Infectious Disease in a Total Institution: A Study of the Influenza Epidemic of 1978 on a College Campus

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INFLUENZA, ONE OF THE MOST COMMON infectious diseases in the United States, has been called "the last great plague of man" (*1*). Although it is no longer one of the most important causes of mortality (*2,3*), influenza still constitutes a major disease problem (*4*). It has recently exhibited antigen shifts that have produced strains leading to major epidemics and to increased influenza-related mortality (*4–8*).

The 1977–78 epidemic of the "Russian flu" (A/USSR/1977 H1N1) is one of the most dramatic examples of this phenomenon. Absent from the United States since 1957 (*9*), the strain that gave rise to this epidemic emerged in Russia and China in 1977 (*5,6*). In the United States, the strain was first isolated in January 1978 in Wyoming (*6*) and was in the unique situation of coexisting with two other major strains (A/Texas/77 H3N2 and A/Victoria/75 H3N2) (*9,10*), a circumstance foreboding a winter of severe influenza in 1978.

A significant characteristic of the influenza epidemic of that winter was the rapid spread and high incidence of the disease in schools with students in residence (*7,9,11–16*), a pattern evidenced in earlier influenza epidemics, in which isolated groups exhibited an epidemic although the incidence of the disease in the surrounding community was low (*17*). A residential school is an example of a "total institution," a "place of residence and work where a large number of like-situated individuals, cut off from the wider society for an appreciable period of time, together lead an enclosed, fully administered round of life" (*18*). The attributes of total institutions that are relevant to health include standardized mass activities under a central authority, the separation of residents from administrators in a castelike stratification, and a separate resident subculture with its own activities and organization.

Total institutions afford a classic example of the effects that social organization may have upon infectious disease. The first clearly defined cluster of influenza in human beings occurred in a total institution, in 1918 at Fort Riley military base in Kansas (*1,19*). The recent epidemics of the H1N1 strain of influenza in the United States in 1946 and 1947 (*8*) have been concentrated in military personnel. The total institutions that

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have been mentioned in the literature as the sites of influenza epidemics include nursing and geriatric homes (*20,21*), ships (*19,22, 23*), residential secondary schools (*15,16,24–31*), colleges (*9,11,15,19, 32*), hospitals (*33*), prisons (*16*), and mental institutions (*34*). Further research on influenza in total institutions can lead to an understanding of how their social structure provides unique opportunities for the spread of infectious disease.

Two aspects of total institutions are pertinent to the spread of influenza: the permeability of their boundaries and the groups and activities within the institution that affect social contact between the residents. The variation in the openness of the boundaries of total institutions results in differences in the amount of contact that residents have with the outside social environment. Infectious disease researchers must examine the openings that may exist in these boundaries, looking for groups or persons who have contacts outside the institution and who thus may serve to introduce the disease into the institution or to release a disease previously confined within the total institution to a wider society. Participation in group activities within the institution may facilitate or inhibit an epidemic once the disease is introduced. The subculture of institutions must be delineated in terms of disease-relevant attributes. If some residents have more contact with the rest of the institutionalized population than others, then the attributes of the institutional structure that promote or inhibit social participation become relevant to the spread of communicable disease.

Because of the rapid diffusion of the 1978 influenza epidemic and the disease's short duration, its mild effects, and the specific target group involved—adults under age 25 (*8,11*)—this epidemic provided an excellent opportunity to study epidemiology in a total institution. Other studies of colleges provide indications of the influence of social factors upon institutional epidemics. Pons and associates (*11*), studying the 1978 influenza outbreak on a university campus, found the disease significantly more prevalent among students residing on campus than those residing off campus, although both groups still had a high attack rate. These authors interpreted the high incidence in both groups as indicating that transmission had occurred primarily through daytime activities, such as classes, and attributed the higher rate for dormitory residents to their greater collective exposure to the disease in the

evenings. Students under the age of 23 were significantly more likely to contract the disease than older students.

Layde and associates (*32*) investigated the 1978 influenza outbreak on a large urban campus, where the disease had spread primarily on one weekend in February 1978. The high attack rate of 62.3 percent among undergraduates was in sharp contrast to the low 9.4 percent incidence among faculty members. Some 50 to 75 percent of the influenza victims reported some absenteeism. Although the average number of days missed was less than 2, this absenteeism resulted in a suspension of classes 1 week after the original weekend of onset. Dental students had an attack rate of 22 percent among 23-24 year olds, 14.3 percent among those 25 and 26, and 8.3 percent among those 27 or older.

