Risk Factors for Meningococcal Disease in College Students

Michael G. Bruce, MD, MPH
Nancy E. Rosenstein, MD
Jennifer M. Capparella, MSPH
Kathleen A. Shutt, MS
Bradley A. Perkins, MD
MarJeanne Collins, MD

Context Elevated rates of meningococcal disease were noted among 18- to 22-year-olds in the mid-1990s. However, national data on rates of meningococcal disease in US college students were not collected until 1998.

Objectives To determine rates of meningococcal disease in US college students and to identify risk factors for meningococcal disease in this population.

Design, Setting, and Patients Prospective surveillance study with nested case-control study of US college students with meningococcal infection from September 1, 1998, to August 31, 1999. Fifty state health departments and 231 college health centers participated.

Main Outcome Measures Incidence of and risk factors for meningococcal disease in US college students.

Results Ninety-six cases of meningococcal disease were identified. The incidence rate for undergraduates was 0.7 per 100,000 persons vs 1.4 per 100,000 for the general population of 18- to 23-year-old nonstudents (P<.001). Freshmen living in dormitories had the highest incidence rate at 5.1 per 100,000. Of the 79 case-patients for whom information was available, 54 (68%) had illness due to vaccine-preventable meningococcal serogroups. On multivariable analysis of case-control study data, freshmen who lived in dormitories had an elevated risk of meningococcal disease (matched odds ratio, 3.6; 95% confidence interval, 1.6-8.5; P=.003) compared with other college students.

Conclusions Freshmen who live in dormitories have an independent, elevated risk of meningococcal disease compared with other college students. Use of the currently available quadrivalent polysaccharide vaccine among college students could substantially decrease their risk of meningococcal disease.

See also pp 694 and 720.
METHODS
Surveillance
In collaboration with CSTE, surveillance for meningococcal disease in college students was conducted in all 50 states from September 1, 1998, through September 1, 2000. A US college student case was defined as having clinically compatible disease with isolation of N meningitidis from a normally sterile site, a positive meningococcal antigen test in cerebrospinal fluid, or clinical purpura fulminans in the absence of a positive blood culture in an undergraduate or graduate student attending a 2-year, 4-year, or vocational college or university in the United States. Surveillance continued through September 1, 2000, but only patients meeting the above case definition identified between September 1, 1998, and August 31, 1999, are reported in this analysis.

State health department surveillance officers were prospectively asked to review all meningococcal disease cases occurring in persons 17 to 30 years of age to determine whether the patient was a college student. A brief supplemental case report form with information on class level, type of housing, and method of diagnosis was forwarded to the CDC for all college student cases along with the routine surveillance form used by the state health department. In addition to state health departments, 231 college health centers within the ACHA network also conducted prospective and retrospective surveillance. After identifying a case at a student health center, case managers notified both the state health department and the ACHA study coordinator to whom they sent a case report form containing demographic and clinical information. Information from state health departments and college health centers was transferred onto a standardized form and entered into an Epi-Info (version 6.04, CDC, Atlanta, Ga) database.

Numerator data for 18- to 23-year-old nonstudents were obtained from the National Electronic Telecommunications System for Surveillance (NETSS), the system whereby meningococcal disease cases are reported to the CDC. The NETSS case definition is identical to the case definition stated above. The number of cases in 18- to 23-year-old nonstudents was determined by taking the number of cases in all people 18 to 23 years of age reported in NETSS and subtracting the number of 18- to 23-year-old college student cases reported through our enhanced surveillance.

Denominator Data for Calculation of Rates
Multiple sources were used to determine population denominators. Census data from 1998 were used to estimate the US population of 18- to 23-year-olds. Data from the National Center for Education Statistics (NCES) at the US Department of Education were used from 1996 to 1997 to determine the college student population. Both US Census data and the NCES data were used to determine the population of 18- to 23-year-old nonstudents. Undergraduate students were categorized as first-time freshmen (2,285,001) or non-first-time freshmen (12,612,267). In this article, the term “freshmen” will refer to first-time freshmen, defined as students who have completed high school and are entering college for the first time.

Data from the 1995 National College Health Risk Behavior Survey and the Higher Education Research Institute at the University of California, Los Angeles, were used to estimate the number of students living in dormitories. We did not define the variables “dormitory,” “fraternity,” or “sorority,” but instead relied on how they were defined by the given college or university. These 3 variables were mutually exclusive.

