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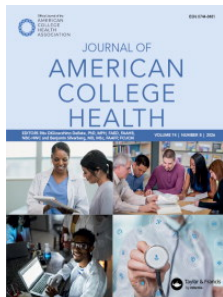
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BRIEF REPORT



Risk perception and young adults' HPV vaccination intention: How perceived severity and susceptibility shape cognitive pathways in HPV vaccination decisions

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ABSTRACT

Objective: To examine whether perceived susceptibility to and severity of human papillomavirus (HPV) infection are associated with HPV vaccination intention through attitudes, social norms, and self-efficacy among unvaccinated young adult college students. **Participants:** Unvaccinated college students aged 18–26 years recruited from four universities in southeast Texas ($N=298$). **Methods:** Cross-sectional baseline survey data from an ongoing randomized controlled trial were analyzed. Separate mediation models examined perceived susceptibility and perceived severity as predictors of HPV vaccination intention through Integrative Model of Behavioral Prediction constructs, controlling for age, gender, race/ethnicity, and sexual activity status. **Results:** Perceived severity was positively associated with vaccination intention through attitudes, social norms, and self-efficacy. Perceived susceptibility was positively associated with vaccination intention through attitudes and social norms, but not self-efficacy. **Conclusions:** Findings suggest that perceived susceptibility and severity may shape HPV vaccination intention through overlapping but distinct cognitive pathways. HPV vaccination interventions for young adults may benefit from messages that highlight both personal risk and serious HPV-related consequences (eg, invasive cancers).

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Cancer prevention; HPV vaccination; perceived severity; perceived susceptibility; young adults

Introduction

Human papillomavirus (HPV) is the most prevalent sexually transmitted infection in the United States (US) and is the leading cause of cervical, anal, penile, and vaginal cancers.¹ Adolescents and young adults aged 15–24 years are particularly vulnerable and have the highest incidence of new HPV infections.² This elevated incidence may be due to high levels of sexual activity, insufficient awareness, underestimated perceived risks, and access barriers to the HPV vaccine.³ For individuals who did not receive the HPV vaccination series at ages 11–12, the U.S. Centers for Disease Control and Prevention recommend “catch-up” vaccination through age 26. However, current efforts to improve HPV vaccination have been predominantly focused on adolescents.⁴ “Catch-up” vaccination among young adults remains suboptimal, especially on US college campuses. Fewer than 60% of college students aged 18 to 26 years have initiated the HPV vaccination series.⁵ Thus, college students represent an important population yet a missed opportunity for HPV vaccination intervention.

Risk perceptions play a central role in behavior change as they shape how individuals evaluate their vulnerability and the benefits of taking preventive action. Risk perceptions consist of two dimensions: perceived susceptibility and perceived severity.⁶ Perceived susceptibility refers to the perceived likelihood of contracting a disease,⁷ while perceived severity refers to the perceived potential health impacts of the disease.⁸ Importantly, college students lack awareness of HPV's negative effects and underestimate their risk of infection.³ Studies indicate that 50% to 75% of college students perceive themselves as at low or no risk of acquiring HPV.⁹

Although perceived susceptibility and severity influence HPV vaccination intention, the behavioral mechanisms underlying these effects are unclear. The Integrative Model of Behavioral Prediction (IMBP) indicates that risk perceptions influence attitudes, self-efficacy, and normative perceptions, which in turn precede behavioral intention.¹⁰ For HPV vaccination, attitudes reflect evaluations of vaccination as beneficial and acceptable;¹¹ perceived social norms reflect perceived support from peers, partners, family, and

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healthcare providers; and self-efficacy reflects confidence in obtaining and completing vaccination. These constructs are especially relevant for college students, whose vaccination decisions may be shaped by emerging healthcare independence,¹² campus environments,¹³ peer norms, and HPV-related stigma.¹⁴ IMBP was selected over other behavioral frameworks (eg, Health Belief Model⁶ or the Theory of Planned Behavior,¹⁵ see a narrative review¹⁶) because it accounts for social norms and is explicitly recognized as the latest iteration for the reasoned action lineage,¹⁷ and provides a more direct and integrative framework for testing the two dimensions of risk perception and their association with intention through the proximal cognitive pathways.

