

Electronic Supplementary Material — Online Resource 1

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

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Authors: Fatma Yağmur Evcil, Esra Çiçek, Hasan Küçükkendirci, Orçun Furkan Bayram

Corresponding author: Fatma Yağmur Evcil, MD, Polatlı District Health Directorate, Ankara Provincial Health Directorate, Republic of Turkey Ministry of Health, Fatih Mah., Atatürk Cad. No. 172, 06900 Polatlı, Ankara, Turkey. Tel.: +90 506 326 18 87. E-mail: fyagmuroyedek@gmail.com

Supplementary Methods

Sample size. The sample size was based on the larger of the numbers required for the scale adaptation and for the analysis of the association between vaccine hesitancy and health locus of control. Although at least 10 participants per item are commonly recommended for scale adaptation studies, Comrey and Lee describe 300 participants as a good sample size for factor analysis. Using G*Power 3.1, the minimum sample required to detect a correlation of $\rho = 0.20$ at $\alpha = 0.05$ with 80% power was 193. A minimum of 300 participants was therefore targeted, and the study was completed with 330 women. A sensitivity analysis showed that the regression sample ($n = 329$) was sufficient to detect, with 80% power, effects of $f^2 = 0.058$ ($R^2 = 0.055$) in a model with 14 predictors and an R^2 increase of $f^2 = 0.034$ ($\Delta R^2 = 0.033$) for the three locus of control dimensions entered in the final block.

Adaptation and content validity. The Turkish form validated in parents was used as the starting point. Items referring to the child (1, 3, 7 and 8) were rephrased in the future tense to refer to the unborn child, the wording of item 6 was simplified, and the remaining items were left unchanged (Table S5). The instructions stated explicitly that the items concern the childhood vaccines to be administered to the unborn child under the National Immunization Schedule. The linguistic appropriateness of the adapted form was reviewed by an expert trained in Turkish language and literature. For content validity, 10 experts from public health ($n = 3$), obstetrics and gynecology ($n = 1$), child and adolescent psychiatry ($n = 1$), pediatrics ($n = 2$), family medicine ($n = 1$) and infectious diseases ($n = 2$) rated each item on a four-point relevance scale. The item-level content validity index (I-CVI) was calculated as the proportion of experts giving a rating of 3 or 4, and scale-level content validity as the average of the item indices (S-CVI/Ave); an I-CVI criterion of 0.78 was adopted for panels of six or more experts. I-CVI values ranged from 0.90 to 1.00 and the S-CVI/Ave was 0.98; no items were removed. A pilot study with 40 pregnant women identified no comprehension problems, and no further changes were made.

Exploratory factor analysis. The suitability of the data for factor analysis was assessed with the Kaiser–Meyer–Olkin (KMO) coefficient, Bartlett's test of sphericity and the measures of sampling adequacy on the diagonal of the anti-image correlation matrix. Because the items were not normally distributed, principal axis factoring with direct oblimin rotation ($\delta = 0$, Kaiser normalization) was used; oblique rotation was preferred on the assumption that the subscales could be theoretically related. The number of factors was decided by jointly considering the eigenvalue criterion, the scree plot and parallel analysis conducted with O'Connor's SPSS syntax, in which reduced eigenvalues were compared with the 95th percentile of eigenvalues obtained from random data sets of the same dimensions. Item-level analyses were based on scored item values, with lack-of-confidence items reverse-coded before analysis, and item–total correlations were calculated within each subscale. Item discrimination was evaluated in the full sample by comparing the lower and upper 27% groups formed according to the VHS total score; participants with tied scores at the cut-points were retained, so the two group sizes differ slightly.

