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Integrating vaccine hesitancy into the health belief model: additive effects on parental decision-making for child RSV vaccination

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Abstract

Background Respiratory syncytial virus (RSV) is a major cause of respiratory infections in young children. With pediatric RSV vaccines in late-stage clinical evaluation, understanding how parental perceptions and vaccine hesitancy (VH) shape vaccination intentions is critical for achieving high vaccination coverage and maximizing public health benefits. This study applied the Health Belief Model (HBM) to identify factors influencing vaccination intentions and examined VH as a distinct outcome alongside vaccination intention within the HBM framework.

Methods A survey of 402 parents of children aged ≤ 5 years in South Korea assessed RSV knowledge, HBM constructs, and VH. Structural equation modeling (SEM) was used to test two models: (1) an HBM-only model examining pathways from knowledge to vaccination intention mediated by HBM constructs and (2) an extended HBM–VH model specifying both vaccination intention and VH as parallel outcomes.

Results Overall, 17% of parents reported no intention to vaccinate their children against RSV. At the bivariate level, RSV knowledge, HBM constructs, and VH were all significantly associated with vaccination intention. In the HBM-only SEM, perceived susceptibility and cues to action mediated the relationship between RSV knowledge and intention. In the extended HBM–VH model, RSV knowledge was indirectly associated with vaccination intention through HBM constructs ($\beta = 0.15$, $p < 0.001$). Vaccination intention was most strongly associated with cues to action ($\beta = 0.31$, $p < 0.001$), whereas VH was most strongly associated with perceived barriers ($\beta = 0.73$, $p < 0.001$).

Conclusions Incorporating VH improved the model's stability and explanatory power. VH represents a distinct construct within the HBM, and its inclusion enhances understanding of parental decision regarding vaccination. Strengthening provider training to address hesitancy and improving parent–provider communication may further promote vaccine acceptance.

Keywords Respiratory syncytial virus (RSV), Health Belief Model (HBM), Vaccine Hesitancy (VH), Structural Equation Modeling (SEM), South Korea

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Introduction

Respiratory syncytial virus (RSV) is a leading cause of acute lower respiratory infections (ALRI) in infants and young children. Approximately 90% of children are infected with RSV within the first two years of life, of whom about 40% develop lower respiratory tract symptoms [1]. While usually mild, RSV can cause severe outcomes in high-risk groups such as premature infants, those with cardiopulmonary disease, and the immunocompromised [2]. Globally, RSV accounts for an estimated 33 million ALRI cases, 3.6 million hospitalizations, and 26,300 deaths annually in children under five [1], and is linked to long-term complications like recurrent wheezing and asthma, further increasing its clinical and societal burden [3]. Currently, there are no targeted treatments for RSV, highlighting the importance of preventive measures such as vaccination [4]. As pediatric RSV vaccines advance to late-stage development, ensuring high uptake will be essential to reduce RSV-related morbidity, mortality, and healthcare costs [5].

The Health Belief Model (HBM) is one of the most widely used theoretical frameworks for understanding preventive health behaviors [6]. According to the HBM, individuals are more likely to engage in a preventive behavior when they perceive themselves as susceptible to a disease, believe that the disease may have serious consequences, recognize the benefits of preventive action, and perceive fewer barriers to taking it. The model further posits that cues to action, such as recommendations from healthcare providers, advice from family or peers, or public health messages, can prompt individuals to initiate preventive behaviors. Given its utility in explaining health-related decision-making, the HBM has been widely applied in research on vaccine attitudes, acceptance, and intention [7, 8]. One limitation of the HBM is its predominant focus on cognitive determinants, which may overlook the structural, social, emotional, and cultural dimensions that shape vaccination decisions [9]. A useful concept to complement the HBM is vaccine hesitancy, capturing these broader psychosocial influences on parental vaccine behavior. Vaccine hesitancy (VH), defined as delaying or refusing vaccination despite availability [10], is shaped by emotional responses (e.g., fear), social dynamics (e.g., misinformation), and broader institutional or cultural contexts (e.g., distrust, political polarization) [11]. It is important to note that overlooking these factors risks incomplete or biased interpretations of vaccination behavior, which can lead to poor communication between providers and patients [12].

During the COVID-19 pandemic, VH emerged as a major global challenge driven by concerns about vaccine safety, widespread misinformation, and growing distrust in health authorities, all of which undermined public confidence in vaccination programs [13]. While VH is related to vaccination intention, the two constructs may reflect distinct psychological processes rather than opposite ends of the same continuum [14]. This distinction supports examining VH alongside vaccination intention in parental decision-making about vaccination. Seasonal influenza vaccination coverage in children declined from 90.2% in 2019/20 to 82.5% in 2023/24 in South Korea [15, 16], from 60.4% in 2019/20 to 55.1% in 2023/24 in England [17], and from 63.7% in 2019/20 to 55.4% in 2023/24 in the United States [18, 19]. This decline may partly reflect growing vaccine hesitancy, among other contributing factors. Evidence from this period highlights that parents' exposure to misinformation and their perceptions of susceptibility and severity were strong predictors of vaccine acceptance [20, 21]. Integrating VH into the HBM, therefore, offers a comprehensive and timely framework for understanding vaccination behaviors, particularly in the context of newly introduced vaccines. This integrated approach is especially relevant for pediatric RSV vaccination, where public awareness and trust in the vaccine are still developing. It informs the development of tailored educational and communication strategies that address the multifaceted barriers to vaccination while enhancing parents' cognitive understanding and motivation to vaccinate their children.

