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VACCINE HESITANCY IN PARENTS OF CHILDREN WITH CONGENITAL UROGENITAL ANOMALIES WITH HYPOSPADIAS AND UNDESCENDED TESTIS

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Parental vaccine hesitancy (VH) toward childhood immunization is a critical public health challenge affecting individual pediatric health and broader societal immunity. This study aimed to evaluate VH among parents of male children by comparing those whose children had congenital urogenital anomalies (CUA), specifically hypospadias and undescended testicles, with those of children without malformations. The assessment also incorporated family demographics, health literacy levels, and adherence to preventive health practices. This descriptive-analytical study included 409 participants, divided into two groups: parents of children presenting for elective circumcision without malformations (CNM) and parents of children diagnosed with CUA. Data were collected using a socio-demographic form, the Turkey Health Literacy Scale (TSOY-32), and the Vaccine Hesitancy Scale (VHS). High vaccine hesitancy was defined as scores in the upper quartile of the VHS (VHS-uQ). The overall vaccination rate among the children was 96.6% (n = 395). In the CUA group, the absence of routine vitamin D supplementation was associated with 25-fold higher odds of VHS-uQ ($p < 0.001$). Mothers with a high school education or higher demonstrated a 4.69-fold higher odds of VHS-uQ ($p < 0.001$). Conversely, COVID-19 vaccination of both parents was associated with lower VHS-uQ rates in both groups ($p < 0.001$). Interestingly, higher TSOY-32 scores were associated with a 4.57-fold higher odds of VHS-uQ ($p = 0.034$). This study identified maternal health literacy and adherence to routine preventive care as key determinants of VH among parents of children with CUA. indings suggest that fostering trust through continuous healthcare engagement and evidence-based counseling is a vital pathway to improving vaccine acceptance in this specific population.

Keywords: vaccine hesitancy, childhood vaccination, parental vaccine hesitancy, hypospadias, undescended testicles, congenital urogenital anomalies

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INTRODUCTION

Hypospadias and undescended testes represent the most prevalent congenital urogenital anomalies (CUA) in male children (1,2). The diagnosis of a congenital anomaly, combined with the necessity for surgical intervention and the potential for complications, often induces significant anxiety and fear in parents. Such emotional stressors can profoundly influence the healthcare-related decisions parents make for their children (3,4). Parents typically acquire health information from mass media, their social environment, and healthcare professionals to manage their children's daily care and long-term well-being (5,6). Within the spectrum of pediatric healthcare, vaccination remains a fundamental and highly effective primary public health strategy for disease prevention (7).

Substantial progress has been achieved through routine childhood immunization, which has targeted infections that were the primary causes of pediatric morbidity and mortality in the last century. It is estimated that global vaccination programs, which have led to the eradication of smallpox and elimination of polio in numerous regions, save more than 3 million children annually (8). However, vaccine hesitancy (VH), identified by the World Health Organization (WHO) in 2019 as one of the top ten global health threats, has increased gradually. This trend has intensified following the COVID-19 pandemic, incited by social media misinformation regarding both COVID-19 and routine childhood vaccines (9,10). VH among parents striving to make optimal health decisions for their children poses a significant challenge, impacting not only individual pediatric health but also collective societal immunity. Evaluating determinants of VH, such as sociocultural influences, economic conditions, environmental factors, and media exposure, is essential for providing timely, evidence-based guidance to parents (9,11,12).

In this study, we aimed to evaluate and compare VH levels among parents of male children diagnosed with CUA (hypospadias and undescended testes) and those of children presenting for elective circumcision without malformations (CNM).

METHODS

Study design and settings

This multicenter, descriptive-analytical study was conducted between February 2024 and May 2024 across four consortium centers in Turkey (Aksaray, Rize, Trabzon, and Kilis). These centers represent three distinct regions, according to the Nomenclature of Territorial Units for Statistics (NUTS-1) and the Turkey Demographic and Health Survey (TDHS) (13).

Study population and sampling

A total of 492 parents of male children aged 0–7 years, who presented to pediatric surgery outpatient clinics for hypospadias, undescended testes, or elective circumcision, were initially recruited using stratified sampling. Participants were categorized into two groups: those with CUA and those seeking CNM.

Exclusion criteria were as follows: 35 participants with comorbidities, 9 who provided uniform (identical) answers to all scale items, 33 patients aged 98 months or older, and 6 who provided contradictory responses. Consequently, the final analysis was performed on 409 participants.

Data collection and instruments

Data were collected through face-to-face interviews conducted by pediatric surgeons at the respective centers. The research instrument consisted of a 31-item structured questionnaire (Supplementary File 1), the Turkey Health Literacy Scale (TSOY-32) (14), and the Vaccine Hesitancy Scale (VHS) (15).

The structured questionnaire comprised five sections:

1. Sociodemographic information: parental education levels, ages, and child-specific data (birth order, weight, and gestational age).
2. Healthcare practices: adherence to routine infant-child-adolescent monitoring protocols of the Turkish Ministry of Health (16), including iron/vitamin D supplementation, antenatal care visits, and maternal vaccination status.
3. Vaccination history and attitudes: perspectives on routine and private vaccines (e.g., rotavirus, meningococci), COVID-19 vaccination status, and the impact of social media on vaccine perception (17-19).
4. Information sources: preferred sources for health information (e.g., pediatricians, family physicians, social media, bloggers, and official websites).

TSOY-32 scale

Maternal health literacy (HL) was assessed using the TSOY-32 scale. This 32-item, 5-point Likert-type scale evaluates four dimensions—accessing, understanding, evaluating, and applying health information—across two domains: "Treatment and Service Utilization" and "Disease Prevention/Health Promotion" (20,21). For the score calculation of the scale consisting of 32 items on a 5-point Likert scale (1=Very easy, 2=Easy, 3=Difficult, 4=Very difficult, 5=No idea') for each item, it was coded as suggested in the literature, and a value of 0 was assigned to the 'no idea' code. Scores ranging from 0 (lowest HL) to 50 (highest HL) were categorized into three levels: 0–25, >25–33, and >33–50 points.