Confirmatory factor analysis. Confirmatory factor analysis was conducted in the validation subsample with maximum likelihood estimation in AMOS 24. The factor loadings of the two risks items were constrained to be equal, because a two-item factor that is uncorrelated with the other factor cannot

be empirically identified otherwise. Model fit was evaluated with χ^2/df , CFI, TLI, GFI, RMSEA with its 90% confidence interval, SRMR and PCLOSE, using the criteria $\chi^2/\text{df} < 3$, CFI and TLI ≥ 0.95 , GFI ≥ 0.90 , and RMSEA and SRMR ≤ 0.08 . The unmodified two-factor model was tested first; a single residual covariance was then specified between items 1 and 2. Because the items are ordinal and multivariate normality was not met (Mardia's coefficient = 37.75; critical ratio = 17.23), the significance of model fit was additionally tested with the Bollen–Stine bootstrap (200 samples), and the same models, together with a one-factor alternative, were re-estimated with WLSMV on polychoric correlations using lavaan in R 4.6.1.

Reliability and validity. Reliability was assessed with Cronbach's α ; for the two-item risks subscale the Spearman–Brown coefficient was reported. Composite reliability and average variance extracted were calculated from the standardized confirmatory loadings, and discriminant validity was evaluated using the criterion that the square root of each subscale's average variance extracted exceeds the inter-factor correlation. Floor and ceiling effects were examined at item, subscale and total-score level, with more than 15% of participants obtaining the lowest or highest possible score interpreted as a meaningful effect.

Known-groups validity and group comparisons. It was hypothesized a priori that VHS scores would be higher among women who refused maternal tetanus vaccination than among those who accepted it, among women whose previous child was incompletely vaccinated or unvaccinated than among those whose child had completed all scheduled vaccines, and among women not vaccinated against influenza during pregnancy than among those who were. The maternal tetanus variable combines vaccination status reported at 20 weeks or later with intention reported before 20 weeks; women who were undecided or previously vaccinated or medically contraindicated were not included in this comparison. For influenza, women who were unvaccinated, undecided, or not pregnant during the influenza season were combined and compared with vaccinated women. Welch's t-test was used for group comparisons and effect sizes were expressed as Cohen's d. Comparisons of VHS scores by descriptive characteristics used the independent-samples t-test, Welch's t-test, one-way ANOVA, Welch's ANOVA or the Kruskal–Wallis test as appropriate, with Games–Howell or Dunn–Bonferroni post hoc tests; these comparisons were exploratory and interpreted as hypothesis-generating.

Hierarchical regression. Variables were entered in four blocks: demographic variables (age, gestational week, education level); vaccination status variables (maternal tetanus vaccination status, influenza vaccination status); vaccine information source; and the three health locus of control dimensions. Categorical variables were dummy-coded, with university education or above, acceptance of maternal tetanus vaccination, influenza vaccination and healthcare professionals as the reference categories. Regression assumptions were checked for normality of residuals, linearity, homoscedasticity, independence of residuals (Durbin–Watson = 2.18) and multicollinearity (maximum variance inflation factor = 1.59). One participant with missing data on the information source variable was excluded, giving $n = 329$.

Supplementary Tables

Table S1 Item discrimination: comparison of the lower and upper 27% groups on the VHS total score (N = 330)

Item	Subscale	Lower 27% (n = 97)	Upper 27% (n = 95)	t	p	Cohen's d
VHS1	Lack of confidence	1.02 ± 0.14	3.33 ± 1.05	21.29	<0.001	3.09
VHS2	Lack of confidence	1.05 ± 0.27	3.24 ± 1.04	19.93	<0.001	2.89
VHS3	Lack of confidence	1.11 ± 0.45	3.53 ± 1.07	20.26	<0.001	2.94
VHS4	Lack of confidence	1.08 ± 0.31	3.59 ± 0.99	23.46	<0.001	3.40
VHS6	Lack of confidence	1.38 ± 0.74	3.35 ± 0.99	15.58	<0.001	2.25
VHS7	Lack of confidence	1.04 ± 0.20	3.40 ± 0.97	23.18	<0.001	3.36
VHS8	Lack of confidence	1.02 ± 0.14	3.02 ± 1.07	18.04	<0.001	2.62
VHS5	Risks	2.45 ± 1.28	3.51 ± 1.18	5.90	<0.001	0.85
VHS9	Risks	2.59 ± 1.21	3.77 ± 1.23	6.71	<0.001	0.97

Values are mean ± SD. Group sizes differ because of tied scores at the cut-points.

