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Prevalence of High Risk Indications for Influenza Vaccine Varies by Age, Race, and Income

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Abstract

Estimates of the proportions of the population who are at high risk of influenza complications because of prior health status or who are likely to have decreased vaccination response because of immunocompromising conditions would enhance public health planning and model-based projections. We estimate these proportions and how they vary by population subgroups using national data systems for 2006-2008. The proportion of individuals at increased risk of influenza complications because of health conditions varied 10-fold by age (4.2% of children <2 years to 47% of individuals >64 years). Age-specific prevalence differed substantially by gender, by racial/ethnic groups (with African Americans highest in all age groups) and by income. Individuals living in families with less than 200% of federal poverty level (FPL) were significantly more likely to have at least one of these health conditions, compared to individuals with 400% FPL or more (3-fold greater among <2 and 30% greater among >64 years). Among children, there were significantly elevated proportions in all regions compared to the West. The estimated prevalence of immunocompromising conditions ranged from 0.02% in young children to 6.14% older adults. However, national data on race/ethnicity and income are not available for most immunocompromising conditions, nor is it possible to fully identify the degree of overlap between persons with high-risk health conditions and with immunocompromising conditions. Modifications to current national data collection systems would enhance the value of these data for public health programs and influenza modeling.

Keywords

Influenza; vaccination; subpopulations

1. Introduction

Seasonal influenza leads to about 36,000 deaths annually in the United States [1] and more than 226,000 hospitalizations, totaling about 3.1 million hospitalized days and five billion

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dollars.[2,3] Risk of these serious influenza complications is much higher for persons with a number of identified health-related risk factors than for other persons.[4-10]

Historically and during times of vaccine shortage, the Centers for Disease Control and Prevention's (CDC's) Advisory Committee on Immunization Practices (ACIP) has recommended that these high risk groups be the initial targeted recipients for vaccination. In 2009, for novel H1N1, ACIP initially recommended influenza vaccination for five high-risk groups defined by age, occupation, and health conditions.[11] The health conditions included pregnancy during the influenza season, chronic pulmonary (including asthma) or cardiovascular (except hypertension), renal, hepatic, neurological/neuromuscular, hematologic, metabolic disorders (including diabetes mellitus), and immunosuppression. (In 2010, the ACIP recommended universal vaccination, see <http://www.cdc.gov/vaccines/recs/provisional/downloads/flu-vac-mar-2010-508.pdf>.) The ACIP selected these health conditions because people who have them have increased risk for influenza-related complications, hospitalizations, and death.

Having accurate estimates of how many people have one or more of these health conditions is important for two main reasons. First, the estimates can help public health officials project the number of vaccine doses needed when vaccination is targeted. Second, the estimates can lead to better projections of morbidity and mortality and the impact of interventions. Increasingly, modeling is used for planning vaccination distributions strategies [12-14] and understanding the impact of vaccination on mitigation [15-17]. Incorporating population heterogeneity, both in terms of risk of infection and risk of complications, would enhance the value of modeling for some applications. Because the main route of transmission for influenza is via respiratory droplets of coughs and sneezes [18-20], contact networks are an important feature of infectious disease models. While many models assume random mixing across the entire population, more realistic modeling is able to account for heterogeneity in the population, and capture how people with similar sociodemographic characteristics are more likely to have contact with each other than with a randomly selected individual. Therefore, understanding how the proportions of the population with high-risk medical conditions vary across sociodemographic groups affects the estimates of disease burden generated by the models.

In this report, we estimate the proportions of the population with one or more of the medically-indicated conditions. Most of the conditions included in the list vary with age. We further examine whether they vary with race and socioeconomic status.[21] Since persons are more likely to live near others who are similar to themselves, such variation could help public health departments develop strategies to reach high-risk populations and could also lead to messaging that is more focused and culturally appropriate for the target population.

CDC monitors vaccination rates for high-risk conditions using definitions based on data from the National Health Interview Survey (NHIS).[22,23] However, these monitoring reports have limited information on individuals with immunocompromising conditions. Nor does CDC monitor how medically-indicated conditions vary by sociodemographic subgroup, other than age. In this report, we develop estimates of immunocompromising conditions, propose a more inclusive strategy for defining high-risk conditions from the NHIS and other national data systems, evaluate heterogeneity, and discuss implications for health policy.

