

RESEARCH PAPER



## Legislative and administrative actions to increase vaccination coverage in Washington schools

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### ABSTRACT

Current outbreaks of vaccine-preventable diseases in the U.S. highlight the consequences of declining levels of vaccination coverage. Attempts to increase coverage by banning or restricting nonmedical exemptions from school-entry vaccination requirements disregard children not up to date on vaccination who already attend school and those who are not up to date for reasons other than vaccine hesitancy. We analyze the potential effects of legislative and administrative options to increase vaccination coverage in Washington schools. We constructed a grade-specific model of the detailed vaccination status for all required vaccines and the MMR vaccine specifically for all children in the state's school system. We used scenario modeling to evaluate the effects of potential legislative and administrative actions on the percent of students up to date on all required vaccines and the MMR vaccine from 2018 to 2030. Our analysis shows that eliminating nonmedical exemptions may not be the optimal solution for reducing disease outbreak risk. Instead, focusing on children not up to date for reasons other than nonmedical exemption could have a larger impact and does not carry the controversy that accompanies attempts to ban or restrict nonmedical exemptions. Further, implementing a one-time catch-up period for all children not up to date would increase coverage promptly. Evidence-based policymaking is an essential component of efforts to reduce the risk of disease outbreaks in U.S. schools, and analysis of potential legislative and administrative actions complement these efforts.

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### Introduction

Despite the safety and effectiveness of vaccines and the extraordinary contribution mass vaccination programs have made to the reduction of worldwide disease burden, vaccine hesitancy persists.<sup>1</sup> Although not a new phenomenon, vaccine hesitancy was recently identified by the World Health Organization as a top 10 threat to global health, drawing attention to the worldwide scale of this issue.<sup>2</sup> In the U.S., recent measles outbreaks in California, Minnesota, New York, Washington, and other states highlight the consequences of vaccine-preventable diseases being introduced into regions with low vaccination coverage. While, so far, these outbreaks have remained relatively modest, they appear to be increasing in size and frequency.<sup>3</sup>

The U.S. has no federal-level vaccination requirements; childhood vaccination is enforced via school-entry mandates, and each state has its own particular requirements.<sup>4</sup> All states offer exemptions from vaccine mandates for children having conditions that contraindicate vaccination (medical exemptions). Nearly all states offer grace periods for children to catch up on required vaccines after entering school (conditional or provisional entrants), although the grace periods' durations vary.<sup>5</sup> Until recently, nonmedical exemptions were available in all states except Mississippi and West Virginia. Nonmedical exemptions are those based on parents' personal,

philosophical, or religious beliefs. California banned nonmedical exemptions beginning in 2016, while Maine and New York passed legislation to ban nonmedical exemptions in 2019. In states with a nonmedical exemption option, the reasons for which they can be claimed and the administrative difficulty of obtaining one varies.

Administrative difficulty in obtaining nonmedical exemptions is associated with lower rates of exemptions and vaccine preventable diseases.<sup>6,7</sup> However, the effects of banning of nonmedical exemptions or tightening requirements need systematic evaluation, as they can have unintended consequences.<sup>8,9</sup> For example, consequences could include a reinforcement of anti-vaccination beliefs,<sup>10</sup> a backfire effect where undecided parents become refusers,<sup>8</sup> and a replacement effect where vaccine hesitant parents exploit alternate means or legislative loopholes to avoid vaccination.<sup>11</sup>

Somewhat lost in the public and policy debate over whether nonmedical exemptions should be banned or restricted are empirical estimates of the potential impacts of these actions on overall disease outbreak risk. Most actions or policies only address children entering kindergarten and have delayed or no implications for exempted children already attending school. Thus, even if a vaccine law or administrative policy immediately reduces exemptions for incoming kindergartners, there may be a substantial lag in its impact on vaccine coverage and disease

risk for all students without a “catch-up” period.<sup>12</sup> A catch-up period is when students who previously had exemptions must become up to date on required vaccinations under the new law or policy and are not “grandfathered” in. Furthermore, children with nonmedical exemptions are only a portion of un- or under-vaccinated children in schools, which also include students with medical exemptions and students who need additional time to become up to date on required vaccinations. Students who need additional time are called conditional or provisional entrants; in a number of states, conditional or provisional entrants outnumber those with nonmedical exemptions.<sup>13</sup>

