



## Short communication

## Efficacy of tailored messages to improve behavioral intent to accept HPV vaccination among mothers may be moderated by sociodemographics

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## ABSTRACT

We assessed differences in response to a tailored recommendation intervention for HPV vaccine by participants' sociodemographic characteristics in this exploratory sub-analysis of a larger web-based, randomized-controlled trial on tailored messaging among mothers with low intent to vaccinate their 11–14-year-old child against HPV. The intervention consisted of pre-recorded video messages tailored to 1–5 common concerns about HPV vaccine. In these exploratory analyses, we used generalized linear models to assess differences in post-intervention intent across intervention arms, stratified by sociodemographic characteristics among 496 trial participants. We found significantly higher post-intervention intent in the intervention participants versus the control group among mothers: 1) with younger children; 2) with white vs. black children; 3) with Non-Hispanic children; 4) who were younger; 5) with some college or vocational training; with household incomes of  $\geq$ \$100,000; and 7) with 1–2 children. Our findings of effect modification by certain sociodemographic factors such as age, race/ethnicity, and household income should be considered when designing similar tailored messaging interventions.

## 1. Introduction

HPV immunization rates lag behind other routinely recommended vaccines. National Immunization Survey-Teen data from 2019 show that only 54.2% of 13–17-year-old adolescents were up to date with HPV vaccination (Elam-Evans et al., 2020). Moreover, persistent differences in HPV vaccine coverage exist by race, ethnicity, poverty-level, urban vs. rural residence, and receipt of a provider recommendation. (Elam-Evans et al., 2020) Such differences are not present for other routinely recommended adolescent vaccines, revealing potential differential recommendation behavior and/or parental vaccine acceptance.

There is a growing body of literature supporting strategies to

improve HPV immunization rates. A strong provider recommendation is one of the most important predictors of HPV vaccine uptake. (Holman et al., 2014) However, persistent differences in immunization rates suggest that the most effective recommendation may not be the same for all parents (Edwards et al., 2016) and there is a need for interventions that address HPV vaccine disparities beyond just the provider recommendation (Panozzo et al., 2020; Vu et al., 2020). In this paper, we report on an exploratory post-hoc analysis that evaluated differences in the efficacy of tailored video messages addressing HPV vaccination concerns within select sociodemographic groups. These differences may suggest insights into disparities in HPV vaccine uptake and inform implementation of tailored messaging interventions in clinical practice.

*Abbreviations:* HPV, Human papillomavirus; RCT, Randomized controlled trial.

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## 2. Methods

In September 2018, we conducted a web-based, randomized-controlled trial among mothers in 27 states with HPV vaccination rates below the national average who did not intend to vaccinate their 11–14-year-old child against HPV within the next 12 months and expressed concerns about vaccination (Clinical Trial Registration: NCT03628885) (Panozzo et al., 2020). The study protocol was approved by the Institutional Review Board at Indiana University and granted exempt status. Participants were recruited using Survey Sampling International (International, SS), an online research platform, and completed a survey that assessed their specific HPV vaccine concerns. Participants were then randomized into one of the following trial arms: a) General, bundled-information video (control,  $n = 267$ ), b) General video + video addressing top HPV vaccine concern (control + top-concern,  $n = 252$ ), or; c) General video +  $\geq 1$  videos addressing all vaccine concerns (control + all-concerns,  $n = 243$ ). The video content was developed through the combined expertise of the study investigators, existing literature, and CDC resources on HPV vaccine messaging; more information on the video content is described elsewhere (Panozzo et al., 2020). The primary outcome was intent to vaccinate within 12 months measured on a 10-point scale (1 = extremely unlikely and 10 = extremely likely). Generalized linear models measured differences in mean post-intervention scores for intent to vaccinate across intervention arms. Overall, mothers in the control + all concerns arm had significantly higher intent to vaccinate post-intervention than those in the control arm (4.2, 95% C. I. 3.9–4.6 vs 3.5 95% 3.1–3.8,  $p = 0.002$ ). A detailed description of the methods, cohort, and main study findings are available elsewhere (Panozzo et al., 2020).