Childhood vaccination differs from adult vaccination in healthcare settings. In most cases, there are no alternative preventive measures available and parental choices directly determine children's health outcomes [22]. Moreover, health-related decisions made on behalf of others, especially in high-stakes contexts, are inherently more complex, emotionally charged, and prone to biases compared to decisions made for oneself [23]. Accordingly, parental VH should not be regarded merely as an individual preference but rather as a critical issue in clinical decision-making and in safeguarding the health rights of children and adolescents [24]. Given these complexities, parents often experience heightened anxiety and decisional burden, underscoring the crucial role of healthcare professionals in providing empathetic guidance, clear communication, and supportive counseling.

Within this context, clinical practice plays a crucial role in addressing VH [25]. Parents' vaccination decisions are shaped not only by the content of health information but also by how it is communicated and the extent to which parental concerns are acknowledged [26, 27]. In health communication research, a key distinction exists between gain-framed messages, which emphasize the benefits of performing a behavior and loss-framed messages, which highlight the risks of not doing so [28]. The relative effectiveness of these strategies depends on the type of health behavior involved; for preventive behaviors such as vaccination, gain-framed messages are generally found to be more persuasive [29]. This pattern extends to

other parental health decisions. For example, Guidetti et al. showed that benefit-focused breastfeeding messages elicited more positive emotional responses and greater information acceptance than risk-focused messages, which instead triggered more negative reactions [30]. Together, these findings highlight that message framing can meaningfully influence how parents respond to preventive health recommendations.

Effective interventions therefore require more than just providing factual information and improving functional literacy. They must also address social and emotional concerns, build trust, and consider social influences. For pediatric RSV vaccines, where public awareness remains limited, clear, empathetic, and consistent communication that connects RSV vaccination to parents' prior positive immunization experiences can strengthen confidence and support informed decision-making. Ultimately, evidence-based communication strategies are crucial not only to increase vaccine uptake but also to directly reduce VH, thereby promoting better health outcomes for children.

In South Korea, RSV has re-emerged as a major public health concern. Following the COVID-19 pandemic, the country, like many others, experienced prolonged and severe RSV epidemics [31, 32], with sharp increases in pediatric cases and hospitalizations. Among 12,011 RSV-related ALRI hospitalizations reported during the 2022/23 season, children aged 1 to 6 years accounted for 61%, up from 48% in 2019/20, with hospitalization rates in this group rising from 230.8 to 357.5 per 100,000 [33]. Although maternal RSV vaccines and monoclonal antibodies may protect infants, older preschool-aged children remain largely unprotected and contribute substantially to the disease burden [34]. Despite imposing a substantial healthcare burden, most research to date has focused on its epidemiology, with limited attention to the behavioral and psychological factors influencing vaccination [35, 36].

Understanding parents' perceptions, hesitancy, and decision-making processes is important to ensure the successful uptake of future RSV vaccines and to mitigate the broader healthcare burden associated with RSV infections. This study had two complementary objectives, addressing both public health and clinical perspectives. From a public health standpoint, the first objective was to examine the psychological and behavioral factors influencing parents' intention to vaccinate their children against RSV, using the HBM as the guiding framework. From a clinical and health communication perspective, the second objective was to evaluate the added role of VH by comparing a standard HBM-based model ("HBM-only" model) with an extended model incorporating VH as an additional construct (extended "HBM-VH" model). This comparison offers insights into how multidimensional factors influence parental decision-making. By bridging behavioral modeling with practical communication implications, the study hopes to inform the design of patient-centered educational and counseling strategies to support RSV vaccine acceptance in pediatric care.

Methods

Participants

This study was approved by the university research ethics committee (ewha-202408-0027-01). Participants were informed of the study's purpose and provided electronic consent before completing the online survey. A survey was conducted among parents of children aged 5 years or younger in South Korea from August to September 2024. Eligible participants were parents of children aged 0–5 years who were able to read and understand Korean and provided informed consent to participate in the study. Children under 5 years of age were selected because RSV infections and hospitalizations occur most frequently in this age group [37]. In addition, several pediatric RSV vaccine candidates currently under clinical development target infants and young children under 5 years of age.

Multiple recruitment methods were employed to ensure a diverse and representative sample. The study invitation, which includes a QR code linking to the online survey, was posted on online parenting communities, social media platforms, pediatric clinics, and children's play facilities, commonly known as "kids' cafes". Interested participants accessed the survey through the QR code and provided informed consent before participation. The survey remained open until the target sample size was reached. The target sample size was determined based on power considerations for SEM. Assuming a significance level (α) of 0.05, statistical power of 0.80, and a small effect size corresponding to a standardized path coefficient of approximately 0.15, the minimum required sample size was estimated at 350 participants. In line with recommendations to inflate the minimum SEM sample size by 10–20% to ensure stable parameter estimation and model convergence [38], the target sample size was set at approximately 400 participants (a 15% inflation of the calculated minimum). A total of 402 participants completed the survey. The survey platform required completion of all items prior to submission; therefore, no missing data were recorded. All 402 participants who completed the survey were included in the analyses.

Measures

The questionnaire was developed for this study based on the review of relevant literature and theoretical frameworks related to vaccination behavior, the HBM, and vaccine hesitancy [6, 11, 20, 39–42]. As pediatric RSV

vaccines are still under clinical development and no validated HBM scale exists for this context, items were adapted from prior studies examining parental vaccination intentions for influenza [43] and COVID-19 [44, 45]. Influenza-based measures were considered relevant due to the clinical and epidemiological similarities between RSV and influenza in young children, while COVID-19 studies informed measurement in the context of a newly introduced vaccine. National survey materials used in South Korea were also referenced to ensure contextual relevance [46].

To enhance content and face validity, the final questionnaire was reviewed by experts in infectious disease epidemiology and psychometrics and pilot-tested with parents to assess clarity and comprehensibility.