Vaccine hesitancy scale
The Turkish version of the 9-item VHS was administered to assess parental hesitancy (15). Items are scored on a 5-point Likert scale, with total scores ranging from 9 to 45; higher scores indicate greater hesitancy. For analysis, participants were dichotomized into two groups based on the upper quartile: lower quartile (VHS-lQ; <25 points) and upper quartile (VHS-uQ; ≥25 points).

Ethics
The study was conducted in accordance with the Declaration of Helsinki and was approved by the Hacettepe University non-interventional Ethics Committee (Approval No. GO 2024/05-42) on January 23, 2024.

Statistical analyses
In the study, the data were collected in Excel format, and analyses were performed using SPSS 22.0 (IBM, USA).
Participants were divided into two groups: those with congenital urogenital anomalies (CUA) and the CNM group.
VHS (Vaccine Hesitancy Scale) scores were evaluated in quartiles, divided into the upper quartile (VHS-uQ) (Q4) and lower quartiles (Q1-3) (VHS-lQ).

The normal distribution of the data was evaluated by the Shapiro-Wilk test. Categorical variables were expressed as n (%) and continuous variables showing normal distribution were expressed as mean ± standard deviation. The Chi-square test was used to compare the percentage distribution of categorical data between groups.

Variables with an association to VH indicated by a p-value of <0.10 were selected for further analysis. Multiple logistic regression analysis was then used to explore associations between child-family parameters (such as sociodemographic characteristics, vaccination practices, healthcare practices, and health information sources) and the VHS-uQ in both the CUA and CNM groups. Additionally, data from the overall group were analyzed to identify associations between VH and child-family parameters, including TSOY-32 scale scores and the different study groups. Adjusted odds ratios with 95% confidence intervals were calculated, and a p-value of <0.05 was considered statistically significant.

RESULTS

Sociodemographic characteristics
In this study, 36.7% (n = 150) of the children were first-borns. Regarding age distribution, 48.9% were younger than 24 months, 29.3% were aged 24–47 months, and 21.8% were 48 months or older. Routine vitamin D supplementation was administered to 90.7% of the participants, while 74.4% adhered to the standard iron supplementation regimen starting at 4 months of age (Table 1).
Maternal age was distributed as follows: 10.3% were under 25 years, 65.3% were between 25 and 34 years, and 24.4% were 35 years or older. In contrast, 55% of the fathers were under 25 years old. The sociodemographic profiles of the CUA and CNM groups were largely comparable, with no significant differences in maternal age (p = 0.585), paternal age (p = 0.544), gestational duration (p = 0.085), child age distribution (p = 0.264), or birth weight (p = 0.232). However, maternal education levels differed significantly: 54.2% of mothers in the CUA group had eight years or less of education compared to 41.9% in the CNM group (p = 0.015) (Table 1).

Vaccination rates and attitudes
The overall childhood vaccination rate was 96.6% (n = 395). While the CUA group showed a slightly higher routine vaccination rate (98%) compared to the CNM group (94.4%), this difference was at the threshold of significance (p = 0.050). Parental COVID-19 vaccination rates were similar between groups (CUA fathers: 61.0% vs. CNM fathers: 63.7%, p = 0.582; overall mothers: 66.5%).
Post-pandemic attitudes revealed that while 37.7% of parents viewed routine childhood vaccines as more essential after COVID-19, a substantial minority (24.9% overall) reported increased hesitancy. Negative impacts from social media news regarding vaccines were reported by 16.4% of parents, with a higher but not statistically significant prevalence in the CUA group (18.5% vs. 13.1%, p = 0.215). Uptake for special vaccines (rotavirus/meningococcal) remained low at 12.5% across both groups (p = 0.550).

Table 1. *Evaluation of socio-demographic, health practice, and vaccination information of parents*

Features	**Overall** n (%)	**CUA*** (n = 249)	**Control** (n = 160)	**pÆ**
Child characteristics				
First child				
1st	150 (36.7)	86 (34.5)	64 (40.0)	0.263
2nd and more	259 (63.3)	163 (65.5)	96 (60.0)	
Child age (month)				
<24	200 (48.9)	114 (45.8)	86 (53.8)	0.264
24-47	120 (29.3)	76 (30.5)	44 (27.5)	
≥48	89 (21.8)	59 (23.7)	30 (18.8)	
Gestational duration				
Mature	339 (82.9)	213 (85.5)	146 (91.3)	0.085
Premature	70 (17.1)	36 (14.5)	14 (8.8)	
Birth weight				
SGAз	50 (12.2)	18 (14.4)	16 (9.3)	0.232
No	359 (87.8)	122 (85.6)	170 (90.7)	
Hospitalization				
Yes	112 (27.4)	74 (29.7)	38 (23.8)	0.186
No	297 (72.6)	175 (70.3)	122 (76.3)	
Childhood vaccination§				
Yes	395 (96.6)	244 (98.0)	151 (94.4)	**0.05**
No	14 (3.4)	5 (2.0)	9 (5.6)	
At least 1 dose of special vaccine&				
Yes	51 (12.5)	33 (13.3)	18 (11.3)	0.55
No	358 (87.5)	216 (86.7)	142 (88.8)	
Parent characteristics				
Maternal age				
<25	42 (10.3)	23 (9.2)	19 (11.9)	0.585
25-34	267 (65.3)	162 (65.1)	105 (65.6)	
≥35	100 (24.4)	64 (25.7)	36 (22.5)	
Paternal age				
<35	225 (55.0)	134 (53.8)	91 (56.9)	0.544
≥35	184 (45.0)	115 (46.2)	69 (43.1)	
Maternal education				
8 years and lessß	202 (49.4)	135 (54.2)	67 (41.9)	**0.015**
High school and above	207 (50.6)	134 (53.8)	93 (58.1)	
Paternal education				
8 years and lessß	186 (45.6)	115 (46.2)	71 (44.4)	0.72
High school and above	223 (54.5)	79 (63.2)	89 (55.6)	
Health care practices				
Antenatal care visit				
1-3 times	42 (10.5)	29 (11.8)	13 (8.3)	0.264
4 and more	359 (89.5)	216 (88.2)	143 (91.7)	
Vaccination during pregnancy				
Yes	308 (75.3)	182 (73.1)	126 (78.8)	0.195
No	101 (24.7)	67 (26.9)	34 (21.3)	
Standard vitamin D supplementation regimen during infancy				
Yes	371 (90.7)	228 (91.2)	144 (90.0)	0.692
No	38 (9.3)	22 (8.8)	16 (10.0)	
Standard iron supplementation regimen during infancy				
Yes	300 (73.3)	172 (69.1)	128 (80.0)	**0.015**
No	109 (26.7)	77 (30.9)	32 (20.0)	