Table S2 Floor and ceiling effects at the item level (N = 330)

Item	Subscale	Mean $\pm$ SD	Floor, n (%)	Ceiling, n (%)
VHS1	Lack of confidence	1.86 $\pm$ 1.19	186 (56.4)	20 (6.1)
VHS2	Lack of confidence	1.89 $\pm$ 1.16	174 (52.7)	17 (5.2)
VHS3	Lack of confidence	2.10 $\pm$ 1.30	155 (47.0)	29 (8.8)
VHS4	Lack of confidence	2.10 $\pm$ 1.27	153 (46.4)	25 (7.6)
VHS6	Lack of confidence	2.21 $\pm$ 1.16	120 (36.4)	18 (5.5)
VHS7	Lack of confidence	1.95 $\pm$ 1.17	163 (49.4)	20 (6.1)
VHS8	Lack of confidence	1.81 $\pm$ 1.08	179 (54.2)	12 (3.6)
VHS5	Risks	3.17 $\pm$ 1.30	50 (15.2)	71 (21.5)
VHS9	Risks	3.39 $\pm$ 1.28	37 (11.2)	90 (27.3)

Items are scored from 1 to 5; higher scores indicate greater hesitancy. Floor, lowest possible item score; ceiling, highest possible item score. Values above 15% indicate a meaningful effect.

Table S3 Floor and ceiling effects for the VHS total score and subscales (N = 330)

Scale / subscale	Score range	Mean $\pm$ SD	Floor, n (%)	Ceiling, n (%)
Overall VHS	9–45	20.48 $\pm$ 7.82	11 (3.3)	3 (0.9)
Lack of confidence	7–35	13.91 $\pm$ 7.27	84 (25.5)	5 (1.5)
Risks	2–10	6.57 $\pm$ 2.13	18 (5.5)	42 (12.7)

Floor, lowest possible scale score; ceiling, highest possible scale score. Values above 15% indicate a meaningful effect.

Table S4 Receiver operating characteristic analysis of the VHS total score and subscales against the three vaccination criteria.

Measure	AUC	95% CI	p	Cut-off	Sensitivity / Specificity
Maternal tetanus vaccine refusal (n = 26 vs 254)					
VHS total score	0.821	0.730–0.911	<0.001	≥21	0.846 / 0.665
Lack of confidence	0.813	0.722–0.903	<0.001	—	—
Risks	0.639	0.521–0.757	0.020	—	—
Incomplete or no vaccination of previous child (n = 16 vs 176)					
VHS total score	0.830	0.701–0.958	<0.001	≥23	0.813 / 0.761
Lack of confidence	0.870	0.775–0.965	<0.001	—	—
Risks	0.544	0.361–0.728	0.557	—	—
No influenza vaccination during pregnancy (n = 316 vs 14)					
VHS total score	0.800	0.656–0.943	<0.001	≥16	0.671 / 0.786
Lack of confidence	0.778	0.644–0.911	<0.001	—	—
Risks	0.705	0.550–0.859	0.010	—	—

AUC, area under the curve; CI, confidence interval. Cut-offs were determined by the Youden index and are reported for the total score only; they were derived in the same sample and are therefore exploratory.

Table S5 Original English items of the Vaccine Hesitancy Scale, the adapted Turkish items used in this study, and English translations of the adapted items

Original English items of the Vaccine Hesitancy Scale, the adapted Turkish items used in this study, and English translations of the adapted items