Sociodemographic characteristics included parental and child age, gender, education, income, marital status, and occupation. These variables were selected based on previous research identifying key sociodemographic factors associated with parental vaccination behavior and hesitancy [47, 48]. As pediatric RSV vaccines are still in development, respondents were asked to consider a hypothetical scenario in which the vaccine is available (e.g., "If RSV vaccines become available, would you…"). Vaccination intention was measured using a 4-point Likert scale with the following response options: "very unlikely", "somewhat unlikely", "somewhat likely", and "very likely". RSV knowledge was assessed using 10 items, each with dichotomous response options ("yes" or "no"). Correct responses were scored as 1 and incorrect responses as 0, yielding a total knowledge score ranging from 0 to 10, with higher scores indicating greater RSV knowledge (e.g., "RSV is a common virus that most children are infected with at least once in their lifetime.").

HBM constructs were operationalized as follows. Perceived susceptibility (1 item, 10-point Likert scale) captured parents' beliefs about their child's likelihood of contracting RSV. Perceived severity (1 item, 10-point Likert scale) reflected beliefs about the seriousness of RSV's health consequences. Perceived benefits (2 items) assessed beliefs about the effectiveness of RSV vaccination in preventing infection and protecting the child and others. Perceived barriers (3 items) captured concerns about vaccination, including potential side effects, vaccine safety, and practical obstacles such as cost or missed vaccination timing. Cues to action (2 items) reflected external prompts that may encourage vaccination, such as healthcare provider recommendations or exposure to RSV-related information. Internal consistency was good for perceived benefits (Cronbach's $\alpha = 0.83$), modest for perceived barriers ($\alpha = 0.62$), and low for cues to action ($\alpha = 0.52$, inter-item $r = 0.35$), indicating that the two cues to action items share only modest variance.

Vaccine hesitancy (VH) was assessed using seven items on a 4-point Likert scale (range: 7–28), covering barriers to vaccination (e.g., "I am concerned about the safety of flu vaccines.") and to immunization in general (e.g., "I have experienced difficulties getting a vaccination appointment."). The items were developed based on the Oxford Vaccine Hesitancy Scale (OVHS), which includes beliefs, pain, and deliberation as key domains, and were expanded to include structural constraints and access barriers from a health equity perspective [49]. Higher scores indicated greater hesitancy, with acceptable internal consistency in the sample ($\alpha = 0.72$).

Influenza-related items were included because influenza vaccination provides a familiar and contextually relevant reference point for parents with young children; both influenza and RSV are respiratory infections disproportionally affecting this age group. As pediatric RSV vaccines are still under clinical development, influenza was considered an appropriate proxy context through which parents may express broader vaccine-related concerns.

Analysis

Descriptive statistics, including frequency distribution, central tendency, and variability, were calculated for all study variables. Comparisons by parental intention to vaccinate against RSV were performed using Chi-square tests for categorical variables and t-tests or one-way ANOVA for continuous variables. Variables with a significance level of $p < 0.2$ in the bivariate analysis were included in multivariate models [50]. Spearman correlation analysis was used to assess multicollinearity. Hierarchical ordinal regression was conducted to examine factors associated with RSV vaccination intention. Variables were entered sequentially in 3 steps: (1) demographic characteristics, (2) RSV knowledge, (3) Health Belief Model (HBM) constructs. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported. In addition, hierarchical linear regression analysis was conducted to examine factors associated with RSV vaccine hesitancy, treated as a continuous variable. The same sequential variable entry procedure was applied. Unstandardized coefficients (B) and standard errors (SE) are reported.

Structural equation modeling (SEM) with maximum likelihood estimation was conducted to examine the structural relationships among RSV knowledge, HBM constructs, VH, and RSV vaccination intention, and to test the proposed theoretical pathways including indirect and total effects [51]. Confirmatory factor analysis (CFA) was performed for both the HBM-only model and extended HBM-VH model, with model fit evaluated χ^2/df and additional indices given its sensitivity to large samples [52]. Acceptable model fit was evaluated using the

following indices: Normed Fit Index (NFI), Relative Fit Index (RFI), Incremental Fit Index (IFI), Tucker–Lewis Index (TLI), and Comparative Fit Index (CFI) with values ≥ 0.90 considered acceptable, and Root Mean Square Error of Approximation (RMSEA), with values ≤ 0.08 considered acceptable [53, 54]. Indirect effects were tested using bootstrapping (1,000 resamples) with bias-corrected CI. All analyses were conducted using SAS 9.4 (descriptive statistics and logistic regression) or AMOS 30.0 (CFA and SEM).

Results

Characteristics of participants

Most participants were female (79.6%), married (95.5%), and had a college education or higher (92.5%), with a mean age of 35.6 years (SD = 4.1). The mean RSV vaccination intention score was 3.00 (SD = 0.88), with negative skewness (− 0.93), indicating that responses were concentrated in the "somewhat likely" and "very likely" categories.

Table 1 summarizes the sociodemographic and attitudinal characteristics of the parents and their children, stratified by RSV vaccination intention. Gender, age, marital status, and occupation were not significantly associated with vaccination intention, while higher education (p = 0.06) and income (p = 0.03) showed modest associations. Child age did not significantly differ between groups (p = 0.17), although children of vaccine-hesitant parents were more likely to be aged 36–47 months (37.1% vs. 22.9%). Parents willing to vaccinate their children reported significantly higher RSV knowledge (mean = 5.8 vs. 3.7, p < 0.0001), greater perceived susceptibility, severity, benefits, and cues to action, and fewer perceived barriers (all p < 0.0001). They also reported lower VH scores (mean = 16.0 vs. 17.4, p = 0.003).