Glass and associates (*9*) investigated influenza in a county in New Jersey, monitoring weekly absenteeism in 95 public schools, infirmary admissions in three residential schools, and febrile illness in four nursing homes. The incidence of illness in nursing homes (which are also total institutions) parelleled that of the general working population. Public school students had lower rates of absenteeism following Christmas vacation and after a week in which school was closed because of snow than at other periods. Glass and associates concluded that the snow recess of the public schools imposed a relative quarantine on the students, preventing pupil-to-pupil contact and an outbreak of disease. In contrast, residential school students—members of educational total institutions—exhibited the greatest risk of influenza of any group. The peak of the epidemic occurred during the snowstorm, when the students were confined within their institutional boundaries. Glazen and associates (*35*), reporting an outbreak of influenza in students immediately following a boarding school recess, attributed the epidemic to the reconvening of the educational institution.

In contrast, Briscoe (*30*) reported that an influenza epidemic in a boarding school subsided slightly after the half-term holiday (which took place just as the epidemic was peaking), but that it reappeared because the break was shorter than the incubation period of the disease (usually 2 to 4 days); a nucleus of influenza carriers who returned to the school had rekindled the epidemic.

These three studies show that vacations or recesses, by breaking the normal boundaries of total institutions, can lead to an epidemic. Residents who are exposed to outside sources of disease during school intermissions are concentrated in one place when they return to the institution. On the other hand, intermissions, by separating residents from one another, may reduce or prevent the spread of disease.

All of the studies we have cited show that social organization can strongly influence influenza epidemics in total institutions. We decided to pursue this subject further by analyzing an influenza outbreak on a college campus in the period 1977–78.

Methodology

To investigate the influenza epidemic at a small private liberal arts college in Pennsylvania, we had 17 students in a medical anthropology course conduct personal interviews based on a nine-question standardized interview schedule. The sample of 418 respondents comprised 21 percent of the total college population of 1,844 students and 137 full-time and 35 part-time faculty members. Less than 5 percent of the students were more than 22 years of age.

Under our sampling procedure, each residential area of the college community was assigned to 1 of the 17 interviewers, who then interviewed a quota sample of 25 residents at each site. Respondents were asked if they had or had not had the flu, as measured by a self-report question. All those who reported having the flu were then asked, in an open-ended question, to list their symptoms (up to seven). The date that the person first contracted the disease was recorded, along with the number of days of illness. In addition, relevant student demographics were collected, including sex, year in school, residence area, floor of residence, membership in a fraternity or sorority, and participation in fraternity or sorority recruitment activities.

A large number of clinical symptoms have been associated with influenza: sudden onset, chills, fever, headache, sore throat, hoarseness, cough, sputum, photophobia, nausea, vomiting, diarrhea, and abdominal pain (*36*)—the last four being less commonly associated with the disease and generally considered to be less indicative of it than the others. Because the symptoms for influenza are nonspecific and the disease is often over-reported (*37*), and because serologic confirmation was not possible in our study, we used a case definition to delineate the illness. A person was considered to have a case of influenza if he or she reported having the disease, reported at least 1 day of sickness, and had two or more of the symptoms of fever, headache, and res-

Number and percentage of persons with cases of influenza reporting various symptoms

Symptoms	Number reporting	Percent reporting [1]
Fever	151	83.0
Headache	113	62.1
Cough	104	57.1
Aches and pains	90	49.5
Sore throat	87	47.8
Congested nose	55	30.2
Tired	44	22.2
Hot and cold spells	36	19.8
Runny nose	26	14.3
Vomiting	14	7.7
Dizziness	14	7.7
Stomach ache	13	7.1
Weakness	10	5.5
Chest pain	10	5.5
Burning eyes	9	4.9
Cold-type symptoms	8	4.4
Swollen throat glands	7	3.8
Fainting	6	3.3
Earache	6	3.3
Dry throat	4	2.2
Loss of appetite	3	1.6
Stiff joints	3	1.6
Diarrhea	2	1.1
Laryngitis	2	1.1
Cramps	2	1.1
Sweating	2	1.1
Stiff neck	1	.5

[1] The percentages do not sum to 100.0 because respondents reported multiple symptoms.

piratory problems. (We realize that the procedure we used was no substitute for laboratory confirmation of the disease. Nevertheless, it was the most applicable indirect technique for a sociological study in which serologic confirmation was not possible because of its complexity and cost in dollars and time (*38*).) When Layde and associates (*32*) used this technique of symptomatic case definition in their influenza survey at a university, they found close agreement between subjective reporting of the flu, the symptom-based case definition, and laboratory assay based on serologic tests (although there were minor discrepancies between their survey and laboratory followup).

