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The Association Between Educational Attainment and COVID-19 Vaccine Hesitancy In the United States

Introduction: One of the most alarming phenomena of the COVID-19 pandemic was the notably mixed reception towards public health mandates, protocols and recommendations set out by epidemiologists and medical experts in the federal government. In some instances, they were even met with significant resistance. As a potential strategy to address the issue of vaccine hesitancy within the US, the association between educational attainment and COVID-19 vaccine hesitancy amongst US residents were examined, by means of logistical modelling.

Literature Review: According to the National Science Teaching Association's Next Generation Science Standards [1] and NRC Framework for K-12 Science Education [2, 3], the working principles of vaccines and basic concepts of immunology are not part of the pre-college level life sciences curriculum, meaning students will receive formal education about vaccinology only if they pursue a life/biological sciences degree above high school level. Dubé et al. [3] also concludes a few dominant historical, societal, cultural and political factors that contributes to one's level of vaccine hesitancy. Firstly, there has been historical and societal shifts of an individual's role in their healthcare from passivity to proactivity, via increasing personal involvement in decision-making in major healthcare decisions, in contrast to the traditional physician-dominant approach. Secondly, traditional and modern media have acted as propagators of vaccination scares, broadcasting and maintaining the prevalence of anti-vaccination objectives from influential groups or individuals. Thirdly, it attributes public distrust in vaccine mandates and policies as the failure of safety communication on the government's part. Safety surveillance systems that are in place to ensure the safety and

quality of vaccines are not well understood by the population or even healthcare providers, which leaves the general public more skeptical than confident. Fourthly, it highlights the contribution of self-perceived knowledge about vaccination necessity and the functioning of the immune system, as well as inaccurate risk perception of vaccine-preventable infectious diseases to one's vaccine hesitancy. If one does not regard vaccinations as necessary, prefer to rely on their innate immunity, or do not fully understand the risks they expose themselves and others around them to, they might be inclined to adopt a more conservative attitude towards vaccines. With consideration of the above, education systems seem to be an ideal channel for distribution of accurate scientific information, and the only strategy that could address vaccine hesitancy from the source. By indiscriminately empowering younger generations with the ability to rationally assess the functioning principles and safety of vaccinations, appreciate its value and importance in modern medicine, and appraise the impacts and consequences of anti-vaccinations on a societal scale, could it significantly influence their level of acceptance or hesitancy towards vaccines? Establishing and quantifying the relationship of how education affects one's level of vaccine hesitancy is therefore a promising notion and will be of great significance in the context of counteracting it in the US.

Numerous studies have observed a connection between vaccine literacy and health literacy [4-6], defined as “the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions [7].” However, since health literacy is a qualitative variable with no well-established definition or measurable parameters, the approach in this study has deferred to establishing educational attainment as the predictor variable. It is objectively quantifiable, measurable and more directly related to one's ability to appraise scientific information and evidence. Since

science education is also a core component in all levels of pre-college education in the US, educational attainment will conveniently also reflect one's relative scientific literacy.

The Report of the WHO Strategic Advisory Group of Experts on Immunization (SAGE Group) on Vaccine Hesitancy [8] highlights that higher educational attainment has been associated with BOTH lower AND higher rates of vaccine hesitancy, illustrating that different geographical contexts can affect the direction and strength of this relationship. This indicates a need to characterize the phenomena unique to the locale instead of adopting a one-size-fits-all strategy in the fight against vaccine hesitancy. Up to the time of writing, no existing study attempts to quantify this relationship by means of statistical modelling on an individual level in the US, which is a gap that this body of work does complement.

Other works have also attributed vaccine hesitancy to mistrust of scientific-medical institutions and experts [9], as well as a large variety of demographical factors such as type of vaccine, race, age, income, rurality etc. [5, 10-13], which reflect that the factors determining level of vaccine hesitancy can differ by country, geographical location, demographical makeup of a population, availability of vaccine types, and political, social and economic factors. Therefore, it is paramount that any attempt to isolate a quantifiable relationship between educational attainment and vaccine hesitancy should also adjust for all these possible covariates, and this consideration is instrumental in dataset choice and model design of this study.

Methods: To assess the strength of the association between individual educational attainment and COVID-19 vaccine hesitancy, and also to adjust for a multitude of possible confounding factors and interactive relationships that could interfere with this association, a selection of 14 socioeconomic, demographic and pandemic circumstantial covariates were chosen from the Household Pulse Survey [13] to construct a logistic model against a dichotomous vaccine

hesitancy outcome variable. Cross-sectional observations provided a comprehensive selection of relevant variables, covariates and representative cohort size, upon which logistic models were constructed to isolate the association of interest. The main hypothesis is that a negative relationship exists between educational attainment and COVID-19 vaccine hesitancy level in individuals residing in the US.

Results: 1.2M observations have been incorporated into the logistic model. A strong, negative associative relationship between educational attainment and a dichotomous vaccine hesitancy variable has been identified, whilst controlling for sociodemographic and pandemic-circumstantial factors that are likely to influence the association of interest. Age, Hispanic/Latinx ethnicity, birth gender, race, marriage status, income, insurance status and most US states of residence are also all associated with vaccine hesitancy. Most of the categories and variables are negatively associated with COVID-19 vaccine hesitancy, except being female, of mixed race, divorced/separated, and living in the states of Idaho, Mississippi, Montana and North Dakota (which are all Republican stronghold states in the US). Interestingly, being of Hispanic/Latinx ethnicity seems to completely reverse the established negative relationship between educational attainment and vaccine hesitancy, suggesting an intriguing association between cultural background/identity and perception of modern preventative medicine. Having experience being diagnosed with COVID-19 is positively associated with vaccine hesitancy, which is within expectations. Many of the essential worker sectors have a positive correlation with vaccine hesitancy as well, except for hospital, nursing/residential healthcare, social service, k-12/schools/institutions sectors. The most notable sectors with a positive correlation with vaccine hesitancy are first responders and correctional facility employees. The first responders subcategory, which include police and firefighters, have rallied some of the most public and unionized demonstrations of resistance against COVID-19 vaccine mandates in the US. For the interaction effect between

educational attainment and experience with COVID-19: it appears that if one has been diagnosed with COVID-19, the higher their education level, the more vaccine hesitant they are. This confirms that experience with COVID-19 was able to override the negative relationship between educational attainment and vaccine hesitancy.

Conclusions: After controlling for a comprehensive collection of socioeconomic, demographic and circumstantial confounders and interaction effects, it can be confirmed that educational attainment has a statistically significant, negative association with individual COVID-19 vaccine hesitancy. The resultant model supports education as a powerful tool to address vaccine hesitancy in the US, and also provides temporally stable and statistically representative coefficient estimates for all variables taken into account. The yielded findings might not be representative of the vaccine hesitancy phenomenon in general, but they are extremely valuable in the occasion of future fast-rising endemics and pandemics. For any respectable governing body, disease outbreak contingencies should to be designed well-in-advance to ensure federal and societal preparedness. Knowing which demographics and communities to prioritize education and relief efforts in these situations, is crucial to mounting effective and rapid preventative actions, minimizing negative impacts, and curbing further spread. Such a model can potentially be used to predict vaccine hesitancy on an individual level, which would be important in the identification of demographics or communities that are more vaccine-hesitant than others, and could inform public health and education policy design when tackling vaccine hesitancy in the long-term.

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