No	Original English item	Adapted Turkish item	English translation of the adapted item
1	Childhood vaccines are important for my child's health (R)	Çocukluk çağı aşıları, doğacak çocuğumun sağlığı için önemlidir.	Childhood vaccines are important for my future child's health.
2	Childhood vaccines are effective (R)	Çocukluk çağı aşıları etkilidir.	Identical to the original item.
3	Having my child vaccinated is important for the health of others in my community (R)	Doğacak çocuğuma aşı yaptırmak, toplumumdaki diğer bireylerin sağlığı için önemlidir.	Having my future child vaccinated is important for the health of others in my community.
4	All childhood vaccines offered by the government programme in my community are beneficial (R)	Toplumumuza devlet tarafından sunulan tüm çocukluk çağı aşıları faydalıdır.	Identical to the original item.
5	New vaccines carry more risks than older vaccines	Yeni aşılar, eski aşılarından daha fazla risk taşır.	Identical to the original item.
6	The information I receive about vaccines from the vaccine programme is reliable and trustworthy (R)	Aşı programından aşılarla ilgili sunulan bilgiler güvenilirlerdir.	The information provided about vaccines by the vaccination programme is trustworthy.
7	Getting vaccines is a good way to protect my child/children from disease (R)	Aşı yaptırmak doğacak çocuğumu hastalıklardan korumak için iyi bir yoldur.	Getting vaccines is a good way to protect my future child from disease.
8	Generally I do what my doctor or health care provider recommends about vaccines for my child/children (R)	Doktorumun veya diğer sağlık personelinin (ebe, hemşire vb.) doğacak çocuğumun aşıları hakkında yapacağı önerilere genel olarak uymayı düşünüyorum.	I generally intend to follow the recommendations of my doctor or other health care providers (midwife, nurse, etc.) about my future child's vaccines.
9	I am concerned about serious adverse effects of vaccines	Aşıların ciddi yan etkileri hakkında endişeliyim.	Identical to the original item.

(R) = reverse-scored item. The validated instrument is the Turkish form; the English translations are provided for readers' convenience and were not psychometrically evaluated.

Table S6 Descriptive statistics, internal consistency and intercorrelations of vaccine hesitancy and health locus of control scores (N = 330)

Variable	Mean $\pm$ SD	α	1	2	3	4	5	6
1. VHS total score	20.48 $\pm$ 7.82	0.881	—					
2. Lack of confidence	13.91 $\pm$ 7.27	0.947	0.963**	—				
3. Risks	6.57 $\pm$ 2.13	0.532 ^a	0.386**	0.122*	—			
4. Internal HLC	23.45 $\pm$ 5.32	0.584	−0.261**	−0.306**	0.085	—		
5. Chance HLC	17.02 $\pm$ 6.56	0.715	−0.122*	−0.174**	0.145**	0.217**	—	
6. Powerful others HLC	23.83 $\pm$ 6.56	0.694	−0.334**	−0.334**	−0.086	0.351**	0.189**	—

* $p < 0.05$; ** $p < 0.01$. HLC, health locus of control; VHS, Vaccine Hesitancy Scale. Pearson correlations and α computed on the full sample. ^a Spearman–Brown coefficient.

Supplementary Figure

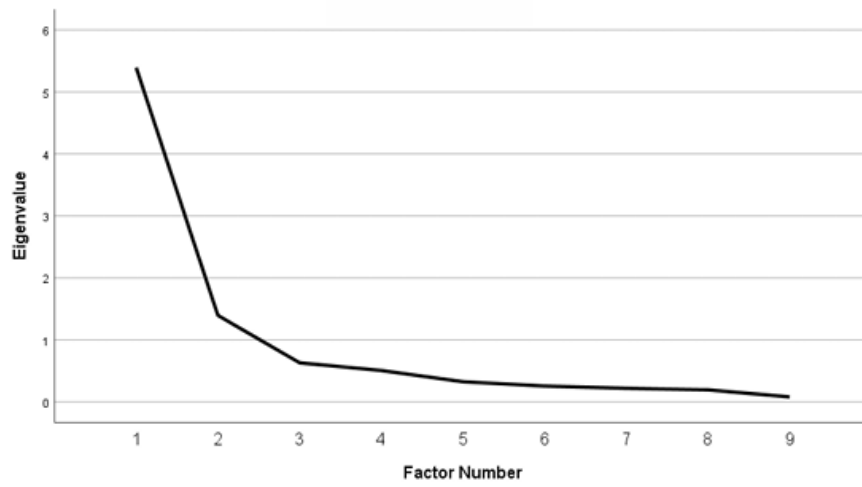


Fig. S1 Scree plot of the initial eigenvalues in the calibration subsample ($n = 165$).

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