2. Methods

2.1 Health Conditions

The ACIP defines high-risk health conditions that are indications for influenza vaccination. [24] The NHIS, a large, nationally-representative population survey that is conducted annually, has been used to estimate prevalences of those high risk conditions that indicate a need for influenza vaccination.[11] A multidisciplinary group of investigators in the Models of Infectious Disease Agent Study (MIDAS) reviewed NHIS questionnaires for 2006 through 2008 to identify questions that best captured the indicated ACIP health conditions. The group's consensus did not always agree with the choices made by CDC to translate the NHIS questions to ACIP indications.[11] The Appendix Table 1 lists the conditions and their definitions that were included for adults. The differences between the definitions used in this report and by CDC are noted. Because the health conditions were derived from the NHIS, co-morbidities are known and the age-specific prevalence in this report is provided as the prevalence of at least one health condition (immunocompromising conditions are addressed separately below). For adults, all age-specific prevalences were weighted averages of 2006-2008 data, except seizures or epilepsy, cerebral palsy, movement disorders, and multiple sclerosis which were only available for 2008.

Appendix Table 2 lists the conditions and their definitions that were included for children. The high prevalence of seizures among children ages 2-4 was thought to be the result of a high frequency of febrile seizures in this age-group, therefore the prevalence for the older age-group, i.e., 5-17 years, was used to estimate non-fever-related seizures for all children, since febrile seizure is not a medical indication for increased risk of influenza complications. For children, all age-specific prevalences were weighted averages of 2006-2008 data, except cerebral palsy, for which reliable data were only available for 2008 and the last half of 2007.

All statistical analyses of NHIS data account for the complex survey design, and were performed using *SAS, version 9 (SAS Institute, Cary, NC)* and *SUDAAN, Release 10.0 (Research Triangle Institute, RTP, NC)*. Sample weights were used to account for differential selection and nonresponse. Standard errors (SEs) were estimated using Taylor series linearization.

2.2 Immunocompromising conditions

To estimate the proportion of the population with immunocompromised conditions, we sought estimates of the numbers of persons with cancer and receiving cancer treatment, persons with HIV/AIDS, persons who have received an organ transplant and persons on kidney dialysis. The NHIS did not have data on any of these conditions except cancer.

Although the NHIS does not include questions about cancer therapy or degree of immunosuppression, it does ask about cancer type and age at diagnosis. We assumed persons with relatively recently diagnosed cancer were most likely to be receiving treatment and to be immunocompromised due to the treatment, whereas those farther from date of diagnosis may be in remission and not receiving active treatment. A judgment call was needed and the group decided to compromise to include the following: adults who reported cancer first diagnosed at an age within three years of their current age and children reporting cancer diagnosed within one year. Since NHIS provides the age at diagnosis rather than the number of years since diagnosis, we needed to include a three-year age window to capture cancers diagnosed within the previous two years. (See Appendix Tables 1 and 2 for definitions.)

The Organ Procurement and Transplantation Network (OPTN), operated by the Health Resources and Services Administration (HRSA), was accessed for data on numbers of solid

organ transplants performed each year and survival rates. (See <http://optn.transplant.hrsa.gov/>) The latter was available for 2009 only. Survival rates were available for 1, 3, and 5-year survival by age at transplant. To estimate the prevalence of individuals with transplants in 2009, we summed of the number of transplants for years 2004-2009, weighted by the appropriate survival rates. Denominator data were obtained using national estimates of intercensal resident populations from the Bureau of Census. (See <http://www.census.gov/popest/national/asrh>)

We used the HIV/AIDS Surveillance System, operated by CDC, to obtain prevalence of individuals with HIV. Estimates of the numbers of individuals living with HIV/AIDS by year and age were available for 2004-2007 using data from 34 states and 5 U.S. dependent areas. (See <http://www.cdc.gov/hiv/topics/surveillance/resources/reports/2007report/table9.htm>) Denominator data were obtained using estimates of intercensal resident populations by state and age from the Bureau of Census. (See <http://www.census.gov/popest/states/asrh/files/SC-EST2008-AGESEX-RES.csv>)

National data were obtained for End-Stage Renal Disease (ESRD) through the United States Renal Data System (USRDS), operated by the Centers for Medicare and Medicaid Services (CMS). (See <http://www.usrds.org/>) The most recent data were for 2006. We used the counts of point-prevalent ESRD patients using any form of dialysis. National intercensal resident population estimates were obtained from the Bureau of Census. (See <http://www.census.gov/popest/national/asrh>)

In summary, the age-specific prevalence of children with immunocompromising conditions include cancer in past 12 months (2007), HIV (2006-2007), ESRD (2006), and transplants (2009). Among adults, the immunocompromising conditions include cancer in past 3 years (2006-2008), HIV (2006-2007), ESRD (2006), and transplants (2009). For the purposes of this research, the total prevalence of immunocompromising conditions was the sum of these conditions. Because these data are derived from different data systems, the degree of co-occurrence of these conditions with each other or with the high-risk health conditions (above) is not determinable.