We evaluated potential effects of recently enacted or proposed legislative and administrative actions intended to increase vaccination coverage. These include eliminating personal/philosophical belief exemptions, eliminating nonmedical exemptions, reducing conditional and out of compliance entrants, and reducing and the length of time conditional and out of compliance students spend in school before getting up to date on required vaccinations. Out of compliance students are those not up to date on vaccination, but without an exemption or meeting the conditional entry requirements. We evaluated possible responses to these actions given uncertainty in how vaccine hesitant parents might react in these situations.

We used Washington state as a quantitative case study. Washington experienced a measles outbreak in early 2019, which prompted a state of emergency declaration<sup>14</sup> and a new law eliminating personal/philosophical exemptions for the MMR vaccine (HB1638).<sup>15</sup> We used the percent of students in the entire school system up to date on all required vaccines, as well as the MMR vaccine specifically, as outcome measures. Our analysis provides a quantitative assessment of vaccination legislative and administrative actions under consideration throughout numerous states across the U.S. and supports evidence-based policymaking intended to increase vaccine coverage and reduce potential outbreak risk.

## Materials and methods

### Data

We gathered publicly-available yearly vaccination and enrollment data for Washington kindergartners, sixth graders, and all students for 2013–2017, as well as a summary data table containing vaccination and enrollment data for years before 2013.<sup>16</sup> School years, which span calendar years, are referred to as the year they begin, e.g., 2013 corresponds to the 2013–14 school year. Students entering kindergarten or sixth grade with all required vaccinations are categorized as up to date. In Washington, not up to date students are categorized as having an exemption for medical, personal/philosophical, religious, or religious membership reasons, as a conditional entrant, or as out of compliance; each category has varying requirements (Table 1).

We constructed a grade-specific model of the detailed vaccination status for all required vaccines and the MMR vaccine specifically for all children in Washington’s school system in 2017.<sup>12</sup> This model allowed us to estimate the effects of potential actions in future years using a realistic representation of the

**Table 1.** Categories of students not up to date on required vaccinations in Washington and their requirements.

Name	Requirement
Medical exemption	1. Signed statement from a health care practitioner (in his or her judgment) that a vaccine is not advisable 2. Signed statement from a health care practitioner confirming education of risks/benefits of vaccination
Personal/philosophical exemption	Signed statement from a health care practitioner confirming education of risks/benefits of vaccination
Religious belief exemption	Signed statement from a health care practitioner confirming education of risks/benefits of vaccination
Religious membership exemption	Demonstrated membership in religious body or church that precludes medical treatment for child
Conditional	Child must start, or continue, getting missed immunizations within 30 days after first day of attendance (unless inconsistent with immunization schedule) or within 30 days of recommended intervals in a vaccine series
Out of Compliance	Not complete, without an exemption, and does not meet conditional requirements (and subject to exclusion from school)

students in the school system and their vaccination status. To accomplish this, we advanced students through grades each year (e.g., kindergartners in 2016 became first graders in 2017). A graphic depiction of the data used to construct the initial grade-specific model for students enrolled and the number of students with exemptions in 2017, as well as future years, is provided in Supplementary Figure 1. For kindergarten enrollment after 2017, the number of students was estimated using the average kindergarten enrollment from 2013 to 2017. For conditional and out of compliance entrants, because there is an additional vaccine requirement at sixth grade, we used 5-year averages for both kindergarten and sixth grade entry in 2018 (Supplementary Figure 2). Because the earliest possible implementation of a policy or administrative action would be 2019, all scenarios used a 5-year average (2013–2017) of the proportion of students in each not up to date category to estimate the number of incoming kindergartners in each category in 2018. The full calculations are provided in Supplementary Data File 1.

