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Using Nonpharmaceutical Interventions to Prevent Influenza Transmission in Elementary School Children: Parent and Teacher Perspectives

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Abstract

Objectives: Schools act as “amplifying sites” for the spread of infectious diseases, outbreaks, and pandemics. This project assessed which nonpharmaceutical interventions (NPIs) are most acceptable to parents and teachers of school children in grades K-5 to K-8 in Pittsburgh public schools.

Methods: During the spring of 2007, the Pittsburgh Influenza Prevention Project surveyed 134 teachers and 151 parents representing nine elementary schools regarding attitudes toward NPIs and their usage by adults and school children during seasonal influenza outbreaks.

Results: General etiquette practices such as covering coughs, handwashing, and using hand sanitizer were highly acceptable to both groups, while masks and gloves were not.

Conclusions: The success of an NPI or a set of NPIs depends on both its efficacy and the feasibility of implementing it with relevant populations. If masks, gloves, and other more intrusive NPIs are to be used in community settings during a severe influenza season or pandemic, it is clear that there is significant preparatory work needed to increase acceptability on the part of the adults. Without such acceptance, it is highly unlikely that children and their supervising adults will participate.

Nonpharmaceutical interventions (NPIs) are an essential intervention. Medical and nonmedical experts agree that should a pandemic occur, there is essentially no possibility that adequate doses of effective vaccine and medication will be available in the community.[1] The possibility of vaccine failure in the face of genetic drift and shift is very real.[2] Consequently, NPIs may be the best (or only) tools available. Markel et al summarized city-to-city variations in US mortality during the 1918–1919 influenza pandemic and demonstrated a strong association between early, sustained, and layered application of NPIs and reductions in total mortality, peak mortality, and greater delays in reaching peak mortality.[3] In 2007, Jefferson et al scanned over 2 300 titles in the Cochrane Register. The authors noted that the hygienic measures suggested by the highest-quality trials in younger children were most effective at preventing the spread of viral respiratory diseases and that "many simple and probably low-cost interventions would be useful for reducing the transmission of epidemic respiratory viruses."[4(p2)]

NPIs may be defined either by desired effect or by which population is targeted. The former category is summarized by the World Health Organization as measures to

* reduce risk that cases transmit infection,
* reduce risk that contacts transmit infection,
* increase social distance,
* decrease interval between symptom onset and patient isolation,
* increase use of disinfection measures, and
* improve screening of persons entering or exiting an infected area within a country.[5]

The latter may be summarized as international measures, community mitigation strategies, and personal protective measures. More specifically, NPIs may include providing information to the public and relevant population subgroups; voluntary home isolation of ill persons and home quarantine of contacts; closure of schools or cancellation of mass gatherings; measures to be taken in group living facilities, such as college dormitories; workplace policies that require all symptomatic employees to stay home; protective sequestration of communities to delay or limit introduction of a pandemic strain; identification of high-transmission nodes (eg, schools, workplaces, or buildings where increased rates of human-to-human transmission may occur); respiratory hygiene/cough etiquette; hand hygiene; and/or use of masks by the public.[6]

The Centers for Disease Control and Prevention (CDC) has posited that the best method of using NPIs is a multilayered application of partially effective interventions, as opposed to relying on any one process or activity. In February 2007, the CDC released the "Community Strategy for Pandemic Influenza Mitigation,"[7] focusing on the challenge of how to address an epidemic for which vaccine would most likely not be available and antiviral medication could either be ineffective or not available on a population-wide scale. The community strategy focused on four areas—isolation of the sick, quarantine of the exposed, social distancing of children, and social distancing of adults. Included as a "given" for any of these strategies are the universal recommendation for cough etiquette and hand hygiene and the use of surgical masks and respirators in appropriate settings. However, the CDC also notes that "the effectiveness of individual infection control measures (e.g., cough etiquette, hand hygiene) and the role of surgical masks or respirators in preventing the transmission of influenza are currently unknown."[7]

In 2007, the Association of Territorial Health Officers published "The Public Engagement Project on Community Control Measures for Pandemic Influenza," a multicity effort designed to engage the public in discussions and deliberations about the economic and social trade-offs associated with community control measures to slow down the spread of the disease.[8] Using small group discussions, overall support for NPIs was quite high, with 64 to 70 percent of adults supporting the use of all NPIs discussed. However, application

and acceptability of cough etiquette, hand hygiene, and mask use were not addressed, despite CDC's statement that these would be "universally recommended" and, hopefully, "universally applied."