Correlations

Spearman correlation was conducted among the study variables included in the multivariate analysis (Table 2). Correlations among variables ranged from 0.13 to 0.59, indicating low to moderate associations, with no evidence of multicollinearity. RSV knowledge (r = 0.13, p < 0.05), perceived susceptibility (r = 0.21, p < 0.001), perceived severity (r = 0.25, p < 0.001) and perceived benefits (r = 0.22, p < 0.001) were positively correlated with RSV vaccination intention, with the strongest correlation among the HBM constructs observed for cues to action (r = 0.40, p < 0.001). In contrast, perceived barriers (r = − 0.23, p < 0.001) and VH (r = − 0.13, p < 0.05) were negatively correlated with RSV vaccination intention and were positively correlated with each other (r = 0.59, p < 0.001). RSV knowledge and VH were not correlated with each other.

Hierarchical ordinal regression for RSV vaccination intention

Table 3 presents the hierarchical ordinal regression results for RSV vaccination intention. In Step 1, higher parental education was significantly associated with vaccination intention (aOR = 2.50, 95% CI: 1.19–5.26), though this association was attenuated in subsequent steps. In Step 2, RSV knowledge was significantly associated with vaccination intention (aOR = 1.16, 95% CI: 1.10–1.22, p < 0.001). In Step 3, RSV knowledge remained significant (aOR = 1.08, 95% CI: 1.02–1.14, p = 0.008). Among HBM constructs, perceived barriers were negatively associated with vaccination intention (aOR = 0.83, 95% CI: 0.74–0.94, p = 0.003), and cues to action were positively associated with vaccination intention (aOR = 1.89, 95% CI: 1.57–2.30, p < 0.001). Perceived susceptibility, severity, and benefits were not significantly associated with vaccination intention.

Hierarchical linear regression for vaccine hesitancy

Table 4 presents the hierarchical linear regression results for RSV vaccine hesitancy. In Step 1, children aged 24–35 months, 48–59 months, and 60–71 months were associated with higher hesitancy scores. RSV knowledge, added in Step 2, was not significantly associated with VH. In the final model, perceived susceptibility (B = 0.29, p < 0.001) and perceived barriers (B = 1.15, p < 0.001) were positively associated with VH, whereas perceived benefits were negatively associated with VH (B = − 0.50, p < 0.001). Cues to action and perceived severity were not significantly associated with VH.

Structural Equation Modeling (SEM): comparison of HBM-only and extended HBM-VH models

Figures 1 and 2 show the structural models, representing the measurement framework of the study. The HBM-only model, which examined the effect of RSV knowledge on vaccination intention mediated by HBM constructs, demonstrated good fit to the data ($\chi 2$ = 1.64, p = 0.20, NFI = 0.99, RFI = 0.93, IFI = 0.99, TLI = 0.97, CFI = 0.99, RMSEA = 0.04). We then estimated an extended HBM model specifying VH and vaccination intention as parallel outcomes predicted by the HBM constructs. Fit indices showed a mixed pattern (χ^2/df = 2.53, RMSEA = 0.058, CFI = 0.94, IFI = 0.94, TLI = 0.90, NFI = 0.90, RFI = 0.83): CFI, IFI, and RMSEA met commonly recommended thresholds, whereas TLI, NFI, and RFI fell below conventional cut-offs, suggesting marginal rather than uniformly acceptable fit. Although the chi-square test was significant in the HBM-VH model, this statistic reflects an overly restrictive criterion, which is rarely satisfied in applied research, even with moderate sample sizes, such as the present study.

Table 1 Characteristics of the participants by RSV vaccination intention

	Total *N* (%)	RSV Vaccination Intention		*p* value
		Yes	No	
Parents				
Gender				0.81
Male	82 (20.4%)	67 (20.2%)	15 (21.4%)	
Female	320 (79.6%)	265 (79.8%)	55 (78.6%)	
Age	35.6 (4.1)	35.6 (4.1)	35.4 (4.0)	0.73
Education level				0.06
≤ High school	30 (7.5%)	21 (6.3%)	9 (12.9%)	
College or above	372 (92.5%)	311 (93.7%)	61 (87.1%)	
Marital status				0.80
Unmarried	6 (1.5%)	6 (1.8%)	0 (0.0%)	
Cohabiting	11 (2.7%)	9 (2.7%)	2 (2.9%)	
Married	384 (95.5%)	316 (95.2%)	68 (97.1%)	
Separated/Divorced/Widowed	1 (0.2%)	1 (0.3%)	0 (0.0%)	
Income[a]				0.03
< 4,000 K	57 (14.2%)	48 (14.5%)	9 (12.9%)	
4,000–5,999 K	133 (33.1%)	110 (33.1%)	23 (32.9%)	
6,000–7,999 K	123 (30.6%)	93 (28.0%)	30 (42.9%)	
> 8,000 K	89 (22.1%)	81 (24.4%)	8 (11.3%)	
Occupation				0.26
Employed	178 (44.3%)	150 (45.2%)	28 (40.0%)	
Part time	41 (10.2%)	31 (9.3%)	10 (14.3%)	
Self-employed	22 (5.5%)	15 (4.5%)	7 (10.0%)	
Housewife	128 (31.8%)	108 (32.5%)	20 (28.6%)	
Healthcare worker	33 (8.2%)	28 (8.4%)	5 (7.1%)	
Children				
Age (months)				0.17
0–5	18 (4.5%)	17 (5.1%)	1 (1.4%)	
6–11	34 (8.5%)	29 (8.7%)	5 (7.1%)	
12–23	53 (13.2%)	48 (14.5%)	5 (7.1%)	
24–35	75 (18.7%)	63 (19.0%)	12 (17.1%)	
36–47	102 (25.4%)	76 (22.9%)	26 (37.1%)	
48–59	66 (16.4%)	54 (16.3%)	12 (17.1%)	
60–71	54 (13.4%)	45 (13.6%)	9 (12.9%)	
RSV knowledge	5.4 (4.0)	5.8 (3.8)	3.7(4.4)	< 0.0001
HBM				
Susceptibility	5.2 (2.3)	5.4 (2.4)	4.2 (1.7)	< 0.0001
Severity	6.7 (2.2)	7.0 (2.1)	5.4 (2.3)	< 0.0001
Benefits	6.3 (1.2)	6.5 (1.1)	5.6 (1.4)	< 0.0001
Barriers	6.7 (1.9)	6.4 (1.8)	7.6 (1.9)	< 0.0001
Cues to action	5.4 (1.4)	5.7 (1.3)	4.1 (1.2)	< 0.0001
Vaccine hesitancy	16.3 (3.6)	16.0 (3.5)	17.4 (3.8)	0.003