### Scenario modeling

We used scenario modeling to evaluate the effects of various legislative and administrative actions on vaccination coverage. Scenario 1 assumes no change and serves as the reference, Scenarios 2–6 are legislative actions eliminating some or all nonmedical exemptions, and Scenarios 7–10 are administrative actions that target conditional and out of compliance students. The scenarios are based on other states’ recent legislative and administrative actions and both observed and potential population reactions to these actions (summarized in Table 2). The actions include SB277 in California, the law banning nonmedical exemptions, and efforts in California and Pennsylvania to reduce the proportion of students entering with a conditional status. We assumed that all actions would begin in 2019.

### Legislative and administrative scenarios

**Scenario 1. No change.** This scenario assumes no policy or administrative actions are taken and the vaccination status of students already in the school system and those entering kindergarten and sixth grade will not change (from their

**Table 2.** Scenarios of potential policy and administrative actions and population compliance.

Scenario	Exemptions					Other		
	ME	PE	RE	RME	Catch-up	Cond	OOC	Catch-up
1. No change					No			No
2. Eliminate only personal/philosophical exemptions (full compliance)		Eliminate			No			No
3. Eliminate all nonmedical exemptions (full compliance)		Eliminate	Eliminate	Eliminate	No			No
4. Eliminate all nonmedical exemptions (full compliance with catch up)		Eliminate	Eliminate	Eliminate	Yes			No
5. Eliminate all nonmedical exemptions (increase in medical exemptions)	Increase	Eliminate	Eliminate	Eliminate	No			No
6. Eliminate all nonmedical exemptions (large increase in medical exemptions)	Increase	Eliminate	Eliminate	Eliminate	No			No
7. Reduce conditional and out of compliance students entering kindergarten and sixth grade					No	Decrease	Decrease	No
8. Reduce conditional and out of compliance students entering kindergarten and sixth grade with increase in nonmedical exemptions		Increase	Increase	Increase	No	Decrease	Decrease	No
9. Ensure conditional and out of compliance students are up to date within one year					No			Yes
10. Reduce conditional and out of compliance students entering kindergarten and sixth grade and ensure they are up to date within one year					No	Decrease	Decrease	Yes

Exemptions: medical (ME), personal/philosophical (PE), religious (RE), religious membership (RME). Other: conditional (Cond), out of compliance (OOC). For Exemptions, Catch-up means all nonmedical exemptions (for all students) are rendered invalid in the first year of implementation. For Other, Catch-up means that all students entering kindergarten or sixth grade with conditional or out of compliance status become up to date by the following school year and a single year when all students with conditional or out of compliance status become up to date by the following school year (regardless of grade). Blank cells represent no change.

5-year average values). Under HB1638 in Washington, parents who previously claimed a personal/philosophical exemption for the MMR vaccine (or would have claimed one in future years) can simply choose a “religious” exemption instead; thus, this scenario also serves as a potential outcome of HB1638 for MMR vaccination rates.

**Scenario 2. Eliminate only personal/philosophical exemptions (full compliance).** This scenario assumes that personal/philosophical exemptions would be banned for students entering kindergarten and sixth grade. Personal/philosophical exemptions for students who entered school before 2019 would remain valid until the students reached sixth grade or graduated. We assumed the percent of children in all other not up to date categories entering kindergarten or sixth grade would not change (full population compliance). This scenario represents the idealized effect of eliminating personal/philosophical exemptions for kindergartners and sixth graders without a catch-up period.

**Scenario 3. Eliminate all nonmedical exemptions (full compliance).** This scenario is the same as #2, but also includes bans on religious and religious membership exemptions, making the approach similar to SB277 in California, but with full population compliance. This scenario represents the idealized effect of eliminating all nonmedical exemptions for kindergartners and sixth graders without a catch-up period, as there would be no replacement effect (parents finding other means to avoid vaccination).

**Scenario 4. Eliminate all nonmedical exemptions (full compliance with catch-up).** This scenario is the same as #3 but includes a catch-up period; nonmedical exemptions would not be valid for any student (regardless of grade) beginning in 2019. Hence, this scenario represents the idealized effect of immediately eliminating all nonmedical exemptions for all students in the school system. For the MMR vaccine, this scenario is the idealized effect of HB1638, as no parents would claim religious exemptions or find alternate means to avoid vaccination.