Case-Control Study
We performed a matched case-control study to examine risk factors for meningococcal disease among college students. For the case-control study, an eligible case-patient was defined as a student with clinically compatible disease and a positive diagnostic test result between September 1, 1998, and April 30, 1999.

An eligible control was defined as a student enrolled at a US college between September 1998 and April 1999 without history of prior meningococcal vaccination. Three controls were matched to each case-patient by college, sex, and undergraduate vs graduate status. Upon identification of a college student case, the study coordinator in conjunction with both the student health service representative and the school database manager generated a list of all currently enrolled students at the institution. Controls were then randomly selected for each case.

Interviews occurred within 2 weeks of receiving a case report, which occurred a mean of 62 days after diagnosis. After obtaining informed consent, we interviewed each case-patient and control (or surrogate for case-patients who had died) by telephone using a standardized questionnaire. The questionnaire was pre-tested and took 15 to 20 minutes to complete. Data collected included basic demographics: class level, housing, active and passive smoking, recreational drug and alcohol use, medical history, and exposure to large groups of people.

As a reference period, we asked about the month preceding the onset of illness for case-patients and about the same calendar month in the matched controls. Telephone interviews were conducted by the project coordinator and staff. The telephone was allowed to ring 10 times before the control patient was considered unavailable. A minimum of 5 attempts were made at different times of the day to contact each potential control over a period of 2 weeks including at least 1 weekend call.

The study was approved by the institutional review board (IRB) (or its equivalent) at the University of Pennsylvania, each participating college, and the CDC.

Statistical Methods
Univariate matched odds ratios were calculated using SAS (version 6.12, SAS Institute, Cary, NC). Conditional logistic regression was performed using the SAS procedure PHREG to determine independent risk factors for disease. Multivariable models included variables found to be significant in pre-
RESULTS

Surveillance

Among college students in the United States, 96 cases of meningococcal disease were identified between September 1, 1998, and August 31, 1999. Fifty (52%) patients were male and 46 (48%) were female with a median age of 19 years (range, 18-37 years). Eighty-six (90%) students were white, 3 (3%) students were black, 2 (2%) were Asian, 1 (1%) was of other race, and 4 (4%) were unknown. One student was of Hispanic ethnicity. Two (2%) cases were outbreak-related. Eighty-six (90%) students attended 4-year institutions and 86 (90%) were full-time students. Ninety (97%) were hospitalized and 8 (9%) died. Of the 96 cases, 91 (95%) were confirmed by culture from a sterile site, 3 (3%) by a positive latex agglutination test result, and 2 (2%) patients had clinical purpura fulminans without a positive culture or latex agglutination test result. Of the 91 isolates available for testing, 46 (51%) were obtained from blood, 44 (48%) from cerebrospinal fluid, and 1 (1%) from synovial fluid. Fifty-two (54%) students were diagnosed with a clinical syndrome consistent with meningitis. Of the 79 isolates for which serogroup information was available, 38 (48%) were serogroup C, 22 (28%) were serogroup B, 15 (19%) were serogroup Y, 1 (1%) was serogroup W-135, and 3 (4%) were non-groupable. Thus, 54 (68%) had illness due to vaccine-preventable serogroups. Forty-four cases (46%) occurred in the winter months from December through March, and rates were highest in the northern and southeastern regions of the United States.

For the 1-year period from September 1, 1998, through August 31, 1999, the incidence of meningococcal disease among US undergraduates was 0.7 per 100000 (TABLE 1), significantly lower than the rate of 1.4 per 100000 for the general population of 18- to 23-year-old nonstudents \( (P<.001) \). Rates were higher among freshmen and among students living in dormitories. Freshmen students living in dormitories had the highest incidence of disease at 5.1 per 100000 (95% confidence interval [CI], 3.4-7.2). Rates of disease were higher among whites than blacks \( (P=.005) \).

Case-Control Study

Of the 82 college students with meningococcal disease onset between September 1, 1998, and April 30, 1999, 75 cases were reported to CDC by May 7, 1999, and of those cases, 50 (67%) were enrolled in the case-control study. Of the 25 cases not included in the case-control study, most were excluded because of late reporting or lack of IRB approval from the school. Twenty-three (46%) were male and 27 (54%) were female with a median age of 19 years (range, 18-24 years). None were of black race. Forty-eight students (96%) attended 4-year institutions and 47 (94%) were full-time students. Forty-nine students (98%) were hospitalized and 4 (8%) died. Of the 42 isolates for which serogroup information was available, 23 (55%) were serogroup C, 10 (24%) were serogroup B, and 9 (21%) were serogroup Y. No students had been vaccinated prior to illness.