Results

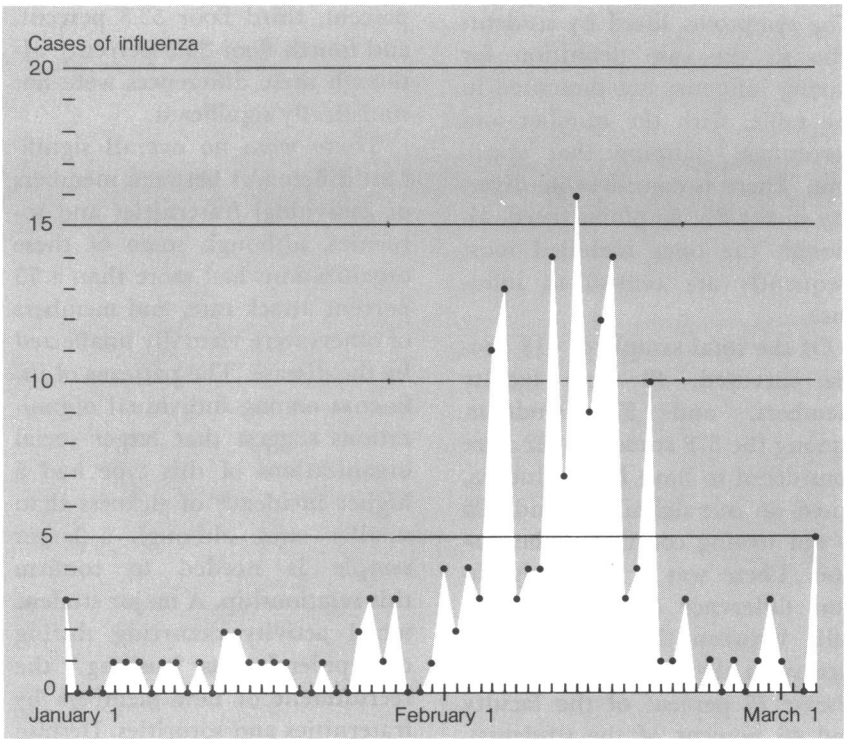
The symptoms listed by students who fit the case definition for having influenza are presented in the table, with the number and percentage claiming that symptom. There is considerable diversity in the 27 symptoms listed, although the ones included most frequently are central to influenza.

Of the total sample of 418 people surveyed, 40 were faculty members, and 378 students. Among the 378 students, 182 were considered to have had influenza, based on our definition, and 196 as not having contracted the disease. There was a highly significant difference (chi square, $P < 0.01$) between the students and faculty in the attack rate for the disease (5 percent of the faculty and 48 percent of the students). We examined subpopulations of the students to analyze their susceptibility to influenza, comparing students in the samples whose cases fit our definition of influenza with those whose cases did not. The sex difference between those with the disease and those without was not statistically significant (48.7 percent of those who contracted the disease were male and 47.5 percent female). Although first-year students had the highest rate (freshmen 56.7 percent, sophomores 46.2 percent, juniors 44.0 percent, and seniors 46.6 percent), the difference was not statistically significant. The ecological variable of residence was not significantly associated with incidence of the disease; 49.6 percent of the dormitory dwellers, 44.4 percent of the fraternity residents, and 44.7 percent of the people who lived in apartments off campus had influenza. The floor of residence showed differences in the attack rate (first floor 49.3 percent, second floor 44.6 percent, third floor 53.8 percent, and fourth floor 35.3 percent), although these differences were not statistically significant.

There were no overall significant differences between members of individual fraternities and sororities, although some of these organizations had more than a 75 percent attack rate, and members of others were virtually unaffected by the disease. The patterns of influenza among individual organizations suggest that larger social organizations of this type had a higher incidence of sickness than smaller ones, although a larger sample is needed to confirm this relationship. A major student social activity occurring during the epidemic was "rushing," the recruitment of new members by fraternities and sororities. Despite our hypothesis that the additional institutional activity of participants in this social activity would lead to their having greater susceptibility to influenza than nonparticipants, the difference was not statistically significant (49.6 percent of those involved in the rushing and 46.2 percent of those not involved had the disease).