**Scenario 5. Eliminate all nonmedical exemptions (increase in medical exemptions).** This scenario is the same as #3 but includes an increase in medical exemptions based on observed data from California after banning nonmedical exemptions (increase of 0.34% in year 1 and an additional 0.22% in year 2 for kindergartners, and increase of 0.27% in year 1 and an additional 0.01% in year 2 for sixth graders).<sup>17</sup> For medical exemptions for any vaccine for kindergartners, we assumed an increase of 0.25% (to 1.25%) in 2019, an additional increase of 0.25% (to 1.5%) in 2020, and no further increases after 2020 for kindergartners. For sixth graders, we assumed an increase of 0.25% (to 1.19%) in 2019 and no further increases. To mirror the percent of medical exemptions specifically for the MMR vaccine, for the MMR scenario, the increases were 0.15% in year 1 and 2 (to 0.77% and 0.92% respectively) for kindergartners and 0.15% in year 1 (to 0.61%) for sixth graders. This scenario represents an expected outcome similar to that observed in California after eliminating nonmedical exemptions.

**Scenario 6. Eliminate all nonmedical exemptions (large increase in medical exemptions).** Washington already has a relatively permissive medical exemption requirement,<sup>18</sup> which could lead to larger increases in medical exemptions than those observed in California after SB277 if nonmedical exemptions were eliminated without a corresponding change in the difficulty of obtaining a medical exemption. Thus, this scenario is the same as #5 but assumes that medical exemptions double in 2019 for kindergartners (from 1% to 2%) and sixth graders (0.94% to 1.87%), and then remain steady at the 2019 level afterward. For medical exemptions to the MMR vaccine, we assume the same (0.62% to 1.24% for kindergartners and 0.46% to 0.92% for sixth graders). As such, this scenario represents a potential outcome of eliminating nonmedical exemptions in a permissive environment for medical exemptions.

**Scenario 7. Reduce conditional and out of compliance students entering kindergarten and sixth grade.** This scenario assumes a successful administrative effort to reduce the number

of conditional or out of compliance students entering kindergarten and sixth grade, which could include education or advocacy efforts to ensure parents understand school entry vaccine requirements and have the resources to actualize them for their children. This scenario is based on results from efforts to reduce conditional entrants in California (for kindergartners, a 35% relative reduction in year 1 and 37% relative reduction in year 2) and Pennsylvania (for kindergartners and seventh graders, a 77% relative reduction in year 1).<sup>17,19</sup> We assumed a relatively modest decrease in the percent of conditional and out of compliance students entering kindergarten and sixth grade in Washington: a 33% relative decrease in 2019 and an additional 33% relative decrease in 2020 (remaining steady after 2020). We assumed no change in the percent of conditional and out of compliance students that become up to date each year. A recent US analysis showed that the large majority of children who are undervaccinated at school entry were *not* undervaccinated because of parental vaccine hesitancy or having a contraindication.<sup>20</sup> Evidence from California's effort does not suggest it led to increases in nonmedical exemptions. Thus, we assumed that conditional or out of compliance entrance was not due to contraindications or parental vaccine hesitancy and the percent of incoming kindergartners with any type of exemption would not change. This scenario represents the idealized effect of an administrative (and public health) effort that would not require legislation banning nonmedical exemptions.

**Scenario 8. Reduce conditional and out of compliance students entering kindergarten and sixth grade with increase in nonmedical exemptions.** This scenario is the same as #7 but assumed that some conditional or out of compliance entrants were due to vaccine hesitancy. In Pennsylvania, the 77% relative reduction in conditional entrants led to a 20% relative increase in nonmedical exemptions in year 1. To emulate this increase over two years, we included a 10% (relative) increase in nonmedical exemptions for kindergartners and sixth graders in 2019 and an additional 10% (relative) increase in 2020 (no change after 2020). As such, this scenario represents the effect of an administrative (and public health) effort that revealed additional vaccine hesitancy within the population.