Of the 276 potential controls called, 148 (54%) were enrolled in the study. Of the 128 students who elected not to participate as controls in the study, 60% reported that they did not wish to spend the time required to complete the questionnaire, 20% did not call back once initial contact was made and an interview time was set up, 15% declined participation due to lack of interest in the study, and 5% hung up. Two controls were previously vaccinated and were excluded from further analysis.

Enrolled case-patients were similar to nonenrolled patients in age, sex, race,

Table 1. Rates of Meningococcal Disease in College Students, September 1998 to August 1999

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. of Cases</th>
<th>Population†</th>
<th>Rates per 100 000 (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All 18-23 y</td>
<td>304</td>
<td>22 070 535</td>
<td>1.4 (1.2-1.5)</td>
</tr>
<tr>
<td>18-23 y, nonstudents</td>
<td>211</td>
<td>14 579 322</td>
<td>1.4 (1.3-1.7)</td>
</tr>
<tr>
<td>All college students</td>
<td>96</td>
<td>14 897 268</td>
<td>0.7 (0.5-0.9)</td>
</tr>
<tr>
<td>Undergraduates</td>
<td>93</td>
<td>12 771 228</td>
<td>0.7 (0.6-0.9)</td>
</tr>
<tr>
<td>Freshmen</td>
<td>44</td>
<td>2 285 001</td>
<td>1.9 (1.4-2.6)</td>
</tr>
<tr>
<td>Nonfreshmen</td>
<td>52</td>
<td>12 612 267</td>
<td>0.4 (0.3-0.5)</td>
</tr>
<tr>
<td>Dormitory resident</td>
<td>48</td>
<td>2 085 618</td>
<td>2.3 (1.7-3.1)</td>
</tr>
<tr>
<td>Freshmen in dormitories</td>
<td>30</td>
<td>591 587</td>
<td>5.1 (3.4-7.2)</td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>6 608 844</td>
<td>0.8 (0.6-1.0)</td>
</tr>
<tr>
<td>Female</td>
<td>46</td>
<td>8 288 424</td>
<td>0.6 (0.4-0.7)</td>
</tr>
<tr>
<td>White</td>
<td>86</td>
<td>10 652 955</td>
<td>0.8 (0.6-1.0)</td>
</tr>
<tr>
<td>Black</td>
<td>3</td>
<td>1 562 038</td>
<td>0.2 (0.04-0.6)</td>
</tr>
<tr>
<td>School characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-Year</td>
<td>86</td>
<td>9 170 339</td>
<td>0.9 (0.8-1.2)</td>
</tr>
<tr>
<td>2-Year</td>
<td>10</td>
<td>5 726 929</td>
<td>0.2 (0.1-0.3)</td>
</tr>
<tr>
<td>Public</td>
<td>65</td>
<td>11 553 168</td>
<td>0.6 (0.4-0.7)</td>
</tr>
<tr>
<td>Private</td>
<td>31</td>
<td>3 344 100</td>
<td>0.9 (0.6-1.3)</td>
</tr>
<tr>
<td>Student type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>86</td>
<td>8 556 390</td>
<td>1.0 (0.8-1.2)</td>
</tr>
<tr>
<td>Part-time</td>
<td>10</td>
<td>6 340 878</td>
<td>0.2 (0.1-0.3)</td>
</tr>
</tbody>
</table>

*Freshmen refers to undergraduate students in their first year of college. Nonfreshmen are all students in their second year or higher of college including sophomores, juniors, seniors, and graduate students. Dormitory resident indicates a student residing in an on-campus dormitory facility, and full-time and part-time student groups were self-reported.
†Some data were taken from references 12-15.
serogroup, hospitalization, class level, and type of school. Case-patients enrolled in the study were more likely than nonenrolled patients to live in dormitories (66% vs 33%, P = .001) and to have been enrolled at a 4-year school (96% vs 83%, P = .03). Use of matched case-control methodology should adjust for any enrollment bias toward students living in dormitories.

In a univariate matched analysis, case-patients did not differ significantly from controls by age, sex, undergraduate vs graduate status, or maternal education. Case-patients, however, were more likely than controls to be freshmen (P = .001), to live in a dormitory (P = .008), and to be freshmen living in a dormitory (P = .001). Case-patients were also more likely than controls to be of white race and to have had an upper respiratory tract infection in the month preceding the onset of meningococcal disease (TABLE 2). Attending 1 or more movies in the month before illness onset was protective; however, movie attendance was inversely correlated with smoking, bar patronage, and alcohol consumption (data not shown). Crowding (defined as ≥2 people per bedroom), active and passive smoking, and low socioeconomic status (≤$30000 per year in household income, which includes parents and student) were not significantly associated with disease.