a. Monthly household income in Korean won (KRW). 1 USD = 1,510 KRW

In the HBM-only model, perceived susceptibility ($\beta = 0.11$, $p < 0.05$), cues to action ($\beta = 0.31$, $p < 0.001$), and perceived barriers ($\beta = -0.14$, $p < 0.01$) were significantly associated with RSV vaccination intention. In the HBM-VH model, these predictors remained significant. Cues to action ($\beta = 0.31$, $p < 0.001$) continued to be the strongest predictor, followed by perceived barriers ($\beta = -0.14$, $p < 0.01$) and perceived susceptibility ($\beta = 0.11$, $p < 0.05$). RSV knowledge had significant effects on all HBM constructs, showing the highest association with cues to action ($\beta = 0.33$, $p < 0.001$). Similarly, all HBM constructs except perceived severity were associated with VH, with perceived barriers showing the strongest association ($\beta = 0.73$, $p < 0.001$). Tables 5 and 6 show path coefficients of the HBM-only and the HBM-VH Model.

Table 7 shows the standardized direct, indirect, and total effects on RSV vaccination intention. In the HBM-only model, RSV knowledge had a significant indirect

Table 2 Spearman correlations among study variables

	1	2	3	4	5	6	7	8
1. RSV knowledge	-	0.16**	0.17**	0.07	-0.07	0.28***	0.04	0.13*
2. Susceptibility		-	0.39***	0.05	0.03	0.18***	0.20***	0.21***
3. Severity			-	0.22***	-0.06	0.30***	0.06	0.25***
4. Benefits				-	-0.37***	0.40***	-0.32***	0.22***
5. Barriers					-	-0.20***	0.59***	-0.23***
6. Cues to action						-	0.01	0.40***
7. Vaccine hesitancy							-	-0.13*
8. RSV vaccination								-

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 Hierarchical ordinal regression for RSV vaccination intention

	Step 1		Step 2		Step 3	
	aOR (95% CI)	*p* value	aOR (95% CI)	*p* value	aOR (95% CI)	*p* value
1. Demographics						
Parents						
Education						
≤ High school (Ref)	-	-	-	-	-	-
College or above	2.50 (1.19–5.26)	0.02	1.64 (0.76–3.53)	0.21	1.31 (0.55–3.12)	0.54
Income						
< 4,000 K (Ref)	-	-	-	-	-	-
4,000–5,999 K	0.85 (0.47–1.56)	0.60	0.74 (0.40–1.37)	0.34	0.72 (0.37–1.40)	0.33
6,000–7,999 K	0.61 (0.33–1.14)	0.12	0.54 (0.29–1.02)	0.06	0.63 (0.32–1.24)	0.18
> 8,000 K	1.00 (0.53–1.91)	0.99	0.87 (0.45–1.68)	0.68	0.96 (0.47–1.95)	0.90
Children						
Age (months)						
0–5 (Ref)	-	-	-	-	-	-
6–11	0.91 (0.31–2.70)	0.86	0.88 (0.29–2.66)	0.81	1.12 (0.33–3.77)	0.85
12–23	0.76 (0.28–2.08)	0.60	0.68 (0.24–1.88)	0.46	0.76 (0.24–2.35)	0.63
24–35	0.51 (0.19–1.33)	0.17	0.39 (0.14–1.04)	0.06	0.37 (0.12–1.08)	0.07
36–47	0.50 (0.19–1.30)	0.16	0.50 (0.19–1.31)	0.16	0.43 (0.15–1.23)	0.12
48–59	0.61 (0.23–1.62)	0.32	0.51 (0.19–1.38)	0.19	0.55 (0.18–1.63)	0.28
60–71	0.56 (0.21–1.53)	0.26	0.51 (0.18–1.40)	0.19	0.77 (0.25–2.36)	0.65
2. RSV Knowledge						
RSV knowledge			1.16 (1.10–1.22)	< 0.001	1.08 (1.02–1.14)	0.008
3. HBM						
Susceptibility					1.10 (1.00–1.22)	0.05
Severity					1.11 (1.00–1.24)	0.06
Benefits					1.11 (0.91–1.37)	0.30
Barriers					0.83 (0.74–0.94)	0.003
Cues to action					1.89 (1.57–2.30)	< 0.001

effect on vaccination intention ($\beta = 0.15$, $p < 0.001$). When VH was added into the HBM-VH model, RSV knowledge continued to show a significant indirect effect on RSV vaccination intention ($\beta = 0.15$, $p < 0.001$), while its indirect effect on VH was not significant ($\beta = 0.007$, $p > 0.05$).