Notably, perceived susceptibility and severity are distinct constructs that may differentially affect IMBP constructs. A meta-analysis indicated that perceived susceptibility may increase the personal relevance of vaccination, prompting more favorable evaluations of vaccination.¹⁸ Perceived severity may likewise strengthen positive attitudes by increasing the perceived importance and value of vaccination as a preventive behavior.^{19,20} Beyond attitudes, greater perceived susceptibility may heighten awareness of personal vulnerability and increase receptivity to preventive health recommendations, whereas greater perceived severity may increase motivation to avoid serious health consequences and strengthen confidence in taking protective action.^{21,22}

However, how these two dimensions in HPV infection individually influence vaccination intention within the IMBP framework has not been tested. A comprehensive examination using IMBP model may provide insights into how targeting these two dimensions of risk perception might enhance HPV vaccination intention formation among young adults.

Therefore, the present study examined the role of HPV risk perceptions in shaping HPV vaccination intention among unvaccinated young adult college students using the IMBP framework. Specifically, this study addressed the research question:

RQ: To what extent do perceived susceptibility to and perceived severity of HPV infection differentially influence HPV vaccination intention through attitudes toward HPV vaccination, perceived social norms, and vaccination self-efficacy?

Methods

Design

Data were from a baseline assessment of an ongoing randomized controlled trial of a multilevel intervention designed to increase HPV vaccination rates among college students.²³

Sample and data collection

Data were collected during the Spring 2022 to Spring 2023 college semesters at four southeast Texas universities as part of a large randomized controlled trial. Texas and the broader Southern region have lower HPV vaccination uptake among US regions: Texas ranks 48th among US states in HPV

vaccination series completion among eligible adolescents and young adults,²⁴ highlighting this critical context for catch-up HPV vaccination research. The participating universities were also selected to reach a racially and ethnically diverse young adult population, including students from Hispanic-serving, historically Black, and racially diverse institutions. Participants were recruited *via* on-campus events, classroom announcements, and flyers. Eligibility criteria were: aged 18 to 26 years; able to read and understand English; has not received any HPV vaccines; enrolled at a participating university with an anticipated enrollment of at least 9 months; not pregnant; has not reported a life-threatening allergy to the HPV vaccine; and has regular access to an internet-connected device. All participants provided consent electronically.

Measures (see supplemental Table 1 for complete measures)

HPV vaccination intention

The primary criterion variable was HPV vaccination intention,²⁵ which was assessed using four items on a five-point Likert scale with good internal reliability ($\alpha = .91$).

Perceived susceptibility and severity

Perceived susceptibility to HPV infection was assessed using two items on a five-point Likert scale, adapted from prior work,⁹ which showed good internal reliability ($\alpha = .78$). Perceived severity of HPV infection was measured using two items on a five-point Likert scale, adapted from prior work,⁹ which showed good internal reliability ($\alpha = .74$).

IMBP mediators

Consistent with IMBP-based measurement recommendations,¹⁷ attitudes toward HPV vaccination attitudes²⁵ were measured with three items on a seven-point Likert scale ($\alpha = .87$). Perceived social norms²⁶ and self-efficacy²⁷ were each assessed with three items on seven-point Likert scales, with acceptable internal reliability ($\alpha = .76$ and $\alpha = .74$, respectively). Higher scores indicated more favorable vaccination attitudes, stronger perceived social norms, and greater vaccination self-efficacy.

Demographic variables

Participants reported key demographic variables including gender, race/ethnicity, status of sexual activity, insurance type, and whether they were born in the US.

Data analysis

First, descriptive statistics (means [M] and standard deviations [SD]) and Pearson correlations were calculated. Next, Hayes' PROCESS macro (model 4) was used to examine the effects of perceived severity and susceptibility on HPV vaccination intention in SPSS 26. Separate mediational models were run for each predictor. Each model included attitudes, social norms, and self-efficacy as mediators and controlled for age, gender, race, and sexual activity status.

