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Individual decisions to vaccinate one's child or oneself: A discrete choice experiment rejecting free-riding motives

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ABSTRACT

It is essential for public health to understand what drives people's hesitance towards vaccination. Theoretical models of vaccination decisions are ubiquitous, often incorporating herd immunity, perceptions of vaccine-related side-effects (VRSE) and of vaccine-preventable burden of disease, but with little to no empirical exploration. Herd immunity is a (usually) positive externality where vaccinated individuals influence others' risks by their reduced capability to transmit an infectious disease to them. It is often assumed that (rational) individuals incorporate this externality in their strategic vaccination decision, from which free-riding behavior arises. We performed a Bayesian D-efficient discrete choice experiment in February–March 2017 to study vaccination behavior in 1919 Belgian respondents. Choice sets with vaccine profiles were constructed using six attributes: vaccine effectiveness, VRSE, accessibility (in terms of convenience and reimbursement), vaccine-preventable burden of disease, local (respondents' network of contacts) vaccination coverage, and population (the population at large) vaccination coverage. VRSE and accessibility are the most influential attributes, followed by vaccine effectiveness and burden of disease. Both population and local coverage are less important than the other attributes, but show a significant direct linear relationship with vaccine utility. This supports the existence of peer influence (more incentivized as more and more vaccinate), rather than free-riding on herd immunity. These findings were independent of whether respondents made vaccine choices for themselves or for their child. Around 40% of the respondents indicated accepting vaccination with little or no questioning. These 'acceptors' were less sensitive to changes in the vaccine-preventable burden of disease for their child's vaccination choices (but not for themselves). Public health institutions are critical in stimulating vaccine uptake by making vaccines conveniently available at an affordable price and by communicating pro-actively on perceived VRSEs. The free-riding assumption as a driver of individual vaccine decisions, seems inappropriate, but this observation needs confirming in other populations.

1. Introduction

Infectious disease prevention is increasingly challenged by globalization (Hufnagel et al., 2004). Not only pathogens spread globally in a matter of days through ever-increasing human mobility (Morse, 2001), but vaccine scares and hesitancy can propagate even faster via social media (Salathé et al., 2013; Larson et al., 2011). The communicability of both infections and rumors undermine hard-fought investments to prevent, control and eradicate infectious diseases (Larson et al., 2016). Hence, understanding individual vaccination decisions is highly relevant for policy-makers and vaccine program managers in order to anticipate and respond to drops in vaccination coverage. Empirical information on how individuals decide about vaccinating themselves or their children is however lacking (Verelst et al., 2016; Funk et al., 2015).

Yielding uncertain benefits in the future, prevention differs fundamentally from cure. People do not know upfront when (or if) they will contract a preventable disease. Other vaccine-specific aspects further complicate an individual's decision to accept vaccination (Corben and Leask, 2016). Widespread vaccination yields (mostly positive) externalities through herd immunity (Fine et al., 2011). Herd immunity - the indirect protection of unvaccinated people in a largely vaccinated population - provides a safety net for those who cannot receive vaccination for medical reasons (e.g. too young, immunocompromised,

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pregnant), those who deliberately reject or delay vaccination or those who are not or no longer immunized by the vaccine they received. Some theoretical models assume herd immunity is incorporated by individuals in their vaccination decision, implying many individuals are assumed to deliberately free-ride on others' vaccination (eg, (Barbagallo and Cojocaru, 2010; Zhang, 2013; Schimit and Monteiro, 2011), see (Verelst et al., 2016) for a systematic review). Though rarely discussed, it remains unresolved whether herd immunity contributes more to vaccine acceptance through altruistic motives (to protect the vulnerable) than to rejection or hesitance through free-riding motives (Quadri-Sheriff et al., 2012; Skea et al., 2008; Vietri et al., 2012). Moreover, vaccination is to a certain extent victim of its own success. Regions with high vaccination coverage experience less vaccine-preventable disease (VPD) burden, and when this occurs over a long period, the need for high coverage vaccination may be questioned to the extent that large VPD outbreaks occur until coverage rises again (Zipprich et al., 2015).

Discrete choice experiments (DCEs), which are well-established in health economics (Clark et al., 2014; de Bekker-Grob et al., 2012), have been used before to elicit preferences for vaccines (Sadique et al., 2013; de Bekker-Grob et al., 2010; Hall et al., 2002; Bishai et al., 2007; Determann et al., 2014; Oteng et al., 2011; Gidengil et al., 2012), but none of these compared adults' vaccine choices for themselves with those for their children, and only one investigated free-riding motives (Hall et al., 2002).