Since results were not significantly different between the control + top-concern and control arms in the main study, in this study, we explored effect modification between the control + all-concerns and control arms only ( $n = 496$ ). We performed post-hoc analyses stratified by child, maternal, and household characteristics using generalized linear models. The potential effect modifiers were selected based upon factors associated with differences in HPV vaccine uptake in prior studies (Elam-Evans et al., 2020).

## 3. Results

Among the 496 mothers who were randomized to the control + all concerns or control arms, 50% had a female child, 17% had a high school education or less, and 11% reported their child's race as black (Table 1). In stratified analyses, intention to vaccinate against HPV was significantly higher in the control + all-concerns arm compared to the control arm among 1) younger children (aged 11–12 years); 2) white and black children; 3) Non-Hispanic children; 4) younger mothers (aged  $\leq 36$  years); 5) mothers with some college or vocational training; 6) households with incomes of  $\geq \$100,000$ , and; 7) households with 1–2 children.

## 4. Discussion and Conclusion

Results from the larger intervention study suggested that for mothers of 11–14 year old children with low intent to vaccinate, tailored messages addressing all HPV vaccination concerns may modestly increase HPV vaccination intent compared with general, bundled messages alone. Our exploratory analyses found that the efficacy of the intervention differed across several sociodemographic characteristics, which may reflect some of the reasons for persistent differences in HPV vaccine hesitancy, and ultimately, HPV vaccination rates. Vaccine hesitancy may be highly associated with concerns about vaccine safety, the top or only concern cited by 46% of the mothers in our post-hoc analyses, and when these concerns are addressed, intention to vaccinate may increase. However, hesitancy can also be associated with other factors not readily addressed by correcting misperceptions or addressing concerns, such as

**Table 1**

Adjusted<sup>a</sup> mean post-intervention intent score<sup>b</sup> (95% confidence interval) presented for the control and control + all concerns intervention groups stratified by child sex, age, race, ethnicity; mother's age and education, and; household income and size.

Characteristic	N (%) <sup>c</sup>	Video Intervention Group <sup>d</sup>		P-value <sup>e</sup>
		Control (n = 259)	All Concerns (n = 237)	
<b>Overall</b>	496	3.5 (3.1–3.8)	4.2 (3.9–4.6)	<0.01
<b>Child Sex</b>				
Female	247 (50)	3.3 (2.8–3.7)	4.0 (3.5–4.5)	0.03
Male	249 (50)	3.6 (3.2–4.1)	4.4 (3.9–4.9)	0.02
<b>Child Age</b>				
11–12 years	258 (52)	3.5 (3.0–3.9)	4.4 (3.9–5.0)	<0.01
13–14 years	238 (48)	3.4 (2.9–3.9)	4.0 (3.5–4.4)	0.11
<b>Child Race</b>				
Black	53 (11)	3.8 (2.8–4.8)	5.5 (4.2–6.8)	0.04
White	395 (80)	3.2 (2.8–3.6)	4.2 (3.8–4.5)	<0.01
Other	42 (9)	4.2 (3.0–5.5)	3.7 (2.4–5.0)	0.59
<b>Child Ethnicity</b>				
Hispanic	38 (8)	3.5 (2.4–4.6)	4.3 (2.4–6.3)	0.44
Non-Hispanic	452 (92)	3.4 (3.1–3.8)	4.2 (3.9–4.6)	<0.01
<b>Mother's Age</b>				
<36 years	135 (27)	3.7 (3.1–4.3)	4.8 (4.1–5.5)	0.02
36–40 years	132 (27)	3.5 (2.8–4.1)	4.1 (3.5–4.8)	0.15
41–45 years	107 (22)	3.2 (2.5–3.9)	3.9 (3.2–4.6)	0.15
46 + years	120 (24)	3.6 (2.9–4.3)	4.0 (3.3–4.7)	0.49
<b>Mother's Education</b>				
High school or less	83 (17)	3.3 (2.4–4.2)	4.2 (3.5–5.0)	0.11
Some college or vocation	212 (43)	3.4 (2.9–3.9)	4.3 (3.8–4.8)	0.01
Bachelor's degree or higher	201 (41)	3.6 (3.1–4.0)	4.1 (3.5–4.7)	0.16
<b>Household Income</b>				
<\$25 K	47 (10)	3.4 (2.1–4.7)	5.0 (3.9–6.0)	0.07
\$25 k-<\$50 K	133 (27)	3.4 (2.8–4.0)	3.9 (3.2–4.5)	0.30
\$50-<\$100 K	122 (26)	3.3 (2.5–4.0)	4.0 (3.4–4.7)	0.12
\$75-<\$100 K	86 (17)	3.5 (2.7–4.3)	3.8 (2.9–4.7)	0.64
\$100 K+	99 (20)	3.4 (2.7–4.1)	5.1 (4.3–5.9)	<0.01
<b>Household Size</b>				
1–2 children	343 (70)	3.3 (2.9–3.7)	4.4 (4.0–4.8)	<0.01
3–4 children	150 (30)	3.7 (3.1–4.3)	3.8 (3.1–4.5)	0.84