Results

Sample characteristics

The average age of the sample ($N=298$) was 20.7 years ($SD=2.08$). Most participants were female (67.4%), not sexually active (59.4%), covered by their parents' insurance (48.3%), and self-identified as non-Hispanic (73.5%). Most participants were non-Hispanic Asian (38.6%) and were born in the US (68.4%). Table 1 reports complete demographics. Vaccination intention was moderate ($M=3.34$, $SD=1.13$). Perceived susceptibility was low-moderate ($M=2.26$, $SD=1.07$). Perceived severity was moderate-high ($M=3.91$, $SD=1.09$).

Univariate statistics and bivariate associations

Table 2 reports descriptive statistics and correlations. Perceived susceptibility and severity were not significantly associated, but each was positively correlated with intention.

Mediation models

Assumptions for mediation were tested to ensure validity of the results. Scatterplots did not provide evidence for

nonlinearity; Q-Q plots suggested that residuals were approximately normally distributed; and residual plots did not indicate heteroscedasticity.

The coefficients for perceived severity predicting HPV vaccination intention through IMBP mediators are shown in Figure 1(A). The model explained 53% of the variance in intention ($p<.001$). Perceived severity exerted a significant total indirect effect on intention (indirect effect = 0.16, $SE=0.05$, 95% CI [0.06, 0.26]), operating through attitudes (indirect effect = 0.07, $SE=0.03$, 95% CI [0.01, 0.13]), social norms (indirect effect = 0.03, $SE=0.01$, 95% CI [0.01, 0.06]), and self-efficacy (indirect effect = 0.06, $SE=0.02$, 95% CI [0.02, 0.11]). After accounting for these mediators, the direct effect of perceived severity on intention was no longer significant ($b=-0.03$, $SE=0.05$, $p=.55$), indicating full mediation. Perceived severity was positively associated with attitudes, social norms, and self-efficacy (all $ps<.05$), and each mediator was positively associated with vaccination intention (all $ps<.001$). The coefficients for perceived susceptibility predicting HPV vaccination intention through IMBP mediators are shown in Figure 1(B). The model explained 55% of the variance in intention ($p<.001$). Susceptibility exerted significant indirect effects through attitudes (indirect effect = 0.04, $SE=0.02$, 95% CI [0.01, 0.08]) and social norms (indirect effect = 0.02, $SE=0.01$, 95% CI [0.003, 0.035]), but not self-efficacy (indirect effect = 0.01, $SE=0.01$, 95% CI [-0.01, 0.04]). The direct effect of perceived susceptibility on intention remained significant ($b=0.10$, $SE=0.02$, $p=.001$), indicating partial mediation. Perceived susceptibility was positively associated with attitudes and social norms (both $ps<.05$), and both mediators were positively associated with vaccination intention (both $ps<.001$). All direct effects to the mediators are presented in Table 3.

Table 1. Sample characteristics ($N=298$).

Variable	%N
Gender	
Male	31.9 (95)
Female	67.4 (201)
Nonbinary	0.7 (2)
Race/ethnicity	
Non-Hispanic White	13.8 (41)
Non-Hispanic Black	21.1 (63)
Non-Hispanic Asian	38.6 (115)
Hispanic White	14.8 (44)
Other	11.7 (35)
Insurance type	
University health insurance	28.7 (82)
Parent insurance	48.3 (138)
Government (Medicaid/CHIP)	12.6 (36)
No insurance	7.7 (22)
Other	2.8 (8)
Sexually active (yes)	40.6 (121)
Born in the US	
Mother (yes)	28.2 (84)
Father (yes)	28.2 (84)
Participant (yes)	68.4 (201)

Note. %N=percentage of the sample; N =total sample size; n =number of participants in each group; CHIP=Children's Health Insurance Program.

Table 2. Univariate statistics and correlations ($N=298$).

Variable	M	SD	1	2	3	4	5
1. Vaccination intention	3.34	1.13	—				
2. Perceived susceptibility	2.26	1.07	.32 [†]	—			
3. Perceived severity	3.91	1.09	.12 [*]	.05	—		
4. Attitudes	3.84	0.90	.57 [†]	.27 [†]	.20 [†]	—	
5. Self-efficacy	3.42	1.00	.55 [†]	.18 [†]	.19 [†]	.38 [†]	—
6. Social norms	2.21	0.97	.44 [†]	.16 [†]	.12 [*]	.29 [†]	.29 [†]

Note. M =Mean; SD =standard deviation.