Standard vitamin D supplementation regimen during pregnancy				
Yes	365 (89.2)	226 (90.8)	139 (86.9)	0.216
No	44 (10.8)	23 (9.2)	21 (13.1)	
Standard iron supplementation regimen during pregnancy				
Yes	327 (80.0)	201 (80.7)	126 (78.8)	0.627
No	82 (20.0)	48 (19.3)	34 (21.3)	
Vaccine History and ideas of parent				
Childhood vaccination§ idea				
Protects the child	313 (76.5)	187 (75.1)	126 (78.8)	0.447
I'm hesitant Ͽ	77 (18.8)	50 (20.1)	27 (16.9)	
Not safeϴ	12 (2.9)	9 (3.6)	3 (1.9)	
Refuse	7 (1.7)	3 (1.2)	4 (2.5)	
Childhood vaccination§ idea after COVID-19				
Yes, necessary	154 (37.7)	93 (37.3)	61 (38.1)	0.811
Yes, hesitant	102 (24.9)	60 (24.1)	42 (26.3)	
No	153 (37.4)	96 (38.6)	57 (35.6)	
COVID-19 vaccination				
Mother	66 (16.1)	45 (18.1)	21 (13.1)	0.454
Father	48 (11.7)	26 (10.4)	22 (13.8)	
Parent	206 (50.4)	126 (50.6)	80 (50.0)	
No	89 (21.8)	52 (20.9)	37 (23.1)	
Maternal COVID-19 vaccination				
Yes	272 (66.5)	171 (68.7)	101 (63.1)	0.246
No	137 (33.5)	78 (31.3)	59 (36.9)	
Paternal COVID-19 vaccination				
Yes	254 (62.1)	152 (61.0)	102 (63.7)	0.582
No	155 (37.9)	97 (39.0)	58 (36.3)	
Influenced by social media news about vaccines				
Yes, hesitant	114 (27.9)	72 (28.9)	42 (26.3)	0.215
Yes, negative	67 (16.4)	46 (18.5)	21 (13.1)	
No, not affect	228 (55.7)	131 (52.6)	97 (60.6)	
Health information sources				
Family elders as a SHI†				
Reliable	274 (67.0)	164 (65.9)	110 (68.8)	0.545
Others	135 (33.0)	85 (34.1)	50 (31.3)	
Pediatrician as a SHI†				
Reliable	400 (97.8)	241 (96.8)	159 (99.4)	0.082
Others	9 (2.2)	8 (3.2)	1 (0.6)	
Family physician as a SHI†				
Reliable	382 (93.4)	232 (93.2)	150 (93.8)	0.819
Others	27 (6.6)	17 (6.8)	10 (6.3)	
Family nurse/midwife as a SHI†				
Reliable	352 (86.1)	215 (86.3)	137 (85.6)	0.837
Others	57 (13.9)	34 (13.7)	23 (14.4)	
Both members of the family medicine unit as a SHI†				
Reliable	344 (84.1)	208 (83.5)	136 (85.0)	0.5
One of them is reliable	46 (11.2)	31 (12.4)	15 (9.4)	
Others	19 (4.6)	10 (4.0)	9 (5.6)	
Social media as a SHI†				
Reliable	18 (4.4)	11 (4.4)	7 (4.4)	0.984
Others	391 (95.6)	238 (95.6)	153 (95.6)	

Government and university website as a SHIŧ				
Reliable	87 (21.3)	47 (18.9)	40 (25.0)	0.14
Others	322 (78.7)	202 (81.1)	120 (75.0)	
Social media blogger as a SHIŧ				
Reliable	34 (8.3)	22 (8.8)	12 (7.5)	0.633
Others	375 (91.7)	227 (91.2)	148 (92.5)	
Book as a SHIŧ				
Reliable	197 (48.2)	118 (47.4)	79 (49.4)	0.695
Others	212 (51.8)	131 (52.6)	81 (50.6)	
Television as a SHIŧ				
Reliable	46 (11.2)	31 (12.4)	15 (9.4)	0.337
Others	363 (88.8)	218 (87.6)	145 (90.6)	
Scales				
VHS Score π				
Lower Qα	306 (74.8)	182 (73.1)	124 (77.5)	
Upper Qα	103 (25.2)	67 (26.9)	36 (22.5)	0.316
TSOY**				
0-25	84 (43.3)	34 (39.1)	50 (46.7)	
>25-33	58 (29.9)	22 (25.3)	36 (33.6)	**0.042**
>33	52 (26.8)	31 (35.6)	21 (19.6)	