<sup>a</sup> Analyses adjusted for maternal education level and child's age.

<sup>b</sup> Vaccination intent in the next 12 months measured on scale of 1 (very unlikely) to 10 (extremely likely).

<sup>c</sup> Some categories do not sum to the overall N due to missing data.

<sup>d</sup> Results for control + top concern group not presented since the overall result for intent was not statistically significant.

<sup>e</sup> These analyses were conducted post-hoc, meaning the original study did not specify that we would examine effect modification and thus power our study accordingly. Thus, failing to achieve statistical significance should be interpreted with caution, especially in the sociodemographic groups with smaller

numbers of participants.

trust or confidence, social norms, or ability to access immunization services (MacDonald, 2015). The prevalence of these factors may vary across different groups, affecting the impact of tailored messages.

Our results should be considered in the context of other tailored messaging interventions that have not demonstrated consistent efficacy in improving vaccination intent or uptake across different sociodemographic groups (Dempsey et al., 2019; Donahue et al., 2018; Yzer et al., 2018; Lee et al., 2016; Pot et al., 2017; Galbraith et al., 2016). Lack of consistent efficacy may be at least partly related to potential effect modification by sociodemographic subgroups such that salient messages are not the same for everyone. Additionally, since our results are exploratory, they should be interpreted cautiously. We were not sufficiently powered to robustly evaluate for effect modification across all groups, particularly for black children ( $n = 53$ ), other race children ( $n = 42$ ), and Hispanic children ( $n = 38$ ). It is important to note, as well, that factors such as child age, maternal age, and number of children in the household may all be interrelated characteristics. Further research is needed to better understand reasons for potential effect modification to further inform the design and improve the efficacy of tailored messaging interventions.

#### Credit authorship contribution statement

**Kristen A. Feemster:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft. **Katharine J. Head:** Conceptualization, Methodology, Investigation, Writing - review & editing. **Catherine A. Panozzo:** Conceptualization, Methodology, Investigation, Data curation, Writing - review & editing. **Sean M. O'Dell:** Conceptualization, Writing - review & editing. **Gregory D. Zimet:** Conceptualization, Methodology, Investigation, Funding acquisition, Writing - review & editing. **Melanie L. Kornides:** Conceptualization, Methodology, Investigation, Data curation, Writing - review & editing, Supervision.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### References