**Scenario 9. Ensure conditional and out of compliance students are up to date within one year.** The data from Washington reveals that a large percent of conditional and out of compliance entrants do not become up to date in a timely manner. Thus, this scenario assumes a successful school-based administrative effort to ensure that all conditional or out of compliance students entering kindergarten or sixth grade become up to date within one year. It also includes a catch-up period in 2019, wherein any conditional or out of compliance student (regardless of grade) becomes up to date by 2020. This scenario is essentially the same as #1 except that all kindergarten and sixth graders entering with conditional and out of compliance status in 2019 or later become up to date by the next year and includes the one-time catch-up period for the entire school system. This scenario represents the idealized effect of an administrative effort to ensure conditional and out of compliance entrants quickly become up to date and would not require legislation.

**Scenario 10. Reduce conditional and out of compliance students entering kindergarten and sixth grade and ensure they are up to date within one year.** This scenario is a combination of #7 and #9 (implemented simultaneously), thus represents the idealized effect of reducing conditional and out of compliance entrants and ensuring they become up to date quickly.

### Implementation of scenarios

Estimating the potential effects of the actions required reconstructing the grade-specific model of the vaccination status of the entire school system in future years for each scenario using its specific assumptions for future outcomes. For scenarios assuming no future change in one or more categories of students not up to date on vaccination, we used a 5-year average to estimate values after 2017. For future scenarios assuming increases or decreases in one or more categories of students not up to date on vaccination, we used deviations from the 5-year average.