Discussion

The findings suggest that the HBM provides a useful framework for understanding how parental knowledge of RSV and health beliefs are associated with both vaccination intention and VH through attitudinal and behavioral pathways. Importantly, incorporating VH into the HBM framework provides a more complete understanding of the cognitive, emotional, and structural factors influencing parental decisions. It highlights a core principle of health behavior theories that effective interventions should address not only informational and attitudinal factors but also emotional and contextual barriers contributing to vaccine hesitancy. To our knowledge, this is the first study in South Korea to apply an integrated HBM-VH framework to examine parental intentions toward pediatric RSV vaccination. By identifying key psychological determinants underlying vaccine decision-making, the study contributes not only to public health

Table 4 Hierarchical linear regression for RSV vaccine hesitancy

	Step 1		Step 2		Step 3	
	B (SE)	***p* value**	**B (SE)**	***p* value**	**B (SE)**	***p* value**
1. Demographics						
Parents						
Education						
≤ High school (Ref)	-	-	-	-	-	-
College or above	1.16 (0.69)	0.09	1.14 (0.7)	0.11	0.44 (0.52)	0.39
Income						
< 4,000 K (Ref)	-	-	-	-	-	-
4,000–5,999 K	0.35 (0.57)	0.54	0.34 (0.57)	0.55	0.23 (0.42)	0.58
6,000–7,999 K	-0.56 (0.59)	0.34	-0.56 (0.59)	0.34	-0.37 (0.43)	0.39
> 8,000 K	0.04 (0.61)	0.95	0.03 (0.62)	0.96	-0.10 (0.45)	0.83
Children						
Age (months)						
0–5 (Ref)	-	-	-	-	-	-
6–11	1.94 (1.04)	0.07	1.93 (1.05)	0.07	-0.12 (0.77)	0.88
12–23	1.31 (0.97)	0.18	1.31 (0.98)	0.18	-0.86 (0.72)	0.23
24–35	2.39 (0.94)	0.01	2.38 (0.94)	0.01	0.47 (0.69)	0.49
36–47	0.80 (0.91)	0.38	0.80 (0.92)	0.38	-0.50 (0.67)	0.46
48–59	2.07 (0.95)	0.03	2.07 (0.95)	0.03	0.62 (0.69)	0.37
60–71	2.19 (0.97)	0.03	2.18 (0.97)	0.03	0.04 (0.71)	0.96
2. RSV Knowledge						
RSV knowledge			0.01 (0.05)	0.90	0.01 (0.04)	0.65
3. HBM						
Susceptibility					0.29 (0.06)	< 0.001
Severity					0.01 (0.07)	0.88
Benefits					-0.50 (0.13)	< 0.001
Barriers					1.15 (0.08)	< 0.001
Cues to action					0.21 (0.11)	0.07

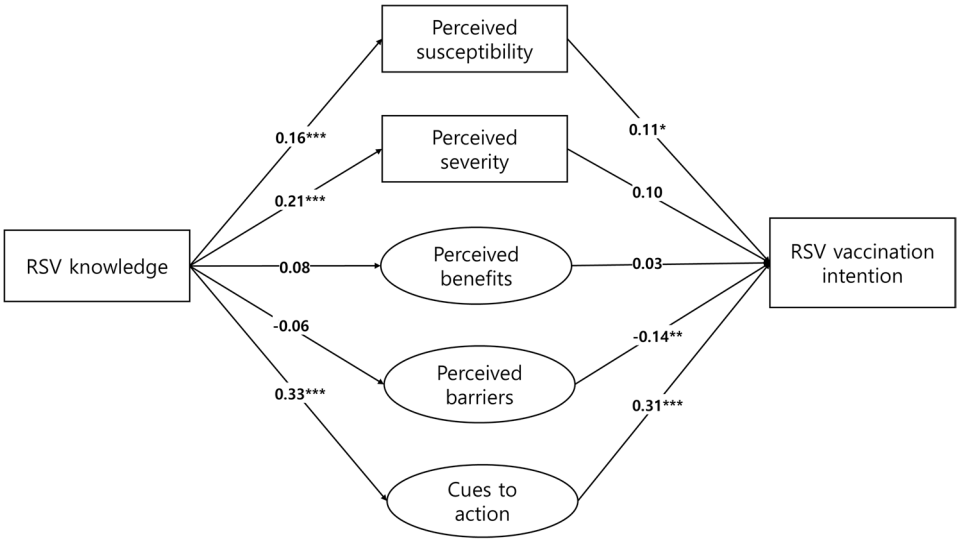


Fig. 1 Path diagram of the initial model showing the influence of RSV knowledge on vaccination intention mediated by HBM constructs *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

and behavioral epidemiology but also to clinical practice, highlighting how understanding parents' beliefs and hesitancy may help inform more effective communication and counseling strategies in pediatric care.

First, RSV knowledge was indirectly associated with vaccination intention, primarily mediated by perceived susceptibility and cues to action. Prior studies have shown that awareness and understanding of RSV can

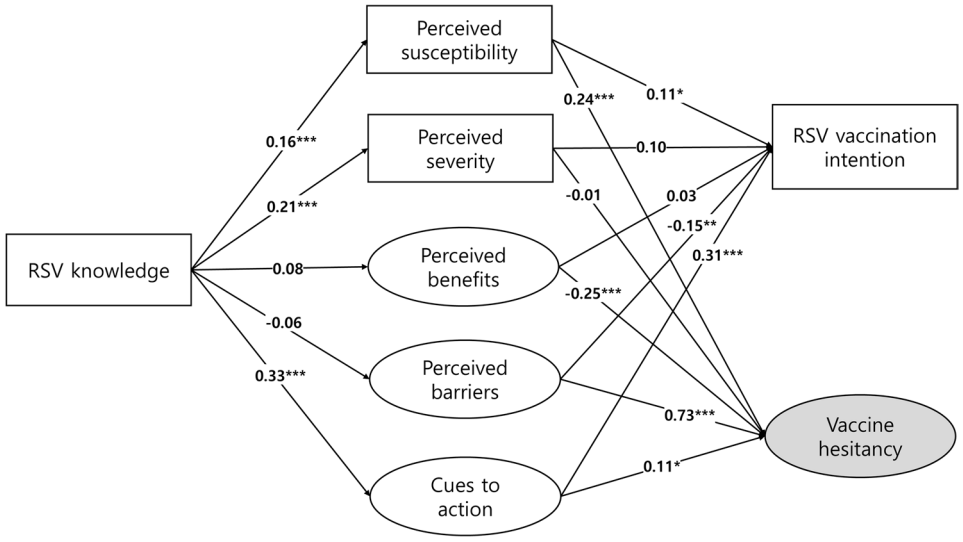


Fig. 2 Path diagram of the alternative model, which extends Model 1 by adding VH as parallel outcomes *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 5 Unstandardized and standardized path loadings for the HBM Alone Model