2.3 Current Pregnancy

Pregnancy frequencies are averages of the 1st and 4th quarters of the NHIS for 2006-2008. The 1st and 4th quarters were selected because these represent the time period for the influenza season. Note this estimates the proportion of women who are aware that they are pregnant.

2.4 Demographic Data

Age—We defined age groups based on two rationale. First, infants <6 months were not included because the ACIP does not recommend administration of influenza vaccine to them and no influenza vaccine is licensed by the Food and Drug Administration (FDA) for this age. Historically, the ACIP selected childhood age groups incrementally, based on the morbidity data. Children <2 years of age have the highest morbidity from influenza infections, then children 2-4 years have the next highest morbidity.[25,26] Starting in 2008, the ACIP increased the age group for routine vaccination through 18 years, with full implementation in 2009.[27] Consequently, we used age 19 years as an age break. Due to the greater mortality in those aged 65 and older, compared to younger adults, this age group has been separated in the recommendations. Morbidity is increased in the 50-64 year-olds, in part due to the increasing frequency of chronic conditions, which led to the ACIP to recommend routine vaccination for 50-64 year olds for seasonal influenza.

Second, the common social settings of children where transmission of influenza is likely to occur vary by age. Among preschool children, less than 5 years, the interaction with other children tends to occur in child care and play group settings. Among children aged 5 to 18, interaction in groups tends to occur in school settings. Likewise, adults aged 19 to 24 tend to interact in college settings, in addition to workplace and social settings, whereas older adults do not tend to interact in college settings. Hence, multiple age-groups were defined, based on common group-interaction settings. In addition, for novel H1N1, ACIP prioritized children, adolescents, and young adults through age 24 years, the later due to the higher frequency of social interactions compared to older adults.[11]

Income—Among the data systems listed above, only the NHIS collects information on income and family size. The Census Bureau defines the Federal Poverty Level (FPL) each year. (<http://aspe.hhs.gov/poverty/09poverty.shtml>) This level is based on family income and the total number of individuals in the family. Cut-point thresholds were determined such that approximately one-third of the national population fell into each group. These cut-points were: less than 2 times the FPL (group 1), 2 to less than 4 times the FPL (group 2), and at least 4 times the FPL (group 3). Due to the high degree of missing data on income, analyses were performed using multiply imputed income files provided by NHIS. (<http://www.cdc.gov/nchs/nhis/2006imputedincome.htm>, with corresponding releases for 2007 and 2008)

Race/Ethnicity—All data systems collected information on race and ethnicity but differ in designation and most systems only accommodated a single racial designation. Consequently, a single race designation system was used for these calculations. Self-identified Hispanics or Latinos were analyzed separately, regardless of race.

2.5 Statistical Methods

Differences within each age group by demographic category were tested using *t*-tests at the .05 significance level within each age category. Bonferroni adjustments were applied to adjust for multiple comparisons. For variables with more than two categories—e.g., race, poverty, and region—one category was chosen as the reference category. The *t*-test corrects for covariance between comparison groups, which is relevant for the comparisons of CDC and MIDAS definitions in the same population.

3. Results

Table 1 presents the age-specific prevalence of individuals with at least one high-risk health condition and the frequencies of immunocompromising conditions. Table 1 also lists the most frequent condition for each age group. For health conditions, the proportions increase until age 5 and then plateau until age 50, when they again increase. The proportions increase ten-fold, such that, in the population aged 65 years and older, almost half of the population has at least one of the medically-indicated conditions. For immunocompromising conditions, the proportions increase in each age group, to about 1 in 16 individuals aged 65 years and older.

The pregnancy data were only available for women less than 45 years of age. Among women aged 19 to 24 years, the proportion who were pregnant during the influenza season was 5.8% (SE 0.61%) The proportion of women aged 25 to 49 years was 3.1% (SE 0.20%).

In three instances, the definitions selected by the MIDAS group differed from the CDC definitions (Appendix Tables 1 and 2): for asthma and cardiovascular disease in adults, and for asthma in children. Table 2 presents a comparison of the proportion of the population with these health conditions, using the two definitions. Each comparison tested as highly

significantly different ($p < 0.0001$), largely due to the high degree of covariance between the two estimates which were based on the same NHIS population. Although significant, among adults, there is little practical difference among the proportions defined as “diabetic”. However, the MIDAS definition yields almost double the proportion using the CDC definition for asthma, but only about half the proportion for cardiovascular. The MIDAS definition includes several conditions not included in the CDC definition that address the ACIP category of “compromises respiratory function or the handling of respiratory secretions or that can increase the risk of aspiration”—such as seizures or epilepsy, movement disorder, multiple sclerosis, and stroke. Overall, the percents of the adult population with at least one condition calculated both ways differ by less than 2 percentage points. However, MIDAS definitions yield higher proportions among the younger adults, when compared to CDC definitions (in percent: 12.35, 15.70, 30.56, and 47.01 compared with 9.1, 14.50, 29.85, and 49.35 for 19- 24, 25-49, 50-64, and 65 years and older). The largest difference among children was the proportion of the population with asthma that increased from 3.81 percent using the CDC definition to 7.26 percent using the MIDAS definition. The MIDAS definition includes Down Syndrome as a chronic metabolic disease and cancer is an immunocompromising condition, whereas the CDC definition does not. Because the preponderance of children in the high risk category has asthma, the overall proportions also differ between the two definitions.