- Elam-Evans, L.D., Yankey, D., Singleton, J.A., et al., 2020. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 Years - United States, 2019. *MMWR Morb. Mortal Wkly Rep.* 69 (33), 1109–1116. <https://doi.org/10.15585/mmwr.mm6933a1>.
- Holman, D.M., Benard, V., Roland, K.B., Watson, M., Liddon, N., Stokley, S., 2014. Barriers to human Papillomavirus vaccination among US adolescents a systematic review of the literature. *JAMA Pediatr.* 168 (1), 76–78. <https://doi.org/10.1001/jamapediatrics.2013.2752>.
- Edwards, K.M., Hackell, J.M., Comm Infect D, Comm Practice Ambulatory M, 2016. Countering vaccine hesitancy. *Pediatrics* 138 (3), 14. <https://doi.org/10.1542/peds.2016-2146> e20162146.
- Panozzo, C.A., Head, K.J., Kornides, M.L., Feemster, K.A., Zimet, G.D., 2020. Tailored messages addressing human Papillomavirus vaccination concerns improves behavioral intent among mothers: a randomized controlled trial. *J. Adolescent Health: Off. Publ. Soc. Adolescent Med.* 67 (2), 253–261. <https://doi.org/10.1016/j.jadohealth.2020.01.024>.
- Vu, M., King, A.R., Jang, H.M., Bednarczyk, R.A., 2020. Practice-, provider- and patient-level facilitators of and barriers to HPV vaccine promotion and uptake in Georgia: a qualitative study of healthcare providers' perspectives. *Health Educ. Res.* <https://doi.org/10.1093/her/cyaa026>.
- Survey Sampling International SSI global panel book by country, 2017. Available at: <https://www.surveysampling.com/site/assets/files/3030/ssi-2017-panel-book.pdf>. Date accessed: December 21, 2018.
- Panozzo, C.A., Head, K.J., Kornides, M.L., Feemster, K.A., Zimet, G.D., 2020. Tailored messages addressing human Papillomavirus vaccination concerns improves behavioral intent among mothers: a randomized controlled trial. *J. Adolescent Health: Off. Publ. Soc. Adolescent Med.* <https://doi.org/10.1016/j.jadohealth.2020.01.024>. Epub 2020 Mar 2020.
- MacDonald, N.E., 2015. Vaccine hesitancy: definition, scope and determinants. *Vaccine* 33 (34), 4161–4164. <https://doi.org/10.1016/j.vaccine.2015.04.036>.
- Dempsey, A.F., Maertens, J., Sevcik, C., Jimenez-Zambrano, A., Juarez-Colunga, E., 2019. A randomized, controlled, pragmatic trial of an iPad-based, tailored messaging intervention to increase human papillomavirus vaccination among Latinos. *Hum. Vaccin. Immunother.* 1–8. <https://doi.org/10.1080/21645515.2018.1559685>.
- Donahue, K., Hendrix, K., Sturm, L., Zimet, G., 2018. Provider communication and mothers' willingness to vaccinate against human Papillomavirus and Influenza: a randomized health messaging trial. *Acad. Ped.* 18 (2), 145–153.
- Yzer, M., Rhodes, K., McCann, M., et al., 2018. Effects of cultural cues on perceptions of HPV vaccination messages among parents and guardians of American Indian youth. *Prev. Med.* 115, 104–109. <https://doi.org/10.1016/j.ypmed.2018.08.021>.
- Lee, H.Y., Koopmeiners, J.S., McHugh, J., Raveis, V.H., Ahluwalia, J.S., 2016. mHealth Pilot Study: text messaging intervention to promote HPV vaccination. *American J. Health Behav.* 40 (1), 67–76. <https://doi.org/10.5993/ajhb.40.1.8>.
- Pot, M., Paulussen, T.G., Ruiter, R.A., et al., 2017. Effectiveness of a web-based tailored intervention with virtual assistants promoting the acceptability of HPV vaccination among mothers of invited girls: randomized controlled trial. *J. Med. Internet Res.* 19 (9) <https://doi.org/10.2196/jmir.7449>.
- Galbraith, K.V., Lechuga, J., Jenerette, C.M., Moore, L.A., Palmer, M.H., Hamilton, J.B., 2016. Parental acceptance and uptake of the HPV vaccine among African-Americans and Latinos in the United States: a literature review. *Social Sci. Med.* (1982) 159, 116–126. <https://doi.org/10.1016/j.socscimed.2016.04.028>.