so that counseling begins before the first vaccine is due rather than at the moment of refusal. Providing facts alone has been reported to backfire in hesitant parents [46], whereas a framework positioning parents along a spectrum from acceptance to refusal with distinct communication goals for each position [47], based on motivational interviewing, proved feasible in the peripartum period, a single maternity-ward session increasing infants' vaccine coverage at seven months by approximately 7% [48]. Our findings suggest a further axis: where hesitancy relates mainly to a lack of confidence, priority should go to continuity of the relationship with the health professional; where risk perception is prominent, fatalistic beliefs should also be addressed and vaccination framed as a concrete protective step the parent can take. Assessment should rest on the total score and the lack of confidence subscale.

Conclusion

The Turkish VHS adapted for pregnant women showed supporting psychometric evidence, particularly for the total score and the lack of confidence subscale, with the original two-factor structure retained across independent subsamples and estimation methods; the risks subscale should not be used on its own. Control attributed to health professionals and to oneself remained associated with lower hesitancy after demographic characteristics and vaccination behavior were controlled for, indicating that antenatal counseling can be oriented to women's control beliefs before the first vaccine is due.

List of abbreviations

AUC, area under the receiver operating characteristic curve

AVE, average variance extracted

CFA, confirmatory factor analysis

CFI, comparative fit index

CR, composite reliability

EFA, exploratory factor analysis

MHLC, Multidimensional Health Locus of Control Scale

RMSEA, root mean square error of approximation

SAGE, Strategic Advisory Group of Experts

SRMR, standardized root mean square residual

TLI, Tucker–Lewis index

VHS, Vaccine Hesitancy Scale

WHO, World Health Organization

WLSMV, weighted least squares with mean- and variance-adjusted statistics

Declarations

Funding: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Author contributions: Conceptualization: Fatma Yağmur Evcil; Methodology: Fatma Yağmur Evcil, Esra Çiçek; Formal analysis and investigation: Fatma Yağmur Evcil, Esra Çiçek, Orçun Furkan Bayram;

Resources: Orçun Furkan Bayram; Writing – original draft preparation: Fatma Yağmur Evcil; Writing – review and editing: Esra Çiçek, Hasan Küçükkendirci, Orçun Furkan Bayram; Supervision: Hasan Küçükkendirci. All authors read and approved the final manuscript.

Ethics approval: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Non-Interventional Clinical Research Ethics Committee of Necmettin Erbakan University, Meram Faculty of Medicine (13 March 2026 / No. 2026/6421).

Consent to participate: Written informed consent was obtained from all individual participants included in the study.

Consent to publish: Not applicable; the manuscript contains no individual person's data in any identifiable form.

Data availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1. Corben P, Leask J (2018) Vaccination hesitancy in the antenatal period: a cross-sectional survey. *BMC Public Health* 18:566. <https://doi.org/10.1186/s12889-018-5389-6>
2. Weiner JL, Fisher AM, Nowak GJ, Basket MM, Gellin BG (2015) Childhood immunizations: first-time expectant mothers' knowledge, beliefs, intentions, and behaviors. *Am J Prev Med* 49(6 Suppl 4):S426–S434. <https://doi.org/10.1016/j.amepre.2015.07.002>
3. Republic of Turkey Ministry of Health (2026) Ulusal Çocukluk Dönemi Aşılama Takvimi [National childhood immunization schedule]. <https://asi.saglik.gov.tr/bagisiklama-programi-ve-asi-takvimi/asi-takvimi.html>. Accessed 15 August 2026
4. World Health Organization (2017) Hepatitis B vaccines: WHO position paper – July 2017. *Wkly Epidemiol Rec* 92:369–392
5. Danchin MH, Costa-Pinto J, Attwell K, Willaby H, Wiley K, Hoq M et al (2018) Vaccine decision-making begins in pregnancy: correlation between vaccine concerns, intentions and maternal vaccination with subsequent childhood vaccine uptake. *Vaccine* 36:6473–6479. <https://doi.org/10.1016/j.vaccine.2017.08.003>
6. Glanz JM, Wagner NM, Narwaney KJ, Shoup JA, McClure DL, McCormick EV, Daley MF (2013) A mixed methods study of parental vaccine decision making and parent-provider trust. *Acad Pediatr* 13:481–488. <https://doi.org/10.1016/j.acap.2013.05.030>
7. MacDonald NE (2015) Vaccine hesitancy: definition, scope and determinants. *Vaccine* 33:4161–4164. <https://doi.org/10.1016/j.vaccine.2015.04.036>
8. World Health Organization (2019) Ten threats to global health in 2019. <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>. Accessed 15 August 2026