Understanding the acceptability of a range of NPIs is of critical importance, given that a highly effective behavioral intervention is of little use if those who need it fail to use it. This topic is both relevant and important for two reasons. First, there is often a significant disconnect between "policy from the top" and what can be practically achieved in a given environment. Second, there is a paucity of research on the attitudes of teachers and parents in public elementary school settings. An exhaustive search of the literature including PubMed, Ovid Health & Psychosocial Instruments, Ovid's MEDLINE, and Scopus yielded only two articles looking at combinations of interventions in a community setting. Sherriff and colleagues 9 looked at the actual use of multilayered sanitary practices with children, but not their acceptability. Kristiansen et al 10 looked at multilayer interventions for flu, but in a very simplified way (using just one question), and also addressed to a population of adult Norwegians, not Americans.

Schools are of special interest given their central role in community spread of disease. Glezen wrote that school-age children "invariably have the highest attack rates during both pandemic and interpandemic periods"11(p72) and children are thought to play a significant role in transmitting influenza virus into and within their households.12,13 The net result is that schools are potent "amplifying sites" for influenza and possibly other pandemic viruses. This is supported by historical data from the 1918–1919 and 1957 pandemics as well.14

Methods

The Pittsburgh Influenza Prevention Project (PIPP) is a prospective, controlled, randomized trial of the effectiveness of NPIs in controlling influenza and related illnesses. It is one of the eight studies funded by the US CDC to prepare for control of pandemic influenza. The PIPP focuses on the practical aspects of implementing NPIs to prevent transmission of influenza in schools, between schools and homes, and within homes.*

The surveys described in this article were undertaken during the spring of 2007 as part of the pilot year of the PIPP and were designed to assess acceptability of NPIs in both the school and the home settings. Survey questions were designed by the project researchers on the basis of specific recommendations and areas of needed research outlined in CDC's Community Strategy. The context provided to respondents was seasonal influenza, not the imminent onset of a severe pandemic. This was done for two reasons. First, because the study authors were most interested in the knowledge, attitudes, and beliefs of teachers and parents in the current environment. Second, because the information obtained was utilized in designing the intervention for the second year of the overall study, which was to prevent and test for seasonal influenza, and thus had to be appropriate for that setting. All research protocols were approved by the University of Pittsburgh Institutional Review Board (#REN08060022/PRO07060250).

NPIs included those used personally both by adults and by elementary school–age children (for which adult supervision and guidance are critically important). NPIs included behaviors that can be characterized as common (eg, handwashing) to those that would be unusual (eg, wearing a mask at school or at home) in the current social environment. The survey responses were used to determine which individual NPI or sets of NPIs were most acceptable to adults in the two indicated settings, and the results were utilized as part of the second and subsequent years of the PIPP as part of the active intervention.13

The demographics of both the teacher survey and the parent survey schools were similar. The six schools included in both surveys had an average size of 375, a racial distribution (black/white/other) of 66/25/8 percent, and 72 percent of students participating in the subsidized lunch program. The three additional schools included in the parent survey had similar demographic characteristics.

Teacher survey

Participants

All 274 teachers from six K-5 and K-8 schools in the public school system in Pittsburgh, Pennsylvania, were invited to complete the survey through invitations left in their mailboxes accompanying the blank survey, which they returned to their principal after completion. Of these, 137 (50%) returned a completed survey (ranging from 37% to 70% by school). Three teachers neglected to answer one or more of the NPI questions, leaving a sample of 134 respondents. Each teacher was given a $5 gift card as an incentive for returning a completed survey.

Measures

The survey asked teachers 11 questions related to the acceptability of a broad array of NPI practices in the school setting. For 10 of these practices, teachers were asked whether they thought that teachers and staff members at their school would be willing to

implement each action, such as personally using a hand sanitizer, insisting that students cover their sneezes and coughs, and wearing a mask. In addition, teachers were asked whether they thought students would be willing to wear a mask (Table 1). The response mode was a 5-point scale, as follows: 1, *Can't or won't do this*; 2, *Probably wouldn't do this to prevent flu*; 3, *Might do this to prevent flu*; 4, *Would do this to prevent flu*; and 5, *Do this usually, regardless of flu*.