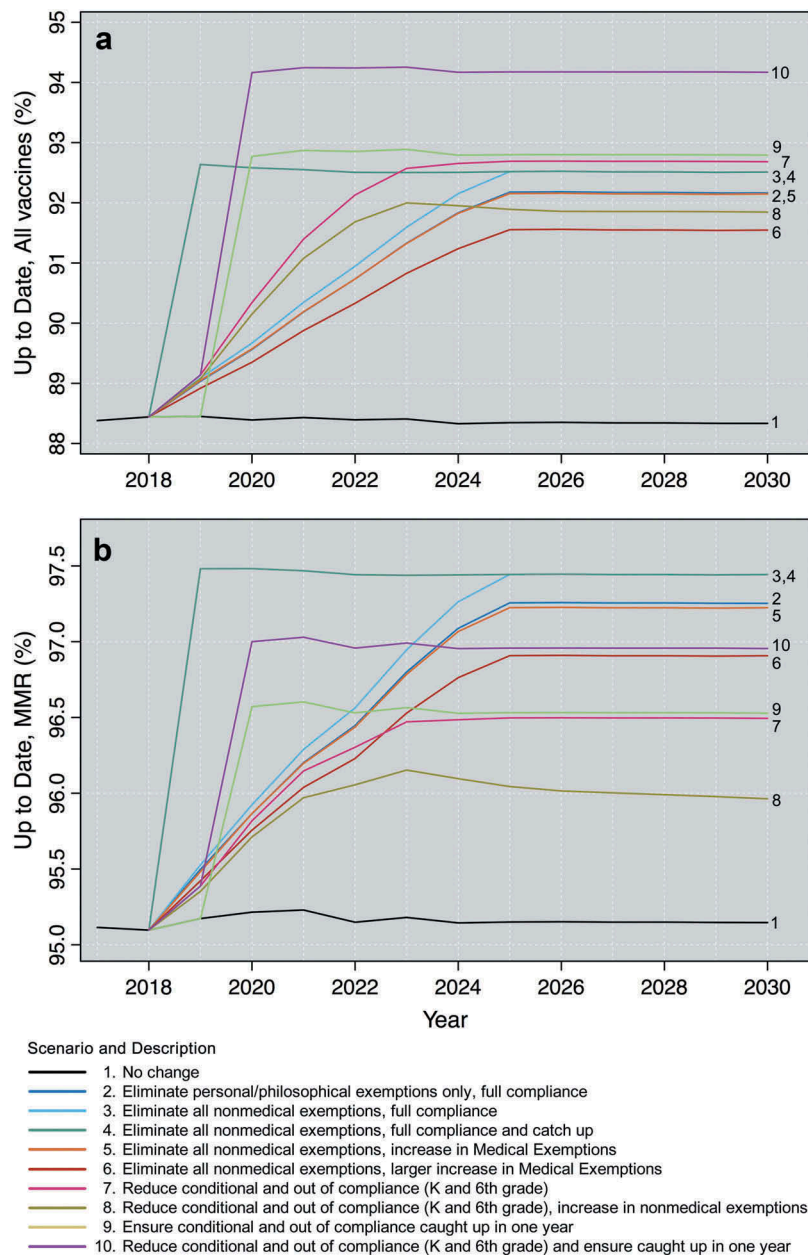
## Results

### Up to date on all vaccinations

The percent of students in Washington's school system up to date on all vaccinations are presented in Figure 1(a) for all scenarios, demonstrating that all potential actions would produce an appreciable increase in coverage compared to Scenario 1, the no change scenario (absolute increases between 3.21% and 5.83%). The percent of students in each not up to date category for all scenarios is presented in Supplementary Figure 3. Eliminating all nonmedical exemptions via legislation (Scenarios 3 and 4) would increase the percent of all students up to date by 4.18%, whereas eliminating only personal/philosophical exemptions (Scenario 2) would lead to a 3.83% increase. Scenarios 5 and 6 demonstrate how the benefits of eliminating all nonmedical exemptions could be mitigated by corresponding increases in medical exemptions (−0.37% and −0.97% relative to Scenario 3, respectively). Scenarios 7, 9, and 10, the administrative actions aimed at reducing conditional and out of compliance entrants and ensuring students entering under these statuses are up to date within one year, have the largest potential impact on the percent of all students up to date, with increases of 4.35%, 4.46%, and 5.83% (7, 9, and 10, respectively). Scenario 8 shows how the impact could be mitigated by increases in nonmedical exemptions (−0.84% relative to scenario 7). Implementing a catch-up period would increase coverage in a shorter time. For eliminating nonmedical exemptions, implementing an immediate catch-up period (Scenario 4) would produce similar results six years earlier than an action without one (Scenario 3). Catching up all conditional and out of compliance students within one year of entry (Scenarios 9 and 10) would dramatically increase coverage by 2020, five years earlier than a similar action without a catch-up period (Scenario 7).

### Up to date on MMR vaccination

The impacts of the potential actions on students up to date on the MMR vaccine are presented in Figure 1(b). For all scenarios, the percent of students in each not up to date category for MMR is presented in Supplementary Figure 4. Eliminating all



**Figure 1.** The percent of all students up to date on all vaccines (a) and on the MMR (b) vaccine for all students in the Washington school system under the potential legislative and administrative action scenarios.

nonmedical exemptions (Scenarios 3 and 4) would improve MMR coverage by 2.3% with full population compliance, but would be reduced to increases of 2.08% and 1.76% with small (Scenario 5) and larger (Scenario 6) increases in medical exemptions for MMR, respectively. Eliminating only personal/philosophical exemptions (Scenario 2) would lead to a 2.11% increase in MMR coverage. The administrative actions aimed at reducing conditional and out of compliance entrants and ensuring these students are caught up within one year would be slightly less effective than eliminating all nonmedical exemptions or only personal/philosophical exemptions, as the percent of students up to date would increase by 1.35% (Scenario 7), 1.38% (scenario 9), and 1.81% (Scenario 10). If additional vaccine hesitancy was

uncovered via efforts to reduce conditional and out of compliance students, there would be a diminished effect (Scenario 8). Implementation of a catch-up period has similar temporal effects for MMR coverage as observed for all vaccines.

## Discussion

In Washington, successful future actions aimed at reducing conditional and out of compliance entrants and ensuring these students become up to date quickly after entrance would likely have a larger overall impact on the percent of students up to date on all vaccinations than legislation banning some or all nonmedical exemptions, especially without a corresponding action to tighten the medical exemption requirements. As such, the administrative actions would likely reduce the risk of a future vaccine-

preventable disease outbreak to a greater degree. The results of the actions on MMR coverage differ from those for all vaccines because many students entering school with exemptions or having a conditional or out of compliance status in Washington are up to date on MMR but not on one or more of the other required vaccines. For MMR coverage, banning some or all nonmedical exemptions would have a larger overall impact than the administrative actions aimed at reducing conditional and out of compliance students; however, the differences among the actions on statewide MMR coverage are quite small and may not appreciably affect the risk of a future measles outbreak.