9. UNICEF (2023) The state of the world's children 2023: for every child, vaccination. UNICEF Innocenti – Global Office of Research and Foresight, Florence
10. Larson HJ, Jarrett C, Schulz WS, Chaudhuri M, Zhou Y, Dubé E et al (2015) Measuring vaccine hesitancy: the development of a survey tool. *Vaccine* 33:4165–4175.
<https://doi.org/10.1016/j.vaccine.2015.04.037>
11. Luyten J, Bruyneel L, van Hoek AJ (2019) Assessing vaccine hesitancy in the UK population using a generalized vaccine hesitancy survey instrument. *Vaccine* 37:2494–2501.
<https://doi.org/10.1016/j.vaccine.2019.03.041>
12. Martin LR, Petrie KJ (2017) Understanding the dimensions of anti-vaccination attitudes: the Vaccination Attitudes Examination (VAX) Scale. *Ann Behav Med* 51:652–660.
<https://doi.org/10.1007/s12160-017-9888-y>
13. Opel DJ, Mangione-Smith R, Taylor JA, Korfiatis C, Wiese C, Catz S, Martin DP (2011) Development of a survey to identify vaccine-hesitant parents: the Parent Attitudes about Childhood Vaccines survey. *Hum Vaccin* 7:419–425. <https://doi.org/10.4161/hv.7.4.14120>
14. Shapiro GK, Tatar O, Dube E, Amsel R, Knauper B, Naz A, Perez S, Rosberger Z (2018) The vaccine hesitancy scale: psychometric properties and validation. *Vaccine* 36:660–667.
<https://doi.org/10.1016/j.vaccine.2017.12.043>
15. Magi CE, El Aoufy K, Bambi S, Campoli A, Longobucco Y, Buccione E, Amato C, Bonacaro A, Rasero L, Iovino P (2025) Psychometric validation of the 5-item parent attitudes about childhood vaccines survey (PACV-5) in an Italian parental population. *Eur J Pediatr* 184:514.
<https://doi.org/10.1007/s00431-025-06342-y>
16. Nuzhath T, Yang Y, Couture MC, Gu NY, Comeau JL, Regan AK (2025) Structural equation modeling to evaluate the adult vaccine hesitancy scale for vaccines recommended during pregnancy. *Vaccine* 45:126568. <https://doi.org/10.1016/j.vaccine.2024.126568>
17. Gowda C, Dempsey AF (2013) The rise (and fall?) of parental vaccine hesitancy. *Hum Vaccin Immunother* 9:1755–1762. <https://doi.org/10.4161/hv.25085>
18. Smith SE, Sivertsen N, Lines L, De Bellis A (2022) Decision making in vaccine hesitant parents and pregnant women – an integrative review. *Int J Nurs Stud Adv* 4:100062.
<https://doi.org/10.1016/j.ijnsa.2022.100062>
19. Wallston KA, Wallston BS, DeVellis R (1978) Development of the Multidimensional Health Locus of Control (MHLC) scales. *Health Educ Monogr* 6:160–170.
<https://doi.org/10.1177/109019817800600107>
20. Magi CE, Buccione E, Bambi S, Iovino P, Zanobini P, Cecchi F et al (2025) Exploring health locus of control among vaccine-hesitant parents: a scoping review. *BMJ Open* 15:e100202.
<https://doi.org/10.1136/bmjopen-2025-100202>
21. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP (2007) The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 370:1453–1457.
[https://doi.org/10.1016/S0140-6736\(07\)61602-X](https://doi.org/10.1016/S0140-6736(07)61602-X)