In addition to examining the prevalence of the disease, we studied its transmission by asking respondents when they had first contracted influenza. December 14, 1977, was the date that the first case of influenza was reported at the campus infirmary. The earliest date that a case was reported in our sample was January 1, 1978, and the latest date was March 4, 1978. There were relatively few cases during January 1978. The progress of the virus in our sample is shown in the chart. The number of cases was relatively low until the end of the first week in February, when a peak occurred; then came a 3-day lag

Progress of influenza on a college campus in 1978



(which corresponds to the incubation period for influenza), followed by 9 days of rapid spread in the campus population, and finally, a decline in the number of cases. Twenty-four cases were recorded on February 5 and 6, the first 2 days after the students returned from their between-semester break. The peak period was February 10–18, the modal day being February 12. This pattern is in line with that in the college infirmary records, which show a peak on February 13; 236 of the total 800 cases brought to the attention of the infirmary were reported to it on that day. An estimated 300 cases were not reported to the infirmary.

Our survey was designed to record a proportional number of officially reported and unreported cases of influenza and also to record the actual date of the onset of each case rather than the time that the students decided to seek medical attention for their symptoms. The initial peak of cases occurred over a weekend, as did the main body of the epidemic, a result suggesting that students "allowed" themselves to attend to their illness only after the weekday press of academic work was completed. These observations indicate that the survey data were more representative of the true epidemiology of influenza on the campus than the medical records.

The final variable that we assessed was the duration of the disease. Duration ranged from 2 to 31 days among the students: infirmary cases averaged 4 days, and the modal value for our sample was also 4 days. There were no statistically significant differences in the duration of the disease by sex, class year, the students' participation in rushing, the floor on which they lived, fraternity or sorority membership, or area of residence.

Discussion

In the total institution that we studied, the institution's ecology, student demographics, and organizational activities (such as fraternity and sorority rushing) were examined in relation to an influenza epidemic. The original introduction of the disease in the population occurred immediately after the intersemester vacation, a period when the boundaries of the total institution were temporarily dissolved and many students were undoubtedly exposed to influenza during contacts with the larger social environment. It is likely that the few cases that appeared during January were due to one of the H3N2 strains that had been present in the State before the H1N1 virus appeared (*6, 39*). These cases may have been caused by strains to which only a few people were susceptible, especially since it was too early for infection from the A/USSR/77 (H1N1) antigen, to which not many people under age 25 were immune. In view of the proximity of the residential students to one another, the relative absence of influenza during January probably was not due to the "preseeding" phenomenon (*17*), in which a virus enters a population without producing an epidemic for some time.

Social aspects of the total institution we studied may have played a role in the low level of influenza during January. January is an unusually inactive social period on this campus, a period when students take a single month-long course and many attend off-campus sessions and participate in internship programs. Normal organized social activities are suspended; those that continue are fragmentary; classes are smaller; thus, organized contact is greatly diminished. All of these factors

may have inhibited the spread of influenza.

Although detailed descriptive epidemiologic reports are not available, by the third week of February, H1N1 outbreaks such as the one described here occurred in total institutions in 19 areas of the United States, including Pennsylvania (*40*), where the college we studied is located. In these total institutions, explosive outbreaks of influenza occurred lasting 1 to 2 weeks, the attack rates were 40 to 70 percent, and the symptoms reported were similar to those we found in our case study (*40*). Thus, our study is probably representative of an epidemic in this type of total institution.

Our study also supports the observation by other researchers that people over age 23 were largely immune to some of the 1977–78 influenza strains, perhaps because of past exposure in 1957 (*9,11,12,* and *41*), or more likely, because of immunity to the 1950 strain (*42*). Age has often been seen as a significant factor in susceptibility to influenza (*43*). Armelagos and associates (*44*) noted that epidemics affect all age segments of a virgin population, whereas endemics or recurring epidemics are often age specific and are concentrated in the old and young. The lower disease rates for faculty than students found in our study is an excellent example of the operation of this age factor. In universities in which graduate students are present, the population is not as homogeneous in age as in purely undergraduate colleges, and therefore the students are less likely to provide a totally virgin population for influenza antigens. Therefore, as we examine the epidemiology of infectious diseases, we need to be sensitive to the age segregation in total institutions, where either virgin populations or groups with high resistance to disease may be voluntarily or involuntarily concentrated. Institutional residence can also create barriers that shield age-homogeneous subpopulations from epidemics occurring in the surrounding population (*24*).