The future impacts of HB1638 in Washington are difficult to predict. Because there is no additional burden for vaccine hesitant parents to simply switch their personal/philosophical exemption to a religious exemption, the law could have little to no effect on MMR coverage in the state. Future examination of how parents react to the new law and its effect on outbreak risk is paramount for other states considering similar actions.

Our analysis demonstrates why states considering measures to increase vaccine coverage should evaluate the current composition of all not up to date students in their entire school system. Potential actions that only address students entering specific “checkpoint” grades will require additional time to reduce disease outbreak risk, thus states should also strongly consider the benefits of implementing a one-time catch-up period for all students when considering potential actions. This option is especially salient for states having a large number of students with nonmedical exemptions already in their school system, a high number of yearly conditional or out of compliance entrants, or difficulties ensuring conditional or out of compliance students become up to date in a timely manner. In Washington, potential actions that include a statewide catch-up period would lead to immediate increases in students up to date on all vaccines and the MMR vaccine, whereas those without this approach would require an additional 5–6 years to reach similar coverage levels. Implementing a catch-up period may be challenging from an administrative perspective, as bringing all conditional and out of compliance students up to date would require a large effort that could substantially burden schools’ resources. However, the near-immediate increase in coverage and corresponding reduction in outbreak risk may be enough to render those concerns mute.

Professional medical associations have called for the elimination of nonmedical exemptions<sup>21</sup> and the former U.S. Food and Drug Administration Commissioner Scott Gottlieb suggested that the federal government may take some form of action to reduce nonmedical exemptions.<sup>22</sup> While bills targeting the availability of nonmedical exemptions appear to be one of policymakers’ *de facto* reactions to disease outbreaks, they often face strong objections from people opposed to vaccination as well as those opposed to government mandates in general; furthermore, these bills are rarely successful.<sup>8,23,24</sup> Although California successfully banned nonmedical exemptions in 2015, vaccine hesitant parents appear to have found alternate means to avoid vaccinating their children nonetheless.<sup>11,12</sup> Our analysis suggests that actions targeting children without vaccine hesitant parents, such as those focusing on conditional or out of compliance entrants, would have a large impact on reducing disease outbreak risk without inducing the disputes and attention that accompany legislative efforts to ban

nonmedical exemptions. Moreover, instituting a one-time catch-up period would contribute to early reduction of outbreak risk.

This analysis has limitations. Although we included ten potential scenarios, these represent a small fraction of the potential future actions and the population’s reactions to them; we did attempt to capture a broad range of outcomes in our scenarios for illustrative purposes. Our approach also requires assumptions about future behaviors, which affect our resulting estimates of vaccination coverage. Although we used data to support our models, all future predictions are limited in this manner. Finally, the analysis is also limited by the data made available for Washington, which required estimating the grade-specific number of children in each not up to date category and the number of children not up to date for the MMR vaccination by category.

A large majority of un- or under-vaccinated children entering school in the U.S. do not have vaccine hesitant parents or a -contraindication,<sup>20</sup> and the percent of students up to date, the appropriate metric for characterizing outbreak risk, is not associated with nonmedical exemption percent at the state level.<sup>5</sup> As such, efforts to reduce the risk of vaccine-preventable diseases in U.S. schools should consider the state’s overall composition of students not up to date on vaccination, not just students with nonmedical exemptions. Furthermore, as appropriate for their particular composition, states should assess the numerous options at their disposal, which could include both legislative and administrative actions.

Reducing the risk of vaccine-preventable disease outbreaks in the U.S. will require the combined efforts of medical professionals, public health officials, policymakers, researchers, social media platforms, and parents (among many others). Evidence-based policymaking should be an essential component of these initiatives, and the evaluation of potential legislative and administrative options as performed in this analysis can complement these efforts.

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No potential conflicts of interest were disclosed.

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