22. Önal Ö, Eroğlu HN, Evcil FY, Kişioğlu AN, Uskun E (2021) Validity and reliability of Turkish version of the Vaccine Hesitancy Scale. *Turk Arch Pediatr* 56:230–235.
<https://doi.org/10.5152/TurkArchPediatr.2021.20028>
23. Polit DF, Beck CT, Owen SV (2007) Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Res Nurs Health* 30:459–467. <https://doi.org/10.1002/nur.20199>
24. Güzel A, Turan S, Üner S (2020) Turkish validity and reliability of Multidimensional Health Locus of Control Scale Form A. *Int J Nurs Pract* 26:e12813. <https://doi.org/10.1111/ijn.12813>
25. Rosseel Y (2012) lavaan: an R package for structural equation modeling. *J Stat Softw* 48(2):1–36. <https://doi.org/10.18637/jss.v048.i02>
26. Horn JL (1965) A rationale and test for the number of factors in factor analysis. *Psychometrika* 30:179–185. <https://doi.org/10.1007/BF02289447>
27. O'Connor BP (2000) SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behav Res Methods Instrum Comput* 32:396–402. <https://doi.org/10.3758/BF03200807>
28. Bollen KA, Stine RA (1992) Bootstrapping goodness-of-fit measures in structural equation models. *Sociol Methods Res* 21:205–229. <https://doi.org/10.1177/0049124192021002004>
29. Hu L, Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Model* 6:1–55. <https://doi.org/10.1080/10705519909540118>
30. Tabachnick BG, Fidell LS (2013) *Using multivariate statistics*, 6th edn. Pearson, Boston
31. Eisinga R, te Grotenhuis M, Pelzer B (2013) The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *Int J Public Health* 58:637–642. <https://doi.org/10.1007/s00038-012-0416-3>
32. Fornell C, Larcker DF (1981) Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res* 18:39–50. <https://doi.org/10.1177/002224378101800104>
33. Terwee CB, Bot SDM, de Boer MR, Knol DL, Dekker J et al (2007) Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 60:34–42. <https://doi.org/10.1016/j.jclinepi.2006.03.012>
34. Cohen J (1988) *Statistical power analysis for the behavioral sciences*, 2nd edn. Lawrence Erlbaum, Hillsdale
35. Helmkamp LJ, Szilagyi PG, Zimet G, Saville AW, Gurfinkel D, Albertin C, Breck A, Vangala S, Kempe A (2021) A validated modification of the vaccine hesitancy scale for childhood, influenza and HPV vaccines. *Vaccine* 39:1831–1839. <https://doi.org/10.1016/j.vaccine.2021.02.039>
36. Cao M, Zhao J, Huang C, Wang X, Ye L, Han X et al (2023) Assessing vaccine hesitancy using the WHO scale for caregivers of children under 3 years old in China. *Front Public Health* 11:1090609. <https://doi.org/10.3389/fpubh.2023.1090609>
37. Sabahelzain MM, Dubé E, Moukhyer M, van den Larson HJ, Bosma H (2020) Psychometric properties of the adapted measles vaccine hesitancy scale in Sudan. *PLoS ONE* 15:e0237171. <https://doi.org/10.1371/journal.pone.0237171>

38. Amit Aharon A, Nehama H, Rishpon S, Baron-Epel O (2018) A path analysis model suggesting the association between health locus of control and compliance with childhood vaccinations. *Hum Vaccin Immunother* 14:1618–1625. <https://doi.org/10.1080/21645515.2018.1471305>
39. Barbieri MA, Cicala G, Molonia A, Alibrandi A, Pallio G, La Fauci E et al (2026) Factors associated with parental vaccine hesitancy in childhood immunization: insights from a cross-sectional survey in Southern Italy. *Pharm Res* 43:1441–1454. <https://doi.org/10.1007/s11095-026-04072-w>
40. Magi CE, Longobucco Y, Amato C, Rasero L, Bambi S, Buccione E et al (2026) Psychometric properties and measurement invariance of the Parental Health Locus of Control Scale in an Italian population. *Interdiscip J Nurs Health* 5:47–59. <https://doi.org/10.82051/ijnh-2026-265>
41. Pisl V, Volavka J, Chvojková E, Čechová K, Kavalířová G, Vevera J (2021) Willingness to vaccinate against COVID-19: the role of health locus of control and conspiracy theories. *Front Psychol* 12:717960. <https://doi.org/10.3389/fpsyg.2021.717960>
42. Prall S, Scelza B, Lopes A (2026) The power of powerful others: health locus of control and vaccination behavior in rural Namibian pastoralists. *BMC Glob Public Health* 4:20. <https://doi.org/10.1186/s44263-026-00251-4>
43. Kendell HA, Vernon PA (2026) The role of personality in vaccination attitudes: a replication and extension. *Int J Psychol* 61:e70199. <https://doi.org/10.1002/ijop.70199>
44. Giuliani M, Ichino A, Bonomi A, Martoni R, Cammino S, Gorini A (2021) Who is willing to get vaccinated? A study into the psychological, socio-demographic, and cultural determinants of COVID-19 vaccination intentions. *Vaccines (Basel)* 9:810. <https://doi.org/10.3390/vaccines9080810>
45. Moffitt TE, Caspi A, Ambler A, Bourassa K, Harrington H, Hogan S et al (2022) Deep-seated psychological histories of COVID-19 vaccine hesitance and resistance. *PNAS Nexus* 1:pgac034. <https://doi.org/10.1093/pnasnexus/pgac034>
46. Gagneur A (2020) Motivational interviewing: a powerful tool to address vaccine hesitancy. *Can Commun Dis Rep* 46:93–97. <https://doi.org/10.14745/ccdr.v46i04a06>
47. Leask J, Kinnersley P, Jackson C, Cheater F, Bedford H, Rowles G (2012) Communicating with parents about vaccination: a framework for health professionals. *BMC Pediatr* 12:154. <https://doi.org/10.1186/1471-2431-12-154>
48. Gagneur A, Lemaître T, Gosselin V, Farrands A, Carrier N, Petit G et al (2018) A postpartum vaccination promotion intervention using motivational interviewing techniques improves short-term vaccine coverage: PromoVac study. *BMC Public Health* 18:811. <https://doi.org/10.1186/s12889-018-5724-y>