*=Congenital urogenital anomaly, **Æ=** Chi-square test was used to compare the CUA and control group. ß= Primary and secondary education (8 years), **§=**Childhood routine vaccination programme, **ŧ=** source of health information, ɜSGA= Small gestational age, **§=**Childhood routine vaccination programme, **π=** Vaccine hesitancy score, α= Lower Q group: <25 points; Upper Q group: ≥25 points **&=**Rota or meningococcal vaccine, Ͽ=I'm hesitant, but there's a vaccine tracking system. ϴ=Not safe, but there's a vaccine tracking system, **ŧ=** Source of health information, **= Turkish Health Literacy Scale

Factors associated with the vaccine hesitancy scale (VHS)

Vaccine hesitancy (VHS-uQ) was significantly lower in children under 24 months (15.5%) compared to older age groups ($p < 0.001$). Furthermore, while only 14.4% of parents who expressed confidence in the national immunization program were in the VHS-uQ group, this rate rose to 59.7% among those who were hesitant and 91.7% among those who perceived vaccines as unsafe ($p < 0.001$) (Table 2).

In the CUA group, maternal education level was a significant predictor: 36.8% of mothers with at least a high school education were in the VHS-uQ group compared to 18.5% of those with lower education levels ($p = 0.001$). Additionally, higher VHS scores were significantly associated with non-adherence to routine preventive care, including lack of routine vitamin D (72.7%) or iron supplementation (69.1%) during infancy ($p < 0.001$ and $p = 0.004$, respectively), and absence of maternal prenatal supplementation ($p < 0.001$). Distrust in the family medicine team was also linked to higher hesitancy ($p = 0.001$) (Table 2).

In the CNM group, 45.2% of those who developed vaccine hesitancy post-pandemic fell into the VHS-uQ category ($p < 0.001$). Parents who were not vaccinated against COVID-19 showed significantly higher hesitancy rates (48.6%) compared to their vaccinated counterparts (11.3%, $p < 0.001$) (Table 2).

Logistic regression analysis

Multivariable analysis of the entire cohort showed no significant association between VH and urogenital anomaly status or basic healthcare practices (all $p > 0.05$). However, significantly higher odds of VH were observed among participants with higher TSOY-32 scores (OR = 4.57, 95% CI: 1.12–18.65) and parents of children aged ≥48 months (OR = 4.13, 95% CI: 1.32–12.97). Conversely, parental COVID-19 vaccination was a protective factor against VH (Table 3).

In the CUA group, the odds of high vaccine hesitancy were 6.31 times higher among mothers with at least a high school education ($p < 0.001$). Lack of routine vitamin D supplementation for the infant was associated with a 25-fold increase in the odds of VH (95% CI: 4.04–156.5). Vaccination of both parents against COVID-19 was strongly associated with lower VH scores (OR: 0.07, 95% CI: 0.02–0.24).

In the CNM group, paternal education (high school or above) was associated with 7.52 times higher odds of VH ($p < 0.001$). Parents who reported increased hesitancy specifically after the COVID-19 pandemic had 11.43 times higher odds of being in the VHS-uQ group (95% CI: 2.52–51.84, $p = 0.002$) (Table 4).

Table 2. *Evaluation of parents' vaccination hesitancy using the Vaccine Hesitancy Scale*

	All			**CUA**			**Control**		
Features	**Overall** n = 409	**VHS π Upper Qα**		**Overall Cua** n = 249	**VHS π Upper Qα**		**Overall Control** n = 160	**VHS π Upper Qα**	
	n (%)	**%****	**p**	**n (%)**	**%****	**p**	**n (%)**	**%****	**P**
Child characteristics									
First child			0.958			0.52			0.315
1st	150 (36.7)	25.3		86 (34.5)	24.4		64 (40.0)	26.6	
2nd and more	259 (63.3)	25.1		163 (65.5)	28.2		96 (60.0)	19.8	
Child age (month)			**<0.001**			**0.003**			**0.02**
<24	200 (48.9)	15.5		114 (45.8)	16.7		86 (53.8)	14	
24-47	120 (29.3)	32.5		76 (30.5)	32.9		44 (27.5)	31.8	
≥48	89 (21.8)	37.1		59 (23.7)	26.9		30 (18.7)	33.3	
Gestational duration			0.678			0.553			0.139
Mature	339 (82.9)	24.8		206 (82.7)	27.7		133 (83.1)	20.3	
Premature	70 (17.1)	27.1		43 (17.3)	23.3		27 (16.9)	33.3	
Birth weight			0.367			0.493			0.441
SGA*	50 (12.2)	20		36 (14.5)			14 (8.8)	14.3	
No	359 (87.8)	25.9		213 (85.5)			146 (91.2)	23.3	
Hospitalization			0.475			0.49			0.201
Yes	112 (27.4)	27.7		74 (29.7)	32.4		38 (23.8)	18.4	
No	297 (72.6)	24.2		175 (70.3)	24.6		122 (76.2)	23.8	
Childhood vaccination§			0.339			0.725			0.4
Yes	395 (96.6)	25.6		244 (98.0)	27		151 (94.4)	23.2	
No	14 (3.4)	14.3		5 (2.0)	20		9 (5.6)	11.1	
At least 1 dose of special vaccine&			0.771			0.428			0.569
Yes	51 (12.5)	23.5		33 (13.3)	21.2		18 (11.2)	27.8	
No	358 (87.5)	25.4		216 (86.7)	27.8		142 (88.8)	21.8	
Parent characteristics									
Maternal age			0.276			0.573			0.182
<25	42 (10.3)	35.7		23 (9.2)	39.1		19 (11.9)	31.6	
25-34	267 (65.3)	25.1		162 (65.1)	27.2		105 (65.6)	21.9	
≥35	100 (24.4)	21		64 (25.7)	21.9		36 (22.5)	19.4	
Paternal age			0.987			**0.013**			0.147
<35	225 (55.0)	28		134 (53.8)	26.9		91 (56.9)	29.7	
≥35	184 (45.0)	21.7		115 (46.2)	27		69 (43.1)	13	
Maternal education			**0.002**			**0.001**			0.238
8 years and lessß	202 (49.4)	18.3		135 (54.2)	18.5		67 (41.9)	17.9	
High school and above	219 (50.6)	31.9		114 (45.8)	36.8		93 (58.1)	25.8	
Paternal education			**0.024**			0.088			0.13
8 years and lessß	186 (45.6)	19.9		115 (46.2)	21.7		71 (44.4)	16.9	
High school and above	223 (54.5)	29.6		134 (53.8)	31.3		89 (55.6)	27	
Health care practices									
Antenatal care visit			**<0.001**			0.492			**<0.001**
1-3 times	42 (10.5)	57.1		29 (11.8)	69		13 (8.3)	30.8	
4 and more	359 (89.5)	21.4		216 (88.2)	20.8		143 (91.7)	22.4	
Vaccination during pregnancy			**0.012**			**0.001**			0.764
Yes	308 (75.3)	22.1		182 (73.1)	21.4		126 (78.8)	23	
No	101 (24.7)	34.7		67 (26.9)	41.8		34 (21.2)	20.6	