Although the student social groups and activities within the total institution that we studied did not make a significant difference in the incidence or duration of influenza, such variables may play significant roles in disease transmission in other total institutions. More research on the topic is needed, and we hope that future investigators will pay special attention to the role of total institutions in epidemiologic processes.

References

1. Kaplan, M. M., and Webster, R. G.: The epidemiology of influenza. Sci Am 237: 88–106 (1977).
2. Eickhoff, T. C., Sherman, I. L., and Serfling, R. E.: Observations on excess mortality associated with epidemic influenza. JAMA 176: 776–782 (1961).
3. Sabin, A. B.: Mortality from pneumonia and risk conditions during influenza epidemics. JAMA 237: 2823–2828 (1977).
4. Gregg, M. B., et al.: Influenza related mortality. JAMA 239: 115–116 (1978).
5. Zhdanov, V. M., et al.: Return of epidemic A1 (H1N1) influenza virus. Lancet 1: 294–295 (1978).
6. Centers for Disease Control: Influenza-worldwide. Morbidity and Mortality Weekly Report, 1978, vol. 27, p. 40.
7. Centers for Disease Control: Influenza—United States. Morbidity and Mortality Weekly Report, 1978, vol. 28, p. 114.
8. Gregg, M. B., Hinman, A. R., and Craven, R. B.: The Russian flu: its history and implications for this year's influenza season. JAMA 240: 2260–2263 (1978).
9. Glass, R. I., et al.: Community-wide surveillance of influenza after outbreaks due to H3N2 (A/Victoria/75 and A/Texas/77) and H1N1 (A/USSR/77) influenza viruses, Mercer County, New Jersey, 1978. J Infect Dis 138: 703–706 (1978).
10. Kendal, A. P., et al.: Laboratory-based surveillance of influenza virus in the United States during the winter of 1977–1978. II. Isolation of a mixture of A/Victoria- and A/USSR-like viruses from a single person during an epidemic in Wyoming, USA, January 1978. Am J Epidemiol 110: 462–468 (1979).
11. Pons, V. G., Canter, J., and Dohn, R.: Influenza A/USSR/77 (H1N1) on a university campus. Am J Epidemiol 111: 23–30 (1980).
12. Foy, H. M., et al.: Influenza surveillance by age and target group. Am J Epidemiol 109: 582–587 (1979).
13. Penny, P. T.: Epidemic influenza in schools. Br Med J 1: 298–299 (1978).
14. Centers for Disease Control: Influenza—United States, USSR. Morbidity and Mortality Weekly Report, 1977, vol. 26, p. 444.
15. Centers for Disease Control: Influenza—worldwide. Morbidity and Mortality Weekly Report, 1979, vol. 35, pp. 3–8.
16. Centers for Disease Control: Influenza—United States, Canada. Morbidity and Mortality Weekly Report, 1978, vol. 27, pp. 55–56.
17. Stuart-Harris, C.: Epidemiology of influenza in man. Br Med Bull 35: 3–8 (1979).
18. Goffman, E.: Asylums. Doubleday & Company, Inc., Garden City, NY, 1961.
19. Walters, J. H.: Influenza 1918: The contemporary perspective. Bull NY Acad Med 54: 855–864 (1978).
20. Genesove, L. J., and Riddiford, M.: Influenza in a nursing home. Can Med Assoc J 118: 1202 (1978).
21. Gondwa, H. T.: Influenza in a geriatric unit. Postgrad Med J 55: 188–191 (1979).