* $p<.05$. [†] $p<.01$. [‡] $p<.001$.

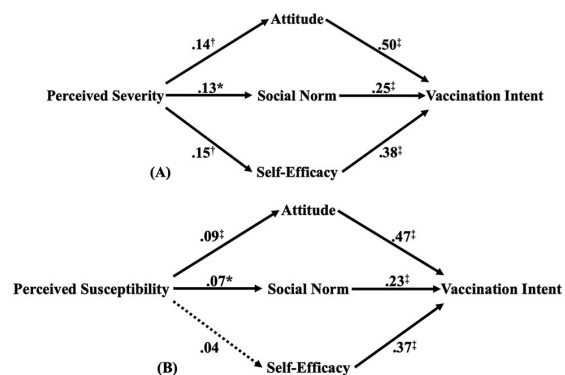


Figure 1. Mediation results for (A) perceived severity and (B) perceived susceptibility predicting HPV vaccination through IMBP mediators.

Note. HPV=human papillomavirus; IMBP=Integrative Model of Behavioral Prediction. Perceived severity predicted HPV vaccination intention through attitude, social norms, and self-efficacy (Figure 1A). In contrast, perceived susceptibility predicted vaccination intention through attitude and social norms but not self-efficacy (Figure 1B). The dotted line corresponds to nonsignificant pathway.

* $p<.05$. [†] $p<.01$. [‡] $p<.001$

Table 3. Summary of direct effects of risk perceptions (perceived severity and susceptibility) predicting IMBP mediators.

Variable	Attitude		Social norm		Self-efficacy	
	<i>b</i> (SE)	95% CI	<i>b</i> (SE)	95% CI	<i>b</i> (SE)	95% CI
Model B—Perceived susceptibility						
Covariates						
Age (years)	0.01 (0.03)	[−0.04, 0.06]	0.06 (0.03)	[0.01, 0.12]	0.08 (0.03)	[0.02, 0.13]
Gender (ref: male) ^a	0.04 (0.10)	[−0.17, 0.24]	−0.19 (0.11)	[−0.41, 0.04]	−0.08 (0.12)	[−0.31, 0.15]
Race (ref: non-Hispanic White) ^b	0.03 (0.04)	[−0.04, 0.10]	0.00 (0.04)	[−0.07, 0.08]	0.05 (0.04)	[−0.03, 0.13]
Sexually active (ref: Inactive)	0.07 (0.11)	[−0.15, 0.28]	0.08 (0.12)	[−0.16, 0.31]	−0.23 (0.12)	[−0.47, 0.02]
Primary predictor						
Perceived susceptibility	0.09 (0.03)	[0.04, .14]	0.07 (0.03)	[0.01, 0.13]	0.04 (0.03)	[−0.02, 0.10]
Model A—Perceived severity						
Covariates						
Age (years)	0.02 (0.03)	[−0.04, 0.07]	0.07 (0.03)	[0.01, 0.12]	0.08 (0.03)	[0.02, 0.13]
Gender (ref: male) ^a	0.03 (0.10)	[−0.18, 0.23]	−0.20 (0.11)	[−0.42, 0.03]	−0.09 (0.12)	[−0.32, 0.14]
Race (ref: non-Hispanic White) ^b	0.06 (0.04)	[−0.01, 0.13]	0.01 (0.04)	[−0.06, 0.09]	0.05 (0.04)	[−0.03, 0.13]
Sexually active (ref: Inactive)	−0.02 (0.11)	[−0.23, 0.20]	−0.01 (0.12)	[−0.24, 0.22]	−0.25 (0.12)	[−0.49, −0.02]
Primary predictor						
Perceived severity	0.14 (0.05)	[0.04, 0.23]	0.13 (0.05)	[0.03, 0.24]	0.15 (0.05)	[0.04, 0.26]

Note. IMBP=Integrative Model of Behavioral Prediction; *b*=unstandardized regression coefficient; SE=standard error; 95% CI=95% confidence interval; ref=reference group.

^aThe two nonbinary participants were recoded into the female category to match their sex assigned at birth due to insufficient sample size.

^bOther race/ethnicity groups were collapsed to form a single comparison group.