Standard vitamin D supplementation regimen during infancy			**<0.001**			**<0.001**			0.377
Yes	371 (90.7)	22.1		227 (91.2)	22.5		144 (90.0)	21.5	
No	38 (9.3)	55.3		22 (8.8)	72.7		16 (10.0)	31.3	
Standard iron supplementation regimen during infancy			**0.003**			**0.004**			0.394
Yes	300 (73.3)	21.3		172 (69.1)	21.5		128 (80)	21.1	
No	109 (26.7)	35.8		77 (33.1)	39		32 (20)	28.1	
Standard vitamin D supplementation regimen during pregnancy			**<0.001**			**0.001**			**0.017**
Yes	365 (89.2)	22.2		226 (90.8)	23.9		139 (86.9)	19.4	
No	44 (10.8)	50		23 (92.4)	56.5		21 (13.1)	42.9	
Standard iron supplementation regimen during pregnancy			**<0.001**			**<0.001**			**0.013**
Yes	327 (80.0)	19		201 (80.7)	19.4		126 (78.8)	18.3	
No	82 (20.0)	50		48 (19.3)	58.3		34 (21.2)	38.2	
Vaccine history and ideas of parents									
Childhood vaccination§ Idea			**<0.001**			**<0.001**			**<0.001**
Protects the child	313 (76.5)	14.4		187 (75.1)	13.4		126 (78.8)	15.9	
I'm hesitant Ͻ	77 (18.8)	59.7		50 (20.1)	68		27 (16.9)	44.4	
Not safeϴ	12 (2.9)	91.7		9 (3.6)	88.9		3 (1.8)	100	
Refuse	7 (1.7)	14.3		3 (1.2)	0		4 (2.5)	25	
Childhood Vaccination§ Idea after COVID-19			**<0.001**			**<0.001**			**<0.001**
Yes, necessary	154 (37.7)	12.3		93 (37.4)	11.8		61 (38.1)	13.1	
Yes, hesitant	102 (24.9)	52.9		60 (24.1)	58.3		42 (26.3)	45.2	
No	153 (37.4)	19.6		96 (38.6)	21.9		57 (35.6)	15.8	
Parental COVID-19 vaccination status			**<0.001**			**<0.001**			**<0.001**
Only mother vaccinated	66 (16.1)	19.7		45 (18.1)	22.2		21 (13.1)	14.3	
Only father vaccinated	48 (11.7)	29.2		26 (10.4)	30.8		22 (13.8)	27.3	
Both parents vaccinated	206 (50.4)	14.1		126 (50.6)	15.9		80 (50.0)	11.3	
Neither parent vaccinated	89 (21.8)	52.8		52 (20.9)	55.8		37 (23.1)	48.6	
Maternal COVID-19 vaccination status			**<0.001**			**<0.001**			**<0.001**
Yes	272 (66.5)	15.4		171 (68.7)	17.5		101 (63.1)	11.9	
No	137 (33.5)	44.5		78 (31.3)	47.4		59 (36.9)	40.7	
Paternal COVID19 vaccination status			**<0.001**			**<0.001**			**0.002**
Yes	254 (62.1)	22.5		152 (61.1)	18.4		102 (63.8)	14.7	
No	155 (37.9)	16.9		97 (38.9)	40.2		58 (36.2)	36.2	
Influenced by social media news about vaccines			0.102			0.054			**0.009**
Yes, hesitant	114 (27.9)	32.5		72 (28.9)	34.7		42 (26.2)	28.6	
Yes, negative	67 (16.4)	32.8		46 (18.5)	30.4		21 (13.1)	38.1	
No, not affect	228 (55.7)	19.3		131 (52.6)	21.4		97 (60.6)	16.5	
Health information sources									
Family elders as a SHI†			0.332			0.213			0.919
Reliable	274 (67.0)	23.7		164 (65.9)	24.4		110 (68.8)	22.7	
Others	135 (33.0)	28.1		85 (34.1)	31.8		50 (31.2)	22	
Pediatrician as a SHI†			0.325			0.35			0.589
Reliable	400 (97.8)	25.5		241 (96.8)	27.4		159 (99.4)	22.6	
Others	9 (2.2)	11.1		8 (3.2)	12.5		1 (0.6)	0	
Family physician as a SHI†			**<0.001**			**<0.001**			**0.031**
Reliable	382 (93.4)	22.8		232 (93.2)	24.1		150 (93.7)	20.7	
Others	27 (6.6)	59.3		17 (6.8)	64.7		10 (6.3)	50	