22. Olson, J. G., Ksiazek, T. G., Irving, G. S., and Rending, R. W.: An explosive outbreak of influenza caused by A/USSR/77-like virus on a United States naval ship. Milit Med 11: 743–745 (1979).
23. Ksiaszek, T. G., et al.: An influenza outbreak due to A/USSR-like (H1N1) virus aboard a U.S. Navy ship. Am J Epidemiol 12: 487–494 (1980).
24. Malan, G.: Outbreak of influenza among scholars. South Afr Med J 54: 303 (1978).
25. Fayinka, O. A., Belayan, M. S., Kirya,, G. B., and Rugyendo, W.: An outbreak of influenza B in a closed community school in Uganda. East Afr Med J 54: 6–8 (1977).
26. Briscoe, J. H.: The protective influence of influenza vaccine in a mixed influenza A and B epidemic in a boys' boarding school. J R Coll Gen Pract 27: 28–31 (1977).
27. Hoskins, T. W., et al.: Influenza at Christ's Hospital: March 1974. Lancet 1: 104–108 (1976).
28. Hoskins, T. W., et al.: Controlled trial of inactivated influenza vaccine containing the A/Hong Kong Strain during an outbreak of influenza due to the A/England/42/72 strain. Lancet 2: 116–120 (1973).
29. Smith, T. C.: The efficacy of influenza vaccination in a boys' boarding school. Practitioner 214: 821–826 (1975).
30. Briscoe, J. H.: Intranasal immunization with inactivated influenza virus vaccine in a boys' boarding school. Practitioner 214: 821–826 (1975).
31. Turtle, P. deBec: Vaccines in the management of influenza epidemics in schools. Practitioner 200: 254–259 (1968).
32. Layde, P. M., et al.: Outbreak of influenza A/USSR/77 at Marquette University. J Infect Dis 142: 347–352 (1980).
33. Hoffman, P. C., and Dixon, R. E.: Control of influenza in the hospital. Ann Intern Med 87: 725–728 (1977).
34. Boger, W. P., and Frankel, J. W.: Asian influenza: Isolated outbreak within a large closed population. Am J Public Health 52: 834–840 (1962).
35. Glezen, W. P., et al.: Epidemiologic observations of influenza B virus infections in Houston, Texas, 1976–77. Am J Epidemiol 111: 13–22 (1980).
36. Douglas, R. G.: Influenza in man. *In* The influenza viruses and influenza, edited by E. Kilbourne. Academic Press, New York, 1975, pp. 395–447.
37. Kilbourne, E.: Epidemiology of influenza. *In* The influenza viruses and influenza, edited by E. Kilbourne. Academic Press, New York, 1975, pp. 483–537.
38. Peterson, D., Andrews, J. S., Levy, B. S., and Mitchell, B.: An effective school-based influenza surveillance system. Public Health Rep 94: 88–92, January–February 1979.
39. Centers for Disease Control: Influenza—Peoples Republic of China, Taiwan, Philippines, United Kingdom, United States. Morbidity and Mortality Weekly Report 1978, vol. 27, p. 24.
40. Centers for Disease Control: Influenza—worldwide. Morbidity and Mortality Weekly Report, 1978, vol. 27, p. 64.
41. Pyhala, R., Aho, K., and Visakorpi, R.: Seroepidemiology of H1N1 influenza: striking differences in the attack rate among young people. Acta Pathol Microbiol Scand 87: 161–164 (1979).
42. Scholtissek, D., von Hoyningen, V., and Rott, R.: Genetic relatedness between the new 1977 epidemic strains (H1N1) of influenza and human influenza strains isolated between 1947 and 1957. Virology 89: 613–617 (1978).
43. Kalter, S. S.: The effects of age upon susceptibility to infection with influenza virus. J Immunol 63: 17–23 (1949).
44. Armalagos, G. J., Goodman, A., and Jacobs, K.: The ecological perspective in disease. *In* Health and the human condition, edited by M. Logan and E. Hunt. Duxbury Press, North Scituate, Mass., 1978, pp. 71–84.

SYNOPSIS

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The influenza epidemic of 1978 was studied on a college campus, since a college is a type of "total institution" in which work, residence, and recreation are all concentrated in one organization with clearly delineated social boundaries and a unique social structure. A survey of a sample of 418 persons (378 students, 40 faculty members) revealed that more than 48 percent of the students contracted influenza and that the intersemester vacation was a social factor that may have aided in the disease's penetration of the institution's boundaries. The vacation exposed the students to the distase, and the resumption of classes allowed influenza to spread rapidly in the student population, which was concentrated within the boundaries of the educational institution. The faculty exhibited relative immunity to the disease compared with the students, having only a 5 percent attack rate. There were no significant differences in the incidence or duration of illness among the students by sex, year in school, residence area, floor of residence, fraternity or sorority membership, or participation in fraternity or sorority recruitment activities.