Discussion

Guided by the IMBP, this study examined whether perceived severity and susceptibility were associated with vaccination intentions indirectly through attitudes, perceived social norms, and self-efficacy. Both perceived severity and susceptibility predicted stronger vaccination intention, mediated by norms and attitudes. Notably, only *perceived severity* positively predicted self-efficacy, which subsequently predicted stronger vaccination intention. These results reveal the dual aspect of risk perception and the distinct pathways through which severity and susceptibility drive HPV vaccination decision-making.

Both perceived susceptibility and perceived severity were positively associated with more favorable attitudes toward HPV vaccination, which, in turn, predicted stronger vaccination intentions. Consistent with our previous work, attitudes emerged as the strongest predictor of vaccination intent.²⁸ Although prior studies have demonstrated associations between perceived risk and vaccination attitudes, the present study further found that perceived severity exhibited a stronger relationship with attitudes than perceived susceptibility. These findings suggest that beliefs about the seriousness of HPV-related disease may play a more influential role in shaping vaccination attitudes than beliefs about personal risk of infection. One possible explanation is that perceived severity may be more emotionally salient than perceived susceptibility, as it reflects evaluations of the seriousness of potential health consequences and the emotions associated with those outcomes, such as fear.⁷ Prior research suggests that emphasizing severe consequences of HPV infection, including HPV-related cancers, can evoke affective responses that are associated with more favorable attitudes toward vaccination.²⁹ However, because emotional responses were not directly measured in the current study, this explanation should be directly tested in future research.

In the current study, both dimensions of perceived risk were positively associated with social norms, which in turn

positively predicted vaccination intent. Although the present study did not assess the mechanisms underlying these relationships, one possible explanation is that individuals who perceive themselves as more susceptible to HPV may be more likely to attend to and seek information from others. This may increase awareness of pro-vaccination norms and reinforce vaccination as a socially endorsed preventive behavior.³⁰ Similarly, individuals who perceive HPV-related diseases as more severe may become more receptive to normative messages that emphasize vaccination as a way to avoid serious health consequences (eg, anogenital cancers and genital warts). Future research should examine the mechanisms underlying these relationships, including whether individuals with greater perceived risk are more attentive to normative information from family, peers, and healthcare providers, or more likely to seek social cues regarding vaccination. A better understanding of how risk perceptions shape social normative beliefs may help inform interventions that simultaneously leverage perceived risk and social influence to promote HPV vaccine uptake.

A notable finding was that perceived severity, but not perceived susceptibility, was positively associated with self-efficacy, which in turn predicted stronger vaccination intention. This finding contrasts with some prior research suggesting that greater perceived severity may reduce self-efficacy or elicit defensive avoidance,²⁹ particularly across health behaviors and contexts.³¹ One possible explanation for our finding is that HPV vaccination represents a discrete and achievable preventive behavior. Individuals who perceive the consequences of HPV infection as more severe may feel greater confidence in completing a clearly defined action, such as initiating vaccination. Another possibility is that perceived severity is associated with affective responses, such as fear,³² which may increase motivation to engage in protective actions.²⁹ However, the present study did not assess the mechanisms underlying the association between perceived severity and self-efficacy. Exploring the behavioral and psychological processes that may account for the relationship

between perceived severity and self-efficacy will help illuminate this association.

In contrast, perceived susceptibility was not significantly associated with vaccination self-efficacy. It may be that perceiving oneself as likely to face a health threat does not necessarily increase confidence in one's ability to prevent it. Moreover, prior research has suggested that greater perceived susceptibility may elicit anxiety,³¹ which has been linked to lower self-efficacy for protective behaviors.³³ Relatedly, individuals with high perceived susceptibility may sometimes view health risks as relatively unavoidable, resulting in feelings of risk inevitability rather than confidence in their ability to act.³⁴ However, these explanations remain unexamined, as the present study did not assess the emotional or cognitive mechanisms underlying the relationship between perceived susceptibility and self-efficacy. A worthwhile next step is to examine potential mechanisms, including anxiety or feelings of risk inevitability, that may help explain why perceived susceptibility was unrelated to vaccination self-efficacy in the current sample.