In Table 3, age-specific prevalence of at least one health condition is shown by demographic, income and region groups. Because of lack of data and use of inconsistent demographic codes across sources, these data could not be reported for immunocompromising conditions. Females had fewer health conditions than males. The contrast between genders was significant for all age groups ($p < 0.05$ for each) except adults aged 50-64 and children less than 2 years. Non-Hispanic African Americans had the highest prevalence for all age groups. The contrast between this group and non-Hispanic Whites was significant for adults aged 50 and over and for children up to age 17 ($p < 0.05$ for each age group). Asian Americans had notably low rates, compared with the other groups. The contrast between this group and non-Hispanic Whites was significant for adults between the ages of 19-49 and for children aged 5-17 ($p < 0.05$ for each age group).

Individuals living in families in the bottom third of the nation in terms of poverty level (that is, less than 2 times the FPL) have significantly elevated prevalence of at least one medical condition, compared to individuals in the top third ($p < 0.05$ for all age groups except 19 to 24 year olds). Among all age groups except the 19 to 24 years olds, the frequencies were at least 50% higher than among individuals living in families in the top third of the poverty level distribution. The differences were not as striking across the four Census regions of the country (also displayed in Figure 1). However, people in the West tended to have lower prevalences; regional differences were statistically significant among children ages 0-17 ($p < 0.05$).

4. Discussion

We have used national data sources to estimate the proportion of the population with a health condition that confers high risk of influenza complications and the proportion with an immunocompromising condition that may have decreased immune response to influenza vaccination. We further have shown that these proportions vary by age, gender, race, and socioeconomic status. Our estimates should be useful both to modelers and to public health departments. For pandemic modeling that includes population heterogeneity, these estimates would allow risk and vaccine response to vary by sociodemographic characteristics. For public health departments these data could help focus and tailor public health campaigns around influenza vaccination to population subgroups and neighborhoods with highest risk

The proportion of the population having medically-indicated conditions varies almost ten-fold across the age groups and is quite large, e.g., almost half of the population over the age of 64, and non-trivial even among the youngest who have the lowest prevalence, 1 out of 25 children under the age of 2 years. There are notable differences between racial and ethnic groups and between income groups. African Americans, in most age groups, had notably higher rates of medically-indicated conditions. The greater and more consistent disparity, however, is for income groups. Individuals living in families with incomes below 200% of the poverty level have consistently higher prevalence of medically-indicated conditions, regardless of age. The increase in prevalence among the poorest third of the population, when compared to the richest third, ranges from 19 % to 200 %.

The subpopulations at greatest risk for complications because of preexisting co-morbidities, that is the poorest and some racial minorities, also are known to have the least access to health care, for myriad reasons. Hutchins et al.[28] suggest some approaches to improve coverage of these populations during influenza epidemics, including culturally competent responses and communications, community health safety net systems, and social policies that minimize economic burdens and improve compliance with isolation and quarantine requirements. Given the notable difference in co-morbidity prevalence among the poorer segment of the population and the wide variation in median income by census tract,[29] targeting neighborhoods is another approach to improving coverage among the medically-indicated population. Generally, however, these subpopulations have not been considered in analyses of optimization and effectiveness of vaccine distribution strategies. The extent to which the inadequate coverage rates in these populations affects the magnitude of epidemics needs to be assessed. At a policy level, the ACIP 2010 recommendations for universal influenza vaccination simplify the recommendations and might help increase coverage in disadvantaged populations.

The ACIP has historically identified high risk health conditions, because people who have them are at heightened risk for influenza-related complications, hospitalizations, and death. A number of studies support this. For instance, in a population-based study, Mullooly et al. [4] found that persons with high-risk conditions had significantly increased hospitalization rates among individuals 50-64 years of age and 65 years and older. Lee et al.[5] found that patients with major comorbidities had higher viral loads and prolonged viral shedding. Barker et al.[6] found that the mortality rate increased with increasing numbers of comorbidities. Ison[7] reviews several studies indicating increased complications among hospitalized patients with influenza who had comorbidities. In a study of children, Coffin et al.[8] found that the incidence of hospitalization and of influenza-related complications was higher among children with a preexisting high-risk condition. Bhat et al.[9] reported that the prevalence of underlying conditions was increased among influenza-associated pediatric deaths. In a study of pregnant women, Jamieson et al.[10] reported an excess of influenza-associated deaths rates. Some policy planning efforts and some modeling studies do not segment the population into high risk groups even though the likelihood of hospitalization and of death vary by whether or not the individuals have these underlying conditions. Herein and on the MIDAS website (www.midasmodels.org), we provide such estimates so the policy planners and modelers can use these data to make better estimates for prioritization during shortages and of pandemic impact.