Family nurse/midwife as a SHI†			**0.029**			0.109			0.127
Reliable	352 (86.1)	23.3		215 (86.3)	25.1		137 (85.6)	20.4	
Others	57 (13.9)	36.8		34 (13.7)	38.2		23 (14.4)	34.8	
Both members of the family medicine unit as a SHI			**<0.001**			**0.001**			0.133
Reliable	344 (84.1)	22.7		208 (83.5)	24.5		136 (85.0)	22.5	
1 of them is reliable	46 (11.2)	28.3		31 (12.5)	25.8		15 (9.4)	33.3	
Others	19 (4.7)	63.2		10 (4.0)	80		9 (5.6)	44.4	
Social media as a SHI†			**0.05**			0.173			0.145
Reliable	18 (4.4)	5.6		11 (4.4)	9.1		7 (4.4)	0	
Others	391 (95.6)	26.1		238 (95.6)	27.7		153 (95.6)	100	
Government and university website as a SHI†			0.054			0.548			**0.029**
Reliable	87 (21.3)	17.2		47 (18.9)	23.4		40 (25.0)	10	
Others	322 (78.7)	27.3		202 (81.1)	27.7		120 (75.0)	26.7	
Social media blogger as a SHI†			0.29			0.643			0.222
Reliable	34 (8.3)	17.6		22 (8.8)	22.7		12 (7.5)	8.3	
Others	375 (91.7)	25.9		227 (91.2)	27.3		148 (92.5)	23.6	
Book as a SHI†			0.752			0.283			**0.048**
Reliable	197 (48.2)	25.9		118 (47.3)	23.7		79 (49.4)	29.1	
Others	212 (51.8)	24.5		131 (52.7)	29.8		81 (50.6)	16	
Television as a SHI†			0.384			0.473			0.685
Reliable	46 (11.2)	30.4		31 (12.4)	32.3		15 (9.4)	26.7	
Others	363 (88.8)	24.5		218 (87.6)	26.1		145 (90.6)	22.1	
TSOY-32 V			0.079						
0-25	84 (43.3)	26.2							
>25-33	58 (29.9)	27.6							
>33	52 (26.8)	11.5							
Disease groups			0.351						
CUA*	249 (60.9)	26.9							
Control	160 (39.1)	22.5							

*=Congenital urogenital anomaly, **= According to the row variable ß= Primary and secondary education (8 years), **§**=Childhood routine vaccination programme **†**= source of health information, ɜSGA= Small gestational age, **§**=Childhood routine vaccination programme, **π**= Vaccine Hesitancy Score, α= Upper Q group: ≥25 points in the VHS **&**=Rota or meningococcal vaccine, Ɔ=I'm hesitant, but there's a vaccine tracking system. ϴ=Not safe, but there's a vaccine tracking system, **†**= source of health information, **V** = Turkey Health Literacy Scale.

DISCUSSION

To the best of our knowledge, this study is the first to evaluate VH specifically among parents of children with CUA.

Our findings reveal that parents in the CUA group who did not routinely administer vitamin D to their infants had 25 times higher odds of VH, suggesting that vaccine refusal may be part of a broader pattern of non-adherence to preventive healthcare. Interestingly, a higher socio-economic and educational profile did not translate to increased vaccine acceptance; mothers with a high school education or higher demonstrated 6.31 times higher odds of VH ($p < 0.001$), and higher TSOY-32 scores were associated with a 4.57-fold increase in hesitancy.

The age of a child also emerged as a significant factor, with parents of children under 24 months showing lower hesitancy rates (15.5%) compared to older age groups ($p = 0.005$), likely due to more frequent healthcare engagement during early infancy. Furthermore, the COVID-19 pandemic significantly reshaped parental attitudes; those who developed hesitancy post-pandemic showed 3.99-fold higher VHS-uQ rates in the CUA group and 11.43-fold higher rates in the CNM group. Conversely, having both parents vaccinated against COVID-19 was strongly associated with lower VH scores in both cohorts ($p < 0.001$), emphasizing that trust in public health interventions remains a cornerstone of routine childhood immunization compliance.

Table 3. *Logistic regression analysis of factors affecting vaccine hesitancy in all participants*

	All			
Features (subgroups (1) vs subgroups)	**Sig.**	**Exp (B)**	**95% C.I.**	
			Lower	Upper
Disease (CUA vs control)	0.25	1.74	0.68	4.46
Father's education (High school and above vs 8 years and lessß)	**0.001**	6.96	2.19	22.14
Child age	**0.041**			
Child age (24-47 vs <24)	0.087	2.88	0.86	9.67
Child age (≥48 vs <24)	**0.015**	4.13	1.32	12.97
Father's age (≥35 vs <35)	**0.04**	0.35	0.13	0.95
Antenatal Care Visit (>4 times vs 1-3 times)				
Standard vitamin D supplementation regimen during pregnancy (No vs Yes)	0.95	1.06	0.17	6.84
Standard iron supplementation regimen during pregnancy (No vs Yes)	0.22	2.56	0.58	11.33
Standard vitamin D supplementation regimen during infancy (No vs Yes)	0.556	1.89	0.23	15.62
Standard iron supplementation regimen during infancy (No vs Yes)	0.401	0.52	0.11	2.42
Childhood Vaccination§ Idea after COVID-19	**0.005**			
Childhood Vaccination§ Idea after COVID-19 (hesitant vs unaffected)	**0.007**	5.34	1.58	18.11
Childhood Vaccination§ Idea after COVID-19 (necessary vs unaffected)	0.762	0.83	0.25	2.79
Parental COVID-19 vaccine status	**0.002**			
COVID-19 vaccine (mother vs none)	**0.007**	0.11	0.22	0.55
COVID-19 vaccine (father vs none)	**0.038**	0.18	0.37	0.91
COVID-19 vaccine (both parent vs none)	**<0.001**	0.08	0.02	0.29
Influenced by social media news about vaccines	0.7			
Influenced by social media news about vaccines (hesitant vs others)	0.498	0.67	0.21	2.16
Influenced by social media news about vaccines (negative vs others)	0.442	0.62	0.18	2.12
Family Nurse/midwife as a SHI† (reliable vs others)	0.658	1.36	0.35	5.37
Government and university website as a SHI† (reliable vs others)	0.382	0.56	0.15	2.06
Book as a SHI† (reliable vs others)				
Vaccination during pregnancy (No vs Yes)	0.123	2.53	0.78	8.21
TSOY	0.056			
(≥33 vs 0-25)	**0.034**	4.57	1.12	18.65
(25-33 vs 0-25)	**0.022**	5.52	1.27	23.93
Constant	0.002	0.03		