Implications

These findings inform the design of HPV vaccination interventions. Interventions may adopt hybrid risk messaging that combines clear information about HPV severity with personalized susceptibility messages. Emphasizing the *severe consequences*, such as six types of invasive cancer, may strengthen attitudes, perceived norms, and self-efficacy, thereby increasing vaccination intention. Similarly, perceived susceptibility can be increased by highlighting the *prevalence* and *personal relevance* of HPV within peers and communities, which normalizes and fosters positive attitudes toward vaccination. At the same time, explicitly emphasizing individual agency and behavioral control (eg, how easy it is to get vaccinated and concrete steps to do so) may enhance self-efficacy through a pathway that susceptibility may not impact. Finally, given the varying mediation effects uncovered, future research may test whether manipulations in the risk perceptions (perceived susceptibility and severity) lead to changes in attitudes, norms, and self-efficacy across other preventive behaviors and contexts.

Strengths, limitations, and future directions

A major strength of this study is its use of the well-established IMBP model in the prevention science context to assess the influence of two understudied aspects of risk perception, susceptibility and severity, on HPV vaccination intention. Furthermore, the analyses robustly distinguished the nuanced cognitive mechanisms through which susceptibility and severity impact vaccination intent. Additionally, whereas previous studies of HPV vaccination have included mostly adolescents, this study included a racially/ethnically diverse sample of young adult college students, a somewhat overlooked but easy to reach population.¹²

Limitations of the study include its cross-sectional design, which precludes causal inferences, and reliance on self-reported data, which may be subject to social desirability bias.

Moreover, the sample, composed of college students from southeast Texas, may limit the generalizability of the findings. However, Texas is among the regions with disproportionately low HPV vaccination rates, making it a critical area for study.

Several directions for future research follow from this report: first, the observed pathways should be replicated in larger and more diverse young adult samples, including college and non-college populations with greater demographic and structural heterogeneity. Longitudinal studies are needed to determine whether indirect effects of perceived susceptibility and perceived severity extend beyond intention to actual vaccination behaviors. Second, an important future direction is to investigate why perceived severity appears to activate self-efficacy, whereas susceptibility does not. Future studies may replicate this and explore the mechanism behind it; for example, they may study whether this effect operates through emotional arousal, perceived urgency, anticipated regret, cancer worry, or other motivational processes. Lastly, intervention studies should experimentally compare susceptibility-focused, severity-focused, and hybrid agency-enhancing messages to determine which combination most effectively promotes HPV vaccination among college students.

In conclusion, this study highlights the value of distinguishing between perceived susceptibility and severity in conceptualizing risk perceptions. Although both dimensions were associated with stronger vaccination intention through more favorable attitudes and social norms, only perceived severity was linked to intention through vaccination self-efficacy. Perceived susceptibility may not impact vaccination self-efficacy among unvaccinated young adults. These findings suggest that HPV vaccination interventions may be strengthened by pairing messages about personal risk and serious HPV-related consequences with strategies that reinforce supportive norms and confidence in obtaining vaccination. By applying the IMBP framework to catch-up HPV vaccination, this study offers theory-informed evidence to guide campus-based interventions for young adults in regions with persistent HPV vaccination disparities.

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Ethical approval

The authors have no conflicts of interest to report. The authors confirm that the research presented in this article met the ethical guidelines, including adherence to the legal requirements, of United States of America and the study protocol was approved by the Institutional Review Board at a University of Texas MD Anderson Cancer Center. The clinical trials registration number: NCT05057312.

Author contributions

CRedit: **Yusi (Aveva) Xu:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing; **Jace D. Pierce:** Investigation,

Methodology, Writing – original draft, Writing – review & editing; **Naomi Q. P. Tan**: Investigation, Writing – original draft, Writing – review & editing; **Lenna Dawkins-Moultin**: Data curation, Funding acquisition, Project administration, Resources, Writing – review & editing; **Dalnim Cho**: Funding acquisition, Investigation, Validation, Writing – review & editing; **Suellen Hopfer**: Resources, Validation, Writing – review & editing; **Yisheng Li**: Funding acquisition, Methodology, Supervision, Validation, Writing – review & editing; **Lois M. Ramondetta**: Funding acquisition, Resources, Writing – review & editing; **Qian Lu**: Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing.

Consent to participate

Written informed consent is required before participation from each participant virtually.

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