Although the NHIS was the principal data source for CDC's estimation of prevalence of high-risk conditions and for our estimates, our translations of the NHIS data to ACIP indications differ from CDC's.[22] There are several reasons for the discrepancies. The ACIP list of indications has grown as new high risk groups, such as neuromuscular conditions, were added. CDC, likely for consistency in trends over time, is using the older definition. There were also several cases where we made different decisions about which

NHIS survey responses most closely mapped onto the ACIP indications list. One of these was whether to include “other heart disease” in the cardiovascular group. Our group agreed with the work of Smith et al.[30] and did not include this, as benign murmurs would be one of the most likely disorders mentioned and is not a hemodynamically significant condition necessitating a recommendation for influenza vaccine. In other cases, our interpretation was broader than CDC's, e.g., our inclusion of Down's syndrome. We understand the need for CDC to look at trends over years whereas our motivation was to provide up-to-date data for modeling and policy purposes.

There were a number of challenges to the calculation of these prevalence rates, both policy and data system challenges. The age-groupings that were included in the ACIP health policy recommendations presented a major challenge as they differ from those typically used by national databases. For instance, most national data systems consider 18 year-old participants as adults whereas 18 year-olds are considered with children in ACIP recommendations; this is due in part to inclusion of this age group in the Vaccines for Children Program under federal law. Another challenging group for calculating prevalence estimates is the narrow age range of 2 to 4 year old children because there are relatively few children represented in the national data systems and most are healthy.. However, given high morbidity in this group compared to school-aged children,[25,26] this is an important group to distinguish. Children 5 years and older are in school settings and, consequently, experience different transmission patterns. Consequently, even though the estimates are imprecise, models used to assess epidemics and vaccine delivery efficacy must incorporate data from using age-groups based on vaccine licensing approvals and on school-age groups for transmission dynamics.

The data systems utilized also presented a number of challenges. The prevalence of individuals with at least one health condition is estimated using data from the NHIS. The NHIS has also been used as a principal source by others estimating the size of various target groups for vaccinations.[22,30] These data are self-reported diagnoses. Self-reported data are known to generate under estimates of the actual frequency of at least some conditions but to be reliable for others.[31,32] However, the large size of the survey and the inclusion of a broad spectrum of conditions enables the estimation of stable age-specific frequencies and the determination of co-morbidities. Defining cancer was particularly difficult as we were interested in prevalent and significant cancer, namely those cancers which could increase the likelihood of complications from influenza or reduce response to vaccination. We used an interactive and iterative group consensus approach to select the questions from NHIS, but acknowledge that this approach has limitations.

The prevalence of immunocompromising conditions, however, cannot be estimated with confidence from the NHIS because prevalence of HIV, transplants and dialysis is not recorded. Because of the need to use multiple sources of national data, it was not possible to determine the overlap between these groups. For instance, we could not determine whether individuals with a “weak kidney” were on dialysis. This could be remedied by including a few more questions on the NHIS that would provide estimates of the most frequent immunocompromising conditions. Specifically, asking about dialysis, transplants, HIV/ AIDS and cancer chemotherapy would facilitate better estimates of the prevalence of immunocompromising conditions and their co-occurrence with other conditions, as well as their distribution by sociodemographic factors.

In summary, the prevalence of high risk conditions varies substantially by age, gender, race, and income. At the local level, this is important for tailoring messages. At the national level, these data were used for MIDAS pandemic modeling efforts and are needed for segmenting the likelihood of hospitalization and death due to underlying conditions which are major

determinants of morbidity and mortality. Without such segmentation, models and planning efforts are unlikely to capture the real risk of influenza-related morbidity and mortality. We also provide estimates of immunocompromising conditions, which is a limitation of the existing literature.