In a multivariable analysis (TABLE 3), freshmen living in dormitories were at highest risk for meningococcal disease. Other risk factors for meningococcal disease were race, upper respiratory tract infection, movie attendance, freshmen, dormitory status, and an interaction term for freshmen and dormitory status. In this model, among freshmen, dormitory residents were at increased risk for meningococcal disease (P = .06) and among dormitory residents, freshmen were at increased risk (P = .07).

**COMMENT**

This study suggests that freshmen living in dormitories have a moderately increased risk of disease, but US college students as a group are at no greater overall risk for meningococcal disease than nonstudents in similar age groups. The reason college students overall are not at increased risk is unclear and additional studies are needed.

Our findings are consistent with the experience in the military24 and our understanding of risk factors for meningococcal disease. Because of the close quarters in which they live, freshmen in dormitories may be exposed to N meningitidis more frequently than other college students. The exposed freshmen who become asymptomatic transient carriers would develop protective immunity leading to lower rates in subsequent years. The higher incidence of disease in freshmen in dormitories suggests that the college setting may be similar to the military setting where, prior to routine vaccination in 1971, the overall rate of meningococcal disease among all active duty members was 25 per 100000 person-years (LTC Frederick Erdt-

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**Table 2. Univariate Analysis of Risk Factors for Disease**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Case-Patients, No. (%)</th>
<th>Controls, No. (%)</th>
<th>Matched OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>26 (52)</td>
<td>38 (26)</td>
<td>3.0 (1.6-5.9)</td>
<td>.001</td>
</tr>
<tr>
<td>Freshman in dormitory</td>
<td>23 (46)</td>
<td>28 (19)</td>
<td>3.7 (1.8-7.7)</td>
<td>.001</td>
</tr>
<tr>
<td>Dormitory residence</td>
<td>33 (66)</td>
<td>67 (45)</td>
<td>2.7 (1.3-5.6)</td>
<td>.008</td>
</tr>
<tr>
<td>On-campus residence</td>
<td>36 (72)</td>
<td>76 (51)</td>
<td>2.9 (1.3-6.2)</td>
<td>.007</td>
</tr>
<tr>
<td>Consumed ≥5 alcoholic drinks†</td>
<td>26 (52)</td>
<td>50 (34)</td>
<td>2.4 (1.2-4.9)</td>
<td>.02</td>
</tr>
<tr>
<td>Frequent ≥3 parties or bars†</td>
<td>19 (38)</td>
<td>36 (24)</td>
<td>2.2 (1.0-4.7)</td>
<td>.04</td>
</tr>
<tr>
<td>Kissed ≥2 persons on the mouth‡</td>
<td>17 (34)</td>
<td>28 (19)</td>
<td>2.3 (1.1-4.8)</td>
<td>.03</td>
</tr>
<tr>
<td>Upper respiratory tract illness§</td>
<td>33 (66)</td>
<td>70 (47)</td>
<td>2.2 (1.1-4.4)</td>
<td>.03</td>
</tr>
<tr>
<td>White race</td>
<td>48 (96)</td>
<td>120 (82)</td>
<td>5.4 (1.2-24.2)</td>
<td>.03</td>
</tr>
<tr>
<td>Radiator heat¶</td>
<td>20 (42)</td>
<td>33 (23)</td>
<td>3.0 (1.3-6.7)</td>
<td>.008</td>
</tr>
<tr>
<td>Dine-in school cafeteria¶†</td>
<td>36 (72)</td>
<td>82 (55)</td>
<td>2.3 (1.1-4.7)</td>
<td>.03</td>
</tr>
<tr>
<td>Attended ≥1 movie‡</td>
<td>30 (61)</td>
<td>117 (79)</td>
<td>0.4 (0.2-0.9)</td>
<td>.02</td>
</tr>
<tr>
<td>Employed during school‡</td>
<td>17 (34)</td>
<td>74 (50)</td>
<td>0.5 (0.3-0.98)</td>
<td>.04</td>
</tr>
<tr>
<td>Low socioeconomic status¶</td>
<td>6 (14)</td>
<td>20 (14)</td>
<td>0.8 (0.3-2.3)</td>
<td>.62</td>
</tr>
<tr>
<td>Crowding‡</td>
<td>24 (48)</td>
<td>64 (43)</td>
<td>1.2 (0.6-2.4)</td>
<td>.51</td>
</tr>
<tr>
<td>Active smoking†</td>
<td>7 (14)</td>
<td>15 (10)</td>
<td>1.5 (0.5-4.0)</td>
<td>.45</td>
</tr>
<tr>
<td>Protective smoke exposure</td>
<td>22 (44)</td>
<td>58 (39)</td>
<td>1.2 (0.6-2.4)</td>
<td>.52</td>
</tr>
</tbody>
</table>