Health literacy (HL) is a critical determinant in parental vaccine decision-making, as it requires parents to effectively interpret and evaluate complex risk-benefit information regarding their children's health. VH remains a global public health challenge that transcends individual pediatric health, impacting collective societal immunity (22). The literature reveals varying rates of VH worldwide; for instance, a large-scale study involving 4,445 parents reported a 6.1% indecision rate regarding routine vaccinations (23), whereas a study in Nigeria found that 31.6% of participants expressed hesitancy (24). The relationship between HL and vaccination status remains a subject of debate in the international literature. While research in the USA found no significant correlation between HL and vaccination adherence (25), a similar study in India demonstrated that maternal HL was directly associated with DTP_3 immunization status (26). A notable finding in our study was that VH was 4.57 times higher among participants with higher TSOY-32 scores (≥33), and this hesitancy was significantly more pronounced among those sceptical of childhood vaccination programs ($p < 0.001$). Despite these identified levels of hesitancy, the overall vaccination rate in our cohort remained high at 96.6%. This discrepancy suggests that a robust vaccination tracking system is an effective tool for maintaining high coverage and supporting parental decision-making, even in the presence of underlying hesitancy.

Table 4. *Logistic regression analysis of factors affecting vaccine hesitancy in the congenital urogenital anomaly and control group*

	CUA*				Control			
Features (subgroups (1) vs subgroups)	Sig.	Exp (B)	95% C.I.		Sig.	Exp (B)	95% C.I.	
			Lower	Upper			Lower	Upper
Maternal education (High school and above vs 8 years and lessß)	**<0.001**	6.31	2.32	17.19				
Paternal education (High school and above vs 8 years and lessß)	0.508	1.41	0.51	3.91	**0.005**	7.52	1.85	30.61
Child age	**0.017**				0.103			
Child age (24-47 vs <24)	0.396	1.58	0.55	4.56	**0.044**	3.45	1.03	11.53
Child age (≥48 vs <24)	**0.005**	4.8	1.62	14.19	0.142	2.86	0.7	11.59
Paternal age (≥35 vs <35)					**0.006**	0.21	0.07	0.64
Antenatal care visit (>4 times vs 1-3 times)	0.465	0.6	0.15	2.37				
Standard vitamin D supplementation regimen during pregnancy (No vs Yes)	0.339	0.48	0.1	2.19	0.921	0.91	0.15	5.47
Standard iron supplementation regimen during pregnancy (No vs Yes)	0.409	1.69	0.49	5.89	0.084	4.1	0.83	20.29
Standard vitamin D supplementation regimen during infancy (No vs Yes)	0.001	25.15	4.04	156.5				
Standard iron supplementation regimen during infancy (No vs Yes)	0.938	0.96	0.3	3.05				
Childhood Vaccination§ Idea after COVID-19	**<0.001**				**0.001**			
Childhood Vaccination§ Idea after COVID-19 (hesitant vs unaffected)	**0.009**	3.99	1.42	11.21	**0.002**	11.43	2.52	51.84
Childhood Vaccination§ Idea after COVID-19 (necessary vs unaffected)	**0.005**	0.18	0.06	0.6	0.67	0.76	0.21	2.69
Parental COVID-19 vaccine status	**<0.001**				**0.005**			
COVID-19 vaccine (mother vs none)	**0.002**	0.11	0.03	0.45	**0.025**	0.14	0.02	0.78
COVID-19 vaccine (father vs none)	**0.011**	0.14	0.03	0.64	**0.035**	0.19	0.04	0.89
COVID-19 vaccine (both parent vs none)	**<0.001**	0.07	0.02	0.24	**<0.001**	0.08	0.02	0.32
Influenced by social media news about vaccines	0.894				0.499			
Influenced by social media news about vaccines (hesitant vs others)	0.639	1.28	0.46	3.52	0.446	0.61	0.17	2.2
Influenced by social media news about vaccines (negative vs others)	0.809	1.16	0.35	3.81	0.249	0.38	0.07	1.98
Family Nurse/midwife as a SHIƗ (reliable vs others)	0.596	1.41	0.4	4.94				
Government and university website as a SHIƗ (reliable vs others)					0.27	0.46	0.12	1.82
Book as a SHIƗ (reliable vs others)					0.907	1.06	0.38	2.97
Vaccination during pregnancy (No vs Yes)	0.384	1.55	0.58	4.15				
Constant	0.195	0.25			0.044	0.17		

*=Congenital Urogenital Anomaly, ß= Primary and Secondary Education (8 years), **§**=Childhood routine vaccination programme, **Ɨ**= source of health information

A woman's journey into motherhood, characterized by a continuous period of learning and adaptation, commences during pregnancy. Throughout this phase, mothers strive to access the most accurate information to make informed and appropriate healthcare decisions for both themselves and their unborn children (27). Enhancing a mother's ability to comprehend health information is critical, as it directly influences her child's long-term well-being and life trajectory. Investing in maternal health literacy and providing access to timely, evidence-based information are essential strategies that yield benefits not only for the individual child but for society as a whole (6,28,29).