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Appendix

Appendix Table 1
Advisory Committee on Immunization Practices'
Recommended Medical Indication among Adults,
Corresponding NHIS Conditions, and Definitions

ACIP Medical Indication	NHIS Condition	MIDAS Definition	Years of Available Data	CDC uses this condition or NHIS question in translation of NHIS to ACIP recommendations ^a
Cardiovascular ^b	Coronary heart disease	"Have you EVER been told by a doctor or other health professional that you had coronary heart disease?"	2006 – 2008	Yes
	Angina	"Have you EVER been told by a doctor or other health professional that you had angina, also called angina pectoris?"	2006 – 2008	Yes
	Heart attack	"Have you EVER been told by a doctor or other health professional that you had a heart attack (also called myocardial infarction)?"	2006 – 2008	Yes
Chronic lung disease (including asthma)	Asthma	"Have you EVER been told by a doctor or other health professional that you had you had asthma?" And "Do you still have asthma?"	2006 – 2008	CDC: "Have you EVER been told by a doctor or other health professional that you had you had asthma?" And "During the past 12 months, have you had an episode of asthma or an asthma attack?"
	Emphysema	"Have you EVER been told by a doctor or other health professional that you had emphysema?"	2006 – 2008	Yes
	Chronic bronchitis	"During the past 12 months, have you been told by a doctor or other health	2006 – 2008	Yes

ACIP Medical Indication	NHIS Condition	MIDAS Definition	Years of Available Data	CDC uses this condition or NHIS question in translation of NHIS to ACIP recommendations ^a
		professional that you had chronic bronchitis?"		
	Diabetes	"Other than during pregnancy, have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes?/Have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes?" Or "Are you NOW taking insulin" Or "Are you NOW taking diabetic pills to lower your blood sugar? These are sometimes called oral agents or oral hypoglycemic agents".	2006 – 2008	CDC: Other than during pregnancy, have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes?/ Have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes?"
Chronic metabolic diseases, including diabetes mellitus, renal, or hepatic dysfunction, hemoglobinopathies, or immunocompromising conditions (including immunocompromising conditions caused by medications or human immunodeficiency virus [HIV])	Weak kidney	"DURING THE PAST 12 MONTHS, have you been told by a doctor or other health professional that you had weak or failing kidneys? Do not include kidney stones, bladder infections or incontinence".	2006 – 2008	Yes
	Liver condition	"DURING THE PAST 12 MONTHS, have you been told by a doctor or other health professional that you had any kind of liver condition?"	2006 – 2008	No
	Cancer, excluding non-melanoma skin cancer, in past 3 year	"Have you EVER been told by a doctor or other health professional that you had cancer or a malignancy of any kind?" And "What kind of cancer was it?" ^a . Time since onset was determined from the current age of the respondent and the response to "How old were you when [kind of cancer] was first diagnosed?"	2006 – 2008	Yes
Any condition that compromises respiratory function or the handling of respiratory secretions or that can increase the risk of aspiration (e.g., cognitive	Seizures or Epilepsy	"Have you ever had epilepsy or seizures?"	2008	No
	Cerebral palsy	"Have you ever had cerebral palsy?"	2008	No

ACIP Medical Indication	NHIS Condition	MIDAS Definition	Years of Available Data	CDC uses this condition or NHIS question in translation of NHIS to ACIP recommendations ^a
	Movement disorder	"Have you ever had movement disorders such as Parkinson's disease, ALS, or Lou Gehrig's disease?"	2008	No
dysfunction, spinal cord injury, or seizure disorder or other neuromuscular disorder)	Multiple sclerosis	"Have you ever had multiple sclerosis?"	2008	No
	Stroke	"Have you EVER been told by a doctor or other health professional that you had a stroke?"	2006 – 2008	No
Pregnancy	Pregnancy	"Are you currently pregnant?" ^b	2006 – 2008	Yes

^a <http://www.cdc.gov/Flu/professionals/acip/coveragelevels.htm> accessed 11/7/09

^b CDC also included "ever being told by a physician that they had "other heart condition".

^c Participants selecting only "Skin (non-melanoma)" were coded as NOT having cancer.

^d Only data from Quarters 1 and 4 were analyzed.

Appendix

Appendix Table 2
Advisory Committee on Immunization Practices'
Recommended Medical Indication among Children,
Corresponding NHIS Conditions, and Definitions

ACIP Medical Indication	NHIS Condition	MIDAS Definition	Years of Available Data	CDC uses this condition of NHIS question in translation of NHIS to ACIP recommendations on CDC flu website ^a
Cardiovascular	Congenital heart disease	"Looking at this list, has a doctor or health professional ever told you that [name] had any of these conditions?" Select: "Congenital heart disease"	2006 – 2008	Yes
	Asthma	"Has a doctor or other health professional EVER told you that [name] had asthma?" And "Does [name] still have asthma?"	2006 – 2008	CDC: "Has a doctor or other health professional EVER told you that [name] had asthma?" And "During the past 12 months, has [name] had an episode of asthma or an asthma attack?"
Chronic lung disease (including asthma)	Cystic fibrosis	"...has a doctor or health professional	2006 – 2008	Yes