*OR indicates odds ratio; CI, confidence interval. On-campus residence includes residence in a dormitory or apartment located on the college campus.
†Per week in month of interest.
‡Two or more of the following symptoms in the month prior to illness: cough, ear infection, runny nose, or sore throat.
§Use of a radiator heating system in the residence in contrast to forced air, wood stove, or other.
¶Self-reported with a minimum of 1.5 meals per day eaten in the cafeteria.
$No more than $30000 per year in household income, which includes parents and student.
**Two or more people per bedroom.
††At least half a pack per day.

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**Table 3. Multivariable Analysis of Risk Factors for Disease**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Matched OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman in dormitory</td>
<td>3.6 (1.6-8.5)</td>
<td>.003</td>
</tr>
<tr>
<td>White race</td>
<td>6.6 (1.2-38.0)</td>
<td>.03</td>
</tr>
<tr>
<td>Radiator heat†</td>
<td>4.0 (1.4-11.0)</td>
<td>.008</td>
</tr>
<tr>
<td>Upper respiratory tract illness‡</td>
<td>2.3 (1.0-5.8)</td>
<td>.04</td>
</tr>
<tr>
<td>Movies§</td>
<td>0.4 (0.2-1.0)</td>
<td>.05</td>
</tr>
</tbody>
</table>

*OR indicates odds ratio; CI, confidence interval.
†Use of a radiator heating system in the residence in contrast to forced air, wood stove, or other.
‡Two or more of the following symptoms in the month prior to illness: cough, ear infection, runny nose, or sore throat.
§In month prior to illness.
MENINGOCOCCAL RISK FACTORS

mann, MC, USA, Office of the Surgeon General, US Army, written communication, 1981) and rates were highest among military recruits.18,19 While rates are elevated among freshmen students living in dormitories, they are not as high as rates among military recruits living in barracks. One possible explanation for this difference is that crowding among freshmen in college dormitories may not reach levels comparable to those of new military recruits in barracks. We evaluated the number of people sharing a room in a college dormitory but did not have more exact measures of crowding, such as distance between beds, which was shown in one military study to be associated with rates of meningococcal carriage.20 While crowding is one possible explanation, insufficient data are available to suggest that changes in living conditions would decrease risk among college students.

In addition, the majority of cases among military recruits occurred shortly after reporting to basic training whereas cases among college students are highest in the winter months, similar to the overall seasonality of meningococcal disease in the United States. These data suggest that while there are similarities between college students and military recruits, risk factors between the groups may differ.

Other studies have examined risk factors for meningococcal disease; however, this is the first case-control study to our knowledge that addresses the risk factors for this disease among college students throughout the United States. Previously identified risk factors for meningococcal disease include underlying immune deficiency,21,22 recent upper respiratory tract infection,23-25 low socioeconomic status,26-28 household and institutional crowding,29-32 tobacco smoke exposure,33-35 bar and nightclub patronage,33-34 and black race.1,36 Aside from implicating freshmen living in dormitories, our study found that students with prior upper respiratory tract infections, students exposed to radiator heat, and white students were at higher risk for disease, while students who attended movies were at lower risk. Tobacco smoke exposure, alcohol consumption, low socioeconomic status, and crowding were not implicated. Exposure to tobacco smoke may not have been associated with meningococcal disease in this population because of the low proportion of people exposed. Only 7 case-patients (14%) and 15 controls (10%) reported smoking, and both case-patients and controls reported infrequent exposure to passive smoke. However, of the 19 case-patients and 36 controls who reported frequenting bars or parties, which are often associated with passive smoke exposure, only 11 (58%) case-patients and 20 (56%) controls reported exposure to passive smoke, suggesting that underreporting may have led us to underestimate the risk.