Parameter estimates	Unstandardized B (SE)	Standardized β
RSV knowledge → Perceived susceptibility	0.09 (0.03)***	0.16***
RSV knowledge → Perceived severity	0.12 (0.03)***	0.21***
RSV knowledge → Perceived benefits	0.02 (0.02)	0.08
RSV knowledge → Perceived barriers	-0.03 (0.02)	-0.06
RSV knowledge → Cues to action	0.12 (0.02)***	0.33***
Perceived susceptibility → RSV vaccination intention	0.02 (0.01)*	0.11*
Perceived severity → RSV vaccination intention	0.02 (0.01)	0.10
Perceived benefits → RSV vaccination intention	0.01 (0.02)	0.03
Perceived barriers → RSV vaccination intention	-0.03 (0.01)**	-0.14**
Cues to action → RSV vaccination intention	0.08 (0.01)***	0.31***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6 Unstandardized and standardized path loadings for the alternative model of HBM-vaccine hesitancy

Parameter estimates	Unstandardized B (SE)	Standardized β
RSV knowledge → Perceived susceptibility	0.10 (0.03)***	0.16***
RSV knowledge → Perceived severity	0.12 (0.03)***	0.21***
RSV knowledge → Perceived benefits	0.02 (0.02)	0.08
RSV knowledge → Perceived barriers	−0.03 (0.02)	−0.06
RSV knowledge → Cues to action	0.12 (0.02)***	0.33***
Perceived susceptibility → Vaccine hesitancy	0.05 (0.01)***	0.24***
Perceived severity → Vaccine hesitancy	-0.00 (0.01)	-0.01
Perceived benefits → Vaccine hesitancy	−0.10 (0.02)***	−0.25***
Perceived barriers → Vaccine hesitancy	0.19 (0.02)***	0.73***
Cues to action → Vaccine hesitancy	0.04 (0.02)*	0.11*
Perceived susceptibility → RSV vaccination intention	0.02 (0.01)*	0.11*
Perceived severity → RSV vaccination intention	0.02 (0.01)	0.10
Perceived benefits → RSV vaccination intention	0.01 (0.02)	0.03
Perceived barriers → RSV vaccination intention	-0.03 (0.01)**	-0.15**
Cues to action → RSV vaccination intention	0.08 (0.01)***	0.31***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7 Standardized direct, indirect, and total effects of RSV knowledge

Path	Direct	Indirect	Total
Model 1: HBM			
RSV knowledge → RSV vaccination intention	-	0.15***	0.15***
Model 2: HBM-Vaccine Hesitancy			
RSV knowledge → RSV vaccination intention	-	0.15***	0.15***
RSV knowledge → Vaccine hesitancy		0.007	0.007

* p <0.05, ** p <0.01, *** p <0.001

enhance immunization acceptance, while limited knowledge remains a significant barrier to the uptake of both maternal vaccines and infant monoclonal antibodies [40, 55]. These findings highlight the need to examine the gap between knowledge and practice through the lens of how parents perceive RSV-related risks and the extent to which they are motivated or prompted to vaccinate. This pattern is consistent with the diffusion of innovation theory [56], which suggests that while disseminating knowledge is vital in the early stages of adopting new practices, sustained behavioral change requires reinforcement through trusted communication and social influence. Therefore, understanding the psychological mechanisms and system enablers that shape vaccination intentions is critical for designing effective interventions in public health as well as clinical practices.

Second, different HBM constructs were differentially associated with the two outcomes. Cues to action showed the strongest association with vaccination intention, while perceived barriers were most strongly associated with VH; perceived susceptibility showed smaller but significant association with both. These findings are consistent with prior RSV vaccine acceptance research [40, 57] and align with Protection Motivation Theory (PMT) [58], which highlights the roles of threat appraisal, coping appraisal, and response efficacy in health decision-making When vaccination messages are conveyed by trusted healthcare providers, parents are more likely to perceive their child as vulnerable, recognize the benefits of preventive action, and feel capable of overcoming barriers to vaccination. These findings suggest that effective public health communication should go beyond knowledge provision to focus on building trust, clarifying the benefits and risks of vaccination, and delivering timely cues that support parental decision-making. Healthcare providers in pediatric settings play a particularly important role in this regard. Consistent with evidence on gain-framed messaging, emphasizing the benefits of RSV vaccination, rather than the risks of non-vaccination, may be more effective in promoting parental acceptance. Guidetti et al. found that benefit-focused messages elicited more positive emotional responses and greater information acceptance than risk-focused messages [30], suggesting that a similar framing approach may be beneficial in RSV vaccine communication.

Third, VH appeared to represent a psychologically distinct construct rather than simply the inverse of vaccination intention. VH was most strongly associated with perceived barriers and lower perceived benefits, suggesting that concerns about safety, side effects, cost, and accessibility may be central to hesitancy toward a future RSV vaccine. This is consistent with theoretical work indicating that performing and not performing a behavior may involve different goals and cognitive processes [14]. Moreover, given that the RSV vaccine is still in development with key attributes such as cost, efficacy, and side effects yet to be clarified, general vaccine hesitancy may currently serve as a more salient predictor of intention. These results emphasize the need to address both general vaccine attitudes and RSV-specific concerns in future health efforts as more concrete information becomes available. Such educational strategies can help bridge the gap between parental uncertainty and confident vaccine acceptance. Treating VH as a separate outcome alongside vaccination intention thus offers a more comprehensive understanding of parental vaccination decision-making.