Current literature highlights a complex relationship between parental education levels and vaccine confidence. For instance, a study involving 2,214 parents in Rwanda demonstrated that individuals with lower education levels were 3.3 times more likely to express confidence in childhood vaccinations (30). Similarly, research conducted in Saudi Arabia found that VH was 1.71 times higher among those with an education level exceeding high school (31). Our findings align with and reinforce this trend, as we observed that mothers in the CUA group with a high school education or higher had 6.31 times higher odds of VH. This suggests that in more complex clinical contexts like CUA, higher educational attainment may be associated with increased questioning or heightened sensitivity to vaccine-related information.

The sources of information accessed by parents regarding child health play a pivotal role in shaping their healthcare attitudes and decisions (7,32). In our study, healthcare professionals emerged as the most trusted sources, with parents reporting high levels of reliance on pediatricians (98.0%), family physicians (93.4%), and family medicine midwives (86.7%). This high level of trust in clinical experts is a significant asset for public health, as these professionals serve as the primary line of defence against vaccine misinformation. However, the rapid proliferation of technology, the internet, and social media platforms has created a dual-edged sword: while access to information is easier than ever, distinguishing between evidence-based facts and inaccurate claims has become increasingly challenging for parents, often leading to vaccine hesitancy (32-34). For instance, during the wave of misinformation regarding the MMR vaccine, research indicated that only a quarter of parents consulted their family physicians to verify the information they encountered (35). Similarly, studies on HPV vaccination have shown that relying on information from family and friends can increase the prevalence of insufficient knowledge by 4.34 times (36). Interestingly, our study found that exposure to health information from sources such as social media, family elders, books, television, and public or university websites had no statistically significant effect on vaccine hesitancy in either the CUA or CNM groups, suggesting that for this specific population, clinical trust may outweigh external influences.

The COVID-19 pandemic, along with the intense global debates surrounding COVID-19 vaccines, has reignited concerns regarding routine childhood immunization. Factors such as perceived side effects, vaccine ingredients, the nature of vaccine pathogens, institutional distrust, religious or cultural beliefs, and a lack of comprehensive information have historically fueled VH and continue to bring these discussions to the forefront (9,37,38). Conversely, addressing specific concerns of families regarding vaccine safety with evidence-based, scientific answers is recognized as a crucial strategy for restoring and increasing vaccine confidence (39,40). The impact of the pandemic on parental risk perception is further illustrated in studies such as that by Salazar et al., which reported that parents with higher levels of VH tended to be less concerned about the clinical risks of COVID-19 (41). Our findings contribute to this narrative by demonstrating that while VH rates were significantly lower in families where both parents were vaccinated against COVID-19, exposure to negative vaccine news led to a 3.99-fold increase in the odds of high hesitancy (VHS-uQ) within the CUA group. Based on these results, we suggest that positive outcomes from personal engagement in health practices and the acquisition of reliable health knowledge serve as protective factors, ultimately reducing VH and fostering parental trust in childhood immunization programs.

Strengths and limitations

A primary strength of this study is its multicenter design, encompassing diverse sociocultural regions, which allowed for a more comprehensive evaluation of VH among parents of children with hypospadias and undescended testes. To our knowledge, this is the first study to specifically address VH within the context of CUA. By exploring the unique psychological and clinical landscape of these families, our research provides essential guidance and a novel perspective for physicians and surgeons operating in this specialized field, highlighting the intersection of surgical diagnosis and public health adherence.

Despite these strengths, certain limitations must be acknowledged. First, while multicentric within a national context, the study lacks international scope, which limits the generalizability of the findings to different global socioeconomic and cultural environments. Additionally, the cross-sectional nature of the research precludes a longitudinal assessment of parental attitudes. As the study was conducted post-pandemic, we were unable to utilize a long-term cohort design starting prior to the COVID-19 era, which would have allowed for a more precise temporal analysis of the pandemic's direct impact on shifting vaccination perceptions.

This study identifies significant predictors of VH among mothers of children with CUA. Multivariate analysis reveals that elevated VH is associated with higher maternal education levels and non-adherence to routine infant vitamin D supplementation protocols. Conversely, protective effects were observed in families where both parents were vaccinated against COVID-19 and among those who perceived an increased necessity for childhood vaccinations following the pandemic. These findings suggest that in the specific context of CUA, VH is often intertwined with broader patterns of healthcare engagement and subjective risk assessment.

Clinically, reduced VH correlates strongly with consistent participation in preventive care, the establishment of a robust therapeutic alliance with healthcare providers, and the receipt of evidence-based health education during clinical encounters. To improve vaccination acceptance in this population, targeted interventions should prioritize three key areas: enhancing provider-parent communication through trusted clinical relationships, delivering science-based immunization information during routine pediatric visits, and developing tailored educational strategies that specifically address the nuanced vaccine concerns of parents with higher health literacy.

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Author Contributions

Conceptualization: S.S.Y and M.S.D.; Methodology: S.S.Y, M.T., and M.S.D; Software: S.S.Y and M.S.D.; Validation: M.S.D and S.S.Y.; Formal analysis: S.S.Y; Investigation: M.S.D.; Resources: M.T., I.O., A.S.C., D.B., and S.S.; Data curation: M.S.D.; Writing – Original Draft Preparation: M.T., M.S.D, and S.S.Y.; Writing – Review and Editing: M.S.D and S.S.Y.; Visualization: M.S.D. and S.S.Y.; Supervision: S.S.Y.; Project administration: M.T., M.S.D, and S.S.Y. All authors have read and approved the published version of the manuscript.

Statement of Ethics

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Hacettepe University non-interventional Ethics Committee (Approval No. GO 2024/05-42) on January 23, 2024.

Statement of Competing Interest

The authors declare no conflict of interest.

Statement of Data Availability

All data analyzed during this study are included in this published article and available from the corresponding author in the form of anonymized data upon reasonable request.

Statement of Generative AI Use

Not applicable.

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