Questions	Median	Mean (SD)	Post hoc groupings
Willing to send a sick child home?	5	4.60 (0.91)$_{a}$	
Willing to wash their hands 2 to 4 times a day?	5	4.15 (0.75)$_{a}$	
Insist that students cover sneezes and coughs?	5	4.13 (0.81)$_{ab}$	
Willing to use a hand sanitizer?	4	3.65 (0.90)$_{abc}$	
Willing to teach about practices to prevent flu?	4	3.47 (0.95)$_{abcd}$	
Implement a procedure for cleaning and sanitizing desks, tables, and other shared surfaces daily?	3	2.94 (0.97)$_{abcd}$	
Willing to screen students for influenza like illness (fever plus cough, or sore throat)?	3	2.62 (1.13)$_{bcd}$	
Would the teachers and staff in your school wear a mask to cover the mouth and nose?	2	2.37 (0.89)$_{cd}$	
Willing to perform a simple test (such as a nasal swab for rapid flu testing) to determine if a student has the flu?	3	2.29 (1.06)$_{cd}$	
Would the students in your school wear a mask to cover the mouth and nose?	2	2.01 (0.89)$_{d}$	
Willing to take temperatures of students daily?	2	1.65 (1.10)$_{d}$	

[a]Means and differences reflect estimated marginal means from the analysis controlling for school effects, with significance levels of differences between particular NPIs noted by different subscripts. Items with means that share the same subscript are not significantly different from one another at the $p < .05$ level.

TABLE 1 Distribution of responses from teacher surveys (N = 134) from most to least acceptable[a]

Analyses

A within-subjects analysis of variance (ANOVA) was conducted using the 11 different NPIs as a repeated measure to determine whether there were differences in how strongly the different NPIs were endorsed. Dummy variables were included for each school (using the school with the most observations, 29, as the comparison group). Post hoc pairwise comparisons were conducted to determine whether some NPIs were endorsed significantly more strongly than others, using the Bonferroni correction to control for type I error.

Parent survey

Participants

One hundred fifty-six parents from nine urban K-5 and K-8 schools in the Pittsburgh Public School system were contacted through school parent-teacher-organization meetings. These parents were eager to share their opinions, and all parents approached at these meetings agreed to participate. Five parents neglected to answer one or more of the NPI questions, leaving a sample of 151 respondents. Each parent was given a $5 gift card as an incentive for returning a completed survey.

Measures

The survey questions asked parents 13 questions about their own flu-prevention behaviors at home and with their children, representing a broad range of NPI practices. Parents were asked to what degree they engaged in each behavior, such as keeping their child at home when sick, wearing gloves when tending to sick family members, and using hand sanitizer (Table 2). The same response scale as stated above was used.

Questions	Median	Mean (SD)	Post hoc groupings
Do you insist that your entire family cover sneezes and coughs?	5	4.23 (1.14)$_a$	
Do you check your child and other family members for signs of the flu when they are sick?	4	3.91 (1.17)$_{ab}$	
Do you insist that family members not share eating and drinking utensils?	4	3.89 (1.30)$_{ab}$	
How likely are you to keep your child home when the child is sick?	4	3.89 (1.21)$_{ab}$	
Do you clean kitchen counters, door knobs, and other commonly touched surfaces daily?	4	3.81 (1.32)$_b$	
Do you use a hand sanitizer daily?	4	3.69 (1.24)$_b$	
How likely are you to stay home with a sick family member who has the flu?	4	3.69 (1.21)$_b$	
How likely are you to stay home when you're sick?	3	3.20 (1.33)$_c$	
Do you keep family members, who are sick with the flu, separated from others in the home?	3	3.13 (1.29)$_{cd}$	
How likely are you to keep all the family at home when one or more people have the flu?	3	3.07 (1.47)$_{cd}$	
How likely are you to call a hot line if you suspect that your child is sick with the flu?	3	2.93 (1.28)$_{cd}$	
How likely are you to wear gloves when caring for a sick family member?	2	2.65 (1.34)$_{de}$	
How likely are you to wear a mask to cover your mouth and nose?	2	2.47 (1.24)$_e$	

[a]Means and differences reflect estimated marginal means from the analysis controlling for school effects, with significance levels of differences between particular NPIs noted by different subscripts. Items with means that share the same subscript are not significantly different from one another at the $p < .05$ level.

TABLE 2 Distribution of responses from parent surveys (N = 151) from most to least acceptable[a]

Analyses

A similar ANOVA analysis as described above was conducted using the 13 different NPIs as a repeated measure. Dummy variables were included for each school with 10 or more observations (using the nine observations combined from three relatively less represented schools as the comparison group) to control for effects of school. Post hoc pairwise comparisons were conducted again using the Bonferroni correction.

Results

Teacher survey

The ANOVA revealed a main effect of the repeated measure (see Table 1), suggesting that some NPIs were seen as more acceptable than others, $F_{10,119} = 4.61$, $P < .001$. Two of the five school dummy variables emerged as significant in the analysis at the $P < .01$ level, both of which also emerged as school-by-NPI interaction. For both schools, this interaction represented differential willingness across schools to taking students' temperatures and performing simple tests such as nasal swabs. This difference did not reflect differences in students' socioeconomic status, racial diversity, or school size.