As the RSV vaccine becomes soon available in pediatric public health programs, it is important to recognize that parents' vaccination decisions are often influenced by their previous experiences with child vaccination. Positive experiences such as perceptions of vaccine effectiveness and minimal side effects can build familiarity, reduce uncertainty, and increase confidence in newly introduced vaccines. Although such experiential influences fall outside the traditional scope of the HBM, they are understood in the concept of VH and therefore play a critical role in shaping trust and motivation for vaccine uptake. Public health agencies and healthcare providers should therefore design RSV communication strategies that reinforce parents' previous positive experiences and existing trust, leverage them as cues to action. For example, for parents who have vaccinated their children against influenza, highlighting the RSV vaccine's durability, safety, and consistent protection can increase perceived benefits and readiness to act. For those with limited vaccination experience, targeted campaigns that raise awareness of RSV-related risks, emphasize social norms supporting vaccination, and demonstrate

trustworthiness of institutions will be essential to encourage informed participation.

In an era saturated with unchecked information, the spread of health-related misinformation particularly through social media has outpaced the dissemination of factual content [13]. The role of credible sources in health communication has become more crucial than ever [59]. Communication strategies that rely solely on factual corrections or statistical evidence often fail to shift beliefs or behaviors, especially when emotional or identity-based factors underpin VH [60, 61]. Health communication at public, community, or individual levels therefore must move beyond information provision to engage with the psychological, emotional, and social dimensions of parental decision-making by acknowledging perceived vulnerability, validating concerns, and building confidence in preventive actions. Enhancing health literacy, specifically functional literacy to evaluate and verify health information remains essential, but who delivers the message matters just as much as the message content. When accurate, empathetic, and personalized communication is delivered by trusted healthcare professionals in clinical settings, it has a far greater potential to counter misinformation, foster trust, and ultimately improve RSV vaccine acceptance.

Our study has several limitations. First, its cross-sectional design limits the ability to draw causal inferences, as exposure and outcome were measured simultaneously. A further limitation is the potential for self-selection bias, as participation was voluntary and the recruitment post described the survey as examining parental perceptions of RSV and RSV vaccination. The sample thus may over-represent parents with stronger prior interest in or views about vaccination. Second, although both primary and non-primary caregivers were included, vaccination decisions are typically made by primary caregivers. Therefore, responses from non-primary caregivers may not fully reflect actual decision-making processes. Future research should prioritize primary caregivers or compare both groups to better understand differences in perspectives. Third, this study employed a hypothetical scenario based on the anticipated availability of an RSV vaccine. As real-world information regarding vaccine cost, safety, and efficacy becomes available, parental intentions may shift, highlighting the need for longitudinal follow-up studies. Fourth, the internal consistency of the two-item cues to action measure was low ($\alpha = 0.52$, $r = 0.35$), indicating limited measurement coherence and potential measurement error. Although alpha is mathematically constrained when very few items are used, this does not render the coefficient adequate, and findings related to this construct should be interpreted cautiously. Although questionnaire items were developed with reference to prior literature and with consideration of content and face validity, the HBM constructs were not assessed using a previously validated scale adapted to this specific context. This limitation reflects the novelty of the research topic: as an approved pediatric RSV vaccine was not available at the time of data collection, validated RSV-specific HBM instruments do not yet exist. Items were therefore adapted from the most contextually similar available measures. Nevertheless, comparability with studies using standardized HBM instruments may be limited, and the construct validity of the measures should be interpreted with caution. Furthermore, the VH measure included influenza-related items as a proxy vaccination context. Although this approach was intended to capture broader vaccine-related concerns in a context relevant to RSV, it may introduce conceptual ambiguity between general vaccine hesitancy and vaccine-specific attitudes. Future studies should more clearly distinguish general from vaccine-specific hesitancy using validated, vaccine-specific measures. Finally, qualitative research exploring VH can provide rich contextual insights into emerging psychosocial factors influencing vaccination decisions and guide the development of tailored communication strategies for both public health and clinical settings.

Conclusion

This study provides important insights into the psychological and behavioral factors that determine parents' decisions to vaccinate their children against RSV. Integrating VH into the HBM enhances our understanding of vaccination behaviors, especially in the context of an emerging vaccine like RSV. The findings highlight that knowledge alone is insufficient to change behavior. Effective strategies must address broader vaccine attitudes, perceived risks, and trust in health information, particularly in a media landscape rife with misinformation. Health communication interventions should therefore move beyond the delivery of factual content to engage parents' emotional and cognitive processes, fostering confidence and empowerment in vaccination decisions in pediatric settings. As real-world data on the RSV vaccine becomes available, longitudinal mixed-method studies and adaptable communication strategies will be crucial to maintaining public trust and promoting equitable vaccine acceptance.

Abbreviations

RSV	Respiratory syncytial virus
HBM	Health Belief Model
VH	Vaccine Hesitancy
SEM	Structural Equation Modeling

Supplementary Information

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Supplementary Material 1.

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Clinical trial number
Not applicable.

Authors' contributions
MP conceived the design for the current research study and HP conducted the preliminary coding and the majority of the data collection. All authors were involved in data analysis. HP wrote the first draft of the manuscript under the supervision of MP and HY, who later revised and made the final draft. All authors commented on the final draft and approved the version of the manuscript to be published.

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

Declarations

Ethics approval and consent to participate
Ethical approval was obtained from the Institutional Review Board of Ewha Womans University (ewha-202408-0027-01). All study procedures were conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all study participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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