Figures

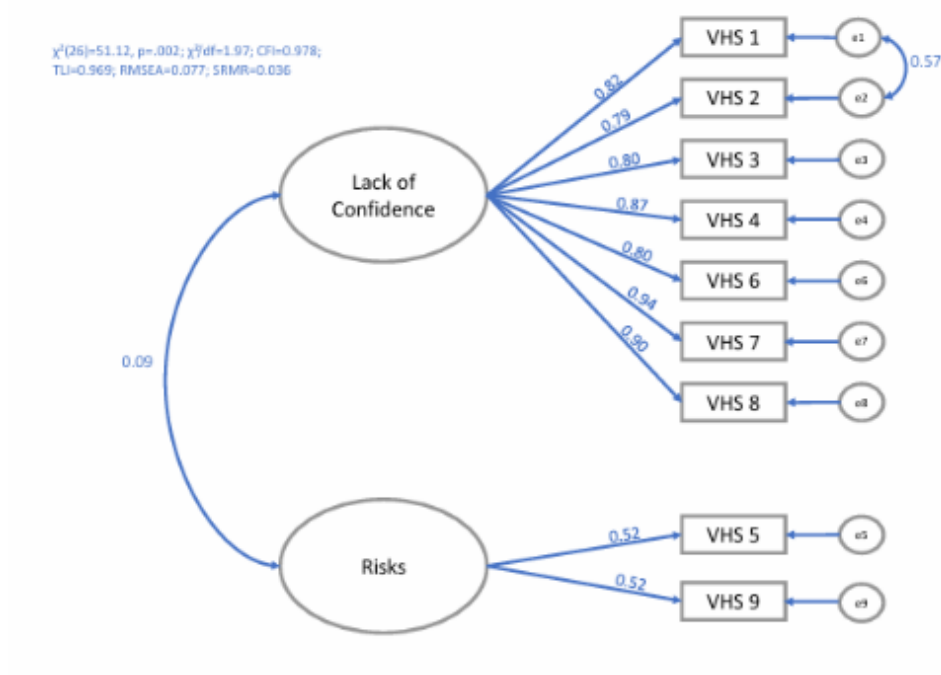


Figure 1

Confirmatory factor analysis model of the Turkish Vaccine Hesitancy Scale adapted for pregnant women (validation subsample, n = 165; maximum likelihood, standardized estimates).

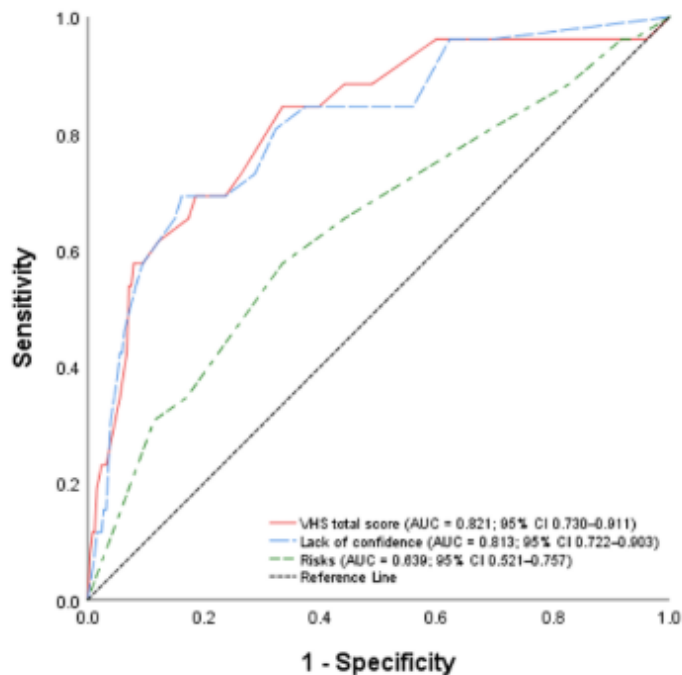


Figure 2

Receiver operating characteristic curves of the Vaccine Hesitancy Scale total score, lack of confidence subscale and risks subscale for maternal tetanus vaccine refusal (n = 280)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [EJPESM.pdf](#)