ACIP Medical Indication	NHIS Condition	MIDAS Definition	Years of Available Data	CDC uses this condition of NHIS question in translation of NHIS to ACIP recommendations on CDC flu website ^a
Chronic metabolic diseases, including diabetes mellitus, renal, or hepatic dysfunction, hemoglobinopathies, or immunocompromising conditions (including immunocompromising conditions caused by medications or human immunodeficiency virus [HIV])	Diabetes	ever told you that [name] had any of these conditions?" Select: "Cystic fibrosis"	2006 – 2008	Yes
	Sickle Cell Anemia	"...has a doctor or health professional ever told you that [name] had any of these conditions?" Select: "Diabetes"	2006 – 2008	Yes
	Cancer	"...has a doctor or health professional ever told you that [name] had any of these conditions?" Select: "Sickle cell anemia"	2007	No
	Down syndrome	"DURING THE PAST 12 MONTHS, has a doctor or other health professional told you that [name] had cancer?"	2006 – 2008	No
Any condition that compromises respiratory function or the handling of respiratory secretions or than can increase the risk of aspiration (e.g., cognitive dysfunction, spinal cord injury, or seizure disorder or other neuromuscular disorder)	Cerebral palsy	"...has a doctor or health professional ever told you that [name] had any of these conditions?" Select: "Down syndrome"	2007: Quarters 3 & 4; 2008 ^b	Yes
	Muscular dystrophy	"...has a doctor or health professional ever told you that [name] had any of these conditions?" Select: "Cerebral palsy"	2006 – 2008	Yes
	Seizures	"...has a doctor or health professional ever told you that [name] had any of these conditions?" Select: "Muscular dystrophy"	2006 – 2008	Yes
		"DURING THE PAST 12 MONTHS, has [name] had... Seizures?" ^c	2006 – 2008	Yes

^a <http://www.cdc.gov/Flu/professionals/acip/coveragelevels.htm> accessed 11/7/09

^b Per NHIS documentation, cerebral palsy data from 2006 and the first two quarters of 2007 were unreliable and therefore not used.

^c Only data from children 5-17 years old were analyzed.

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Table 1
Proportions of Age-specific Population Having At least One Health Condition and Immunocompromising Conditions

Age	At Least One Health Condition ^{a,b} (in percent, SE shown in parentheses)	Immunocompromising Conditions ^b (in percent)	Most Frequent Health Condition (in percent)
6 to 23 months	4.15 (0.44)	0.02	Asthma (3.47)
2 to 4 years	8.83 (0.51)	0.03	Asthma (7.97)
5 to 18 years	11.68 (0.30)	0.24	Asthma (10.47)
19 to 24 years	12.35 (0.55)	0.68	Asthma (8.57)
25 to 49 years	15.70 (0.27)	1.31	Asthma (6.81)
50 to 64 years	30.56 (0.44)	3.27	Diabetes (13.46)
65 years and older	47.01 (0.50)	6.14	Cardiovascular (21.41)

^aSee Appendix Tables 1 and 2 for list of possible health conditions.

^bSee Methods for sources.

Table 2
Comparison of Proportion of Population with Selected Conditions Using CDC and MIDAS Definitions

Condition	Age Group	Proportion of Population (SE) using:	
		CDC Definition (in percent, with SE)	MIDAS Definition (in percent, with SE)
Diabetes ^a	19 and older	8.07 (0.14)	8.50 (0.15)
Asthma ^b	19 and older	3.81 (0.10)	7.26 (0.13)
Cardiovascular ^c	19 and older	11.52 (0.18)	6.43 (0.13)
Total "at least one condition"	19 and older	23.49 (0.24)	24.13 (0.24)
Asthma ^b	18 and younger	5.46 (0.17)	9.29 (0.22)
Total "at least one condition"	18 and younger	7.63 (0.19)	10.38 (0.23)

Source: National Health Interview Survey, 2006-2008.

Note: 18 year olds are not included in these statistics. Although the ACIP recommends 18 years olds be assigned to the child category, CDC assigns 18 year olds to the adult category.¹¹

^a CDC definition includes those ever diagnosed; MIDAS definition includes those ever diagnosed or those taking insulin or medications for diabetes.

^b CDC definition includes those ever diagnosed and episode in the past 12 months; MIDAS definition includes those ever diagnosed and still have asthma.

^c CDC definition includes "Other heart conditions", MIDAS definition does not.