Recent upper respiratory tract infection was also independently associated with meningococcal disease and was common in this population through the entire school year (data not shown), suggesting that multiple etiologies could be responsible and that prevention would be difficult. Alcohol has been reported as a risk factor for meningococcal disease in several outbreaks;33,34,37 our finding of alcohol consumption as a risk factor on univariate analysis, but not in the multivariable analysis, suggests that it may be a marker for other high-risk behaviors such as active and passive smoking. Likewise, movie attendance and radiator heat are probable markers for other exposures or behaviors.

The data from our study are consistent with 2 other recent US studies that found no significant increased risk of meningococcal disease in college students but found that subgroups of college students were at higher risk;9,10 however, these previous studies have important limitations. A survey published in 1988 found a low overall incidence of meningococcal disease among college students, but higher rates of disease in students living in dormitories compared with students living in other types of residences.12 However, responses were available from only 38% of the 1900 universities to which surveys were sent and the study design did not allow separate evaluation of the risk among freshmen. A study from Maryland found that from 1992 to 1997 on-campus residents (defined as students living in a dormitory or apartment located on campus) were at higher risk of meningococcal disease. However, the number of cases detected was small and the data from Maryland may not be representative of the entire country.9 Consistent with this, although only a single year of national data is available, in our study the incidence of meningococcal disease in college students varied by geographic region with the highest rates in the southeast, northeast, and north central regions. A recent study from the United Kingdom where rates of serogroup C meningococcal disease are higher than in the United States found that unlike those in the United States, college students in the United Kingdom were at higher risk than other 18- to 23-year-olds.11 This increased risk along with the overall higher rates of meningococcal disease in the United Kingdom led the National Health Service to begin routine vaccination of college students with a serogroup C polysaccharide vaccine.38 Similar to the US studies, UK students living in catered halls (equivalent of US dormitories) were at higher risk.11 In our case-control study, 85% of freshmen lived in dormitories, making it difficult to disentangle these 2 risk factors.

The 96 cases of meningococcal disease in college students detected between September 1998 and August 1999 represent approximately 3% of the total number of cases that occur each year in the United States (NETSS data). Of these 96 cases, 30 (31%) occurred among freshmen in dormitories. Immunization with the currently available quadrivalent meningococcal polysaccharide vaccine would decrease the risk for meningococcal disease in college students who choose to be vaccinated, but would not eliminate risk because the vaccine confers no protection against the 28% of cases that were serogroup B and its efficacy against serogroups A, C, Y, and W-135 is 85% to 95%.7 Our study is important because it identified a relatively small group of college students at a higher risk for meningococcal disease.
cocal disease who are easily accessible and could be targeted for immunization. Both ACIP and AAP used these data and other recently published studies\textsuperscript{8-11} as a basis for new recommendations.\textsuperscript{12,13} In addition, they considered data on cost-effectiveness that showed from a societal perspective vaccination of college freshmen is unlikely to be cost saving; however, cost-effectiveness analysis does not take into consideration disruption of campus life, public anxiety, and private tragedy resulting from a case of severe meningococcal disease (R. Douglas Scott II, PhD, unpublished data, 2000). The ACIP and AAP recommended educating college freshmen, especially those who live in dormitories, and their parents about the risk of meningococcal disease and the availability of a safe and effective vaccine that could decrease their risk; they further recommended increasing access to the vaccine for college freshmen.

Meningococcal conjugate vaccines are currently under development and will be available within 2 to 3 years in the United States. These vaccines, similar to Haemophilus influenzae type b vaccine and pneumococcal conjugate vaccines,\textsuperscript{30-36} are expected to provide long-lasting immunity in infants and adults and possibly confer herd immunity. During this interim 2- to 3-year period, widespread use of the currently available quadrivalent polysaccharide vaccine among college freshmen could substantially decrease their risk of meningococcal disease. When conjugate vaccines become available, further evaluation will need to be performed to assess the use of conjugate vaccines among college students compared with less expensive polysaccharide vaccines.

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**Acknowledgment:** We thank all state and local health departments who participated in surveillance, all participating colleges, The Meningitis and Varicella Surveillance Project network, and the American College Health Association. Special thanks to Jim Singleton, MS, and Ray Strikas, MD, of the National Immunization Program for their assistance in developing the surveillance network; Jordan Tappero, MD, of the Meningitis and Special Pathogens Branch for his review of the manuscript; Matt Carter, MD, at the State Health Department in Connecticut; and Patricia Quinlisk, MD, at the Iowa Department of Public Health for their assistance.

**REFERENCES**