In Belgium, the administration of childhood vaccines up to age 15 months is organized at the regional level through well-baby clinics, which are attended by about 70% of infants (KindGezin, 2015). During five vaccination consults, these infants receive up to 13 vaccine doses (jabs and oral intakes combined) against 12 pathogens. Only poliomyelitis vaccination is mandatory in Belgium. Most recommended vaccines are available on site for free. Only the oral rotavirus vaccine requires parents to first get a prescription, buy the vaccines at the pharmacy (co-payment of 11.90 euro per dose), and take the vaccine to the well-baby clinic or general practitioner (GP) for its administration. School-age children are vaccinated through a regional-level institution of school nurses and physicians. In general, vaccination coverage of recommended vaccines (i.e. in the basic immunization schedule) in children is stable and high (92.9–96.2%) (Vandermeulen et al., 2017). Despite the above practical hurdles and personal costs, even rotavirus vaccine coverage attained 89.7% in Flanders, the Dutch speaking part of Belgium (Vandermeulen et al., 2017). As such, the Flemish population remained up till now largely indifferent to vaccine controversies (Larson et al., 2016; Vandermeulen et al., 2017), except for some clusters of susceptibles interfering with measles elimination (e.g. measles outbreak linked to an antroposophic school (Braeye et al., 2013)). Nonetheless, an understanding of the individuals' "vaccination blackbox" is important to inform simulation models, and to guide policy-makers in case of spill-overs of vaccine hesitancy or refusals from other countries (Larson et al., 2016; Hanley et al., 2015; Peretti-Watel et al., 2013).

Flemish adults are familiar with vaccination decisions as well. More specifically, they are familiar with seasonal influenza vaccine (recommended for risk groups and elderly), booster doses for tetanus, diphtheria and acellular pertussis (Tdap) every 10 years (with additional recommendations for future parents) and travel vaccinations such as typhoid fever, yellow fever and hepatitis A. Pneumococcal and shingles vaccines are licensed for adults, though the uptake remains low. Tdap is offered for free and is available at the vaccinator, while others require a subscription or a visit to the pharmacy or travel clinic (Belgisch Centrum).

In this paper we explore determinants of Flemish individuals' decision-making on vaccination by means of a DCE. As such, the decision-making process is represented as a multi-criteria decision in which we can determine the importance individuals assign to each attribute. We discuss the relevance of our findings for modeling and vaccine policy-making.

2. Methods

We conducted a survey among Flemish-Dutch speaking Belgian inhabitants in February–March 2017, recruiting respondents from a registered consumer panel. Multiple techniques guaranteed a high-quality panel, such as consistency checks, mobile phone ID verification and the identification of 'straight-liners' (respondents answering the same for each question) and 'speeders' (respondents completing the survey much faster than a reference time). Only one respondent per household could take part. Participation was incentivized through credit rewards, transferable into coupons, airline miles, etc. No physical samples were collected and the ethical committee of the Antwerp University Hospital (UZA) approved the study protocol.

A representative sample was drawn in terms of gender, age group and province with Flemish-Dutch native speakers. Respondents filled out the survey for themselves or for their youngest child (< 18 years), which we distinguish as the 'adult' and 'child' group, respectively. Demographic and household info was used to include and assign panel members until the sample quota were reached (Table 2). In total, 1919 panel members completed the full survey through a web-link directing them to an online version of the questionnaire. We surveyed 1091 respondents in the adult group and 828 in the child group. The participation rate was 88% (in a multi-source, routed environment with efficient participant allocation), implying 12% of respondents started but chose not to complete the survey. Other respondents completed the full survey or were dropped out automatically, when pre-defined sample quota were reached.

2.1. DCE attributes

The construction of choice sets with vaccine profiles by means of attributes is a trade-off between completeness and cognitive feasibility. We retrieved relevant elements from the literature (Determann et al., 2014; Oteng et al., 2011; Bults et al., 2011; Luyten et al., 2015; Brunson, 2013; Funk et al., 2010; Brown et al., 2012), departing from systematic reviews (Verelst et al., 2016; Quadri-Sheriff et al., 2012) in order to make vaccine profiles and to match attributes to the parameterization of vaccine-decision models. Attributes were then ranked and categorized through a focus group discussion. Final selection and tuning of relevant attributes occurred through a pilot study with free-form feedback, followed by a soft launch in the study population with respondent feedback scoring. Feedback from the focus group and the pilot study resulted in a reduced number of attributes (from 8 to 6) and an adapted DCE design with only 10 choice sets (instead of 15) of two vaccine profiles. Feedback from the respondents of the soft launch confirmed feasibility of the DCE with an average score of 8.1/10 based on survey length and experience (survey company tool). The details of the attribute and attribute level selection are displayed in Fig. 1. Table 1 lists the final attributes and corresponding levels, the rationale of which can be summarized as follows:

1. Vaccine effectiveness is described as the proportion of vaccinated persons protected by the vaccine and has two levels: 50% and 90%. These levels were chosen to represent vaccines with moderate effectiveness, such as seasonal influenza vaccination (CDD, 2017; Kelly et al., 2009) and high effectiveness, such as hepatitis B (Szmuness et al., 1981) and measles (Sudfeld et al., 2010) vaccination.
2. Burden of disease is a combination of disease prevalence and severity. Both these sub attributes have two levels, implying four levels describe the burden of disease attribute: rare/common and mild/severe (see Table 1). Mild/severe disease is further specified as hospitalization occurring exceptional/often and being not life-threatening/life-threatening. We chose two extreme levels for both