Respondents were most confident that teachers and staff at their school would be willing to send a sick child home, wash their hands four to four times per day, and insist that students cover their sneezes and coughs. Moderate confidence was indicated for using hand sanitizer, teaching about influenza, and making environmental sanitation efforts. Less confidence was indicated for symptom screening of students. Teachers expressed lowest confidence for activities furthest from their usual behavior, especially willingness to wear masks on the part of either their fellow teachers or students and, in some schools, willingness to take temperatures and perform nasal swab tests.

Parent survey

The ANOVA again revealed a main effect of the repeated measure (see Table 2), suggesting again that some NPIs were seen as more acceptable than others, $F_{12,133} = 3.17$, $P < .001$. Two of the six school dummy variables emerged as significant in the analysis at the $P < .01$ level and one school-by-NPI interaction emerged representing a slightly flatter line for this school compared with other schools. However, the overall pattern remained the same and the results reported here control from these effects of school location.

Overall, respondents were most confident in their ability to insist that their family cover sneezes and coughs. Moderate confidence was indicated for monitoring family members for flu symptoms, preventing sharing of utensils, keeping their child at home when sick, cleaning common surfaces daily, using hand sanitizer daily, and staying at home with sick family members. Parents expressed less confidence about staying home when sick themselves, keeping sick family members separated, keeping the whole family home when one was sick, or calling a hotline when a family member was sick. Parents expressed least interest in using gloves or wearing a mask when caring for sick family members.

Conclusions and Discussion

These results show that the level of acceptability of NPIs varies across a wide range. General etiquette practices such as covering one's cough, washing hands, and keeping sick kids at home were highly acceptable to both parents and teachers. On the other end of the continuum, barrier methods such as use of masks and gloves were generally seen as unacceptable by both groups in the context of seasonal influenza. One interesting finding was that use of hand sanitizer was considered highly acceptable by both teachers and

parents. This likely represents a change over the last few years, as hand sanitizers have become more commonly utilized in home, work, and school settings.15

These findings indicate that behavioral interventions that are generally perceived as more intrusive and/or different from typical day-to-day behavior will encounter more resistance from the population. Parents are not engaging in these practices, and teachers do not think it would be very feasible to get their colleagues or students to do so. Simple etiquette behaviors may be easier to target, as they are perceived as normal (by parents) and acceptable (by teachers).

The moderately acceptable NPIs such as early screening or isolating exposed family members may be good targets for implementation, so long as teachers and parents are adequately trained in their importance and/or usefulness. For adults, there is often a real or perceived financial or social disincentive to stay at home when sick with an infectious disease, in spite of the risk to coworkers. There is often a similar disincentive to staying at home with a child who is not "very" ill when the alternative—dosing the child with medication and sending him or her to school--may allow a parent to maintain their regular work schedule.

Both teachers and parents could be given the tools to better screen children for signs of influenza and related diseases, potentially keeping them out of school before they become highly symptomatic or at least reducing the number of classmates who are exposed to their illness. Targeting these interventions may result in more people engaging in new behaviors that could be of critical importance given CDC's focus on a "multilayered" approach.

However, behavioral interventions that are perceived as more intrusive or different from typical day-to-day behavior, such as mask use, will encounter more resistance from adults who either participate in the activity or must oversee the participation of elementary school–age children. Achieving community-wide use of these NPIs will likely require both extensive education and an actual pandemic or very real threat. It may also require substantial education about which kind of mask and gloves to buy or, perhaps, advance stockpiling of appropriate supplies.

Although the PIPP is based on studying influenza, these results have application for other infectious diseases spread through personal contact, droplets, and aerosols. Seasonal influenza is largely preventable through an annual immunization; many other common infectious diseases are not. School districts have a particular interest in the wellness of their children and its effect on attendance and academic performance. In addition, activities that reduce the disease burden in children will most likely reduce the rate of teacher and staff infection as well. Any schools that are implementing disease prevention programs or policies would be well served to utilize these data and extend them to their own unique populations. Additional research on a larger scale or in other school districts with different demographic characteristics will help advance the research base on these issues. In addition, it is possible that the survey process itself will sensitize teachers and parents to the kinds of options that would be on the table in the event of a pandemic, and might, thus, provide a form of early warning and education.

Limitations

There are several limitations to the study. First, the sample was not randomly selected, thus limiting generalizability to national populations of parents and teachers. Demographic factors such as race, income, and education were not included in either survey, so any variations in response related to these factors remains unknown. Parents surveyed were already engaged in their school's process, were highly motivated to participate, and may not represent the attitudes of the entire population of parents and guardians. Results may not be applicable to nonurban schools, different geographical regions, or in settings involving nonelementary school–age children.

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KEY WORDS: elementary school; influenza; nonpharmaceutical intervention; parent; teacher

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