Table 3

Proportions of Age-specific Population (in percent, with SE) Having At least One Health Condition^a by Demographic, Income, and Region

	5-23 Months	2-4 years	5-18 years ^b	All children ^c	19-24 years	25-49 years	50-64 years	65 years and older	All adults ^c
Gender									
Male	4.75 (0.62)	10.81 (0.83) [†]	13.16 (0.43) [†]	11.85 (0.33) [†]	10.63 (0.73) [†]	13.45 (0.35) [†]	31.36 (0.66)	51.61 (0.75) [†]	23.14 (0.32) [†]
Female ^Q	3.52 (0.60)	6.75 (0.65)	10.14 (0.44)	8.85 (0.34)	14.07 (0.73)	17.90 (0.39)	29.80 (0.59)	43.55 (0.65)	25.06 (0.30)
Race and Ethnicity									
Hispanic	4.37 (0.80)	7.79 (0.94)	10.37 (0.55)	9.13 (0.42)	8.75 (0.92) [†]	12.79 (0.47) [†]	33.41 (1.55)	48.24 (1.57)	18.63 (0.45) [†]
Non-Hispanic White ^Q	3.08 (0.60)	7.23 (0.71)	10.69 (0.42)	9.36 (0.33)	13.38 (0.75)	16.52 (0.35)	29.35 (0.52)	46.36 (0.57)	25.32 (0.29)
Non-Hispanic African American	8.49 (1.44) [†]	15.75 (1.67) [†]	17.65 (0.77) [†]	16.33 (0.62) [†]	13.44 (1.37)	17.04 (0.61)	37.42 (1.21) [†]	53.30 (1.55) [†]	25.57 (0.57)
Asian American	N.S.	7.14 (2.09)	6.43 (0.87) [†]	6.13 (0.79) [†]	7.27 (1.48) [†]	9.63 (0.74) [†]	23.58 (2.05)	42.52 (2.48)	16.24 (0.71) [†]
Others ^d	N.S.	16.14 (5.08)	18.92 (3.16)	15.75 (2.17) [†]	15.88 (4.49)	25.59 (3.29)	49.58 (4.62) [†]	54.44 (7.25)	32.81 (2.22) [†]
Poverty Level									
<2 times FPL ^e	5.89 (0.74) [†]	10.62 (0.85) [†]	13.23 (0.57) [†]	11.81 (0.43) [†]	13.38 (0.75)	19.69 (0.53) [†]	44.11 (1.03) [†]	52.79 (0.81) [†]	29.41 (0.44) [†]
2 to <4 times FPL	2.78 (0.75)	8.07 (0.95)	11.31 (0.48)	9.97 (0.39)	11.64 (1.02)	15.50 (0.51) [†]	32.58 (0.89) [†]	47.10 (0.87) [†]	24.79 (0.39) [†]
≥4 times FPL ^Q	1.94 (0.74) [*]	6.40 (0.80)	9.86 (0.52)	8.59 (0.42)	11.25 (1.33)	12.96 (0.38)	23.48 (0.53)	39.81 (0.95)	19.49 (0.31)
Region									
Northeast	6.27 (1.33) [†]	10.10 (1.42) [†]	12.98 (0.79) [†]	11.86 (0.66) [†]	12.03 (1.23)	15.11 (0.59)	27.71 (1.00)	44.81 (1.17)	23.23 (0.47)
Midwest	3.56 (0.97)	9.84 (1.06) [†]	12.60 (0.79) [†]	11.16 (0.57) [†]	14.08 (1.35)	16.55 (0.69)	30.81 (0.92)	47.96 (0.97)	25.02 (0.57)
South	5.42 (0.78) [†]	9.93 (0.92) [†]	11.56 (0.42)	10.60 (0.33) [†]	11.99 (0.76)	15.65 (0.42)	33.08 (0.78) [†]	47.74 (0.82)	24.68 (0.41)
West ^Q	1.32 (0.41)	5.45 (0.75)	9.87 (0.48)	8.12 (0.35)	11.29 (1.24)	15.30 (0.48)	28.49 (0.85)	46.55 (1.11)	22.96 (0.46)
Total for United States									

	5-23 Months	2-4 years	5-18 years ^b	All children ^c	19-24 years	25-49 years	50-64 years	65 years and older	All adults ^c
Total	4.15 (0.44)	8.83 (0.51)	11.68 (0.30)	10.38 (0.23)	12.35 (0.55)	15.70 (0.27)	30.56 (0.44)	47.01 (0.50)	24.13 (0.24)

Source: National Health Interview Survey, 2006-2008.
Note: See Appendix Tables 1 and 2 for a list of conditions.

N.S.: Data not shown, does not meet standard of statistical reliability and precision, Relative Standard Error is greater than 40%.

^aDoes not include immunocompromising conditions, such as cancer.

^bData on children only are through age 17 years.

^cBecause health condition questions differed for children and adults, these data are presented separately.

^dOther race-ethnicity groups include: American Indian or Alaska Natives, Primary race not reportable, Multiple race / No primary given.

^eFPL is the Federal Poverty Level.

^QBaseline category

[†]Prevalence is significantly