Estimating the Usual Prevalence and Incidence of Acute Illness in the Community: Implications for Pandemic Influenza and Bioterrorism Preparedness

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Background: Early clinical signs of influenza caused by a pandemic strain will presumably not differ significantly from those caused by other respiratory viruses. Similarly, early signs of diseases that may result from bioterrorism are frequently non-specific and resemble those of influenza-like illness. Since the time window for effective intervention is narrow, treatment may need to be initiated prior to a definitive diagnosis. Consequently, planning of medications, manpower and facilities should also account for those who would be treated for an unrelated acute illness.

Objectives: To estimate usual patterns of acute illness in the community as a baseline for integration into pandemic influenza and bioterrorism preparedness plans.

Methods: Between 2000 and 2003 we conducted 13 telephone surveys to estimate the usual incidence and prevalence of symptoms of acute illness in the community.

Results: On average, 910 households were included in each of the surveys, representing about 3000 people. The compliance rates for full interviews ranged from 72.3% to 86.0%. In winter, on average, about 2% of the Israeli population (individuals) suffered each day from fever of ≥ 38ºC, and about 0.8% during the other months. The prevalence of cough was higher, 9.2% in winter and 3% during summer. Daily incidence of fever ranged from about 0.4% per day in winter to about 0.2% in the fall. The prevalence and incidence of both fever and cough were highest for infants followed by children aged 1–5 years.

Conclusions: These background morbidity estimates can be used for planning the overall treatment requirements, in addition to actual cases resulting from pandemic influenza or a bioterrorist incident.

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Stockpiling medications and vaccines and scheduling manpower and facilities is part of the preparedness programs developed by the World Health Organization and many countries to cope with pandemic influenza as well as the threat of bioterrorism [1-7]. Clinical signs of influenza caused by a pandemic strain presumably will not differ significantly from those caused by other respiratory viruses. Similarly, early signs of diseases that may result from bioterrorism (anthrax, plague, etc.) are frequently non-specific and resemble those of influenza-like illness. Since early treatment of cases is essential to improve outcome, during an outbreak many cases will be treated on the basis of symptoms and signs only, prior to a definitive laboratory diagnosis. Some of these people will be suffering from unrelated acute illness. In order to model resources required to treat all those ill, it is essential to take into account the background illness in the community. This requires data on the usual prevalence and incidence of symptoms of acute morbidity, by factors such as age, season and place. Since information on this subject is sparse, we conducted a number of population-based surveys.

Methods

Population

Thirteen national, seasonal, acute morbidity household surveys were carried out in Israel between January 2000 and July 2003.

Sample size

The sample size calculations were based on the number required to estimate prevalence of fever of 3% with 95% confidence interval of ± 0.6%. The number obtained was about 3000 people (about 940 households).

Sampling method

Based on a predicted response rate of 50%, a random sample of 1800 telephone numbers was taken from the national telephone directory using commercial software. The telephone directory does not include numbers of cellular phones. However, based on the Israel Central Bureau of Statistics data for 2002 [8], 90.9% of the households in Israel owned at least one telephone line. Ownership rates of at least one telephone line were 73.6%, 82.0% and 83.8% in the first three deciles of the population, respectively, 90.5% in the fourth decile and 98.8% in the tenth decile. For each survey a new sample was prepared.

Survey description

Data were collected through telephone interviews by trained interviewers, monitored during each of the surveys. The interviewees had to be at least 18 years old, and were asked to report for all the permanent household members who live within the family at least 3 days a week. All the surveys were carried out during the afternoon and evening hours (4.00 to 10.00 p.m.). Each survey was usually accomplished in 4 days, during which there was a complete round of contact trials with the sample households and another four rounds trying to contact those households that were not available at the first trial. At the end of each survey, the actual sample was compared with the general Israeli population by number of persons in a household, age and residential region. Compliance was computed by dividing the number of full

interviews with the number of households where the connection trials were successful.

The questionnaire

A structured questionnaire was constructed and translated into Arabic, Russian and English in order to facilitate interviewing non-Hebrew speakers. The interviewees were asked questions about all household members regarding demographic characteristics, fever of ≥ 38°C, cough, nausea and/or vomiting, sore throat and myalgia on the day of the survey. If any of the symptoms were present, the interiewees were asked when the symptom began (today, yesterday or before). The question on fever was also accompanied by a question on the maximum temperature measured for the household members reported to suffer with fever on the surveyed day. Other questions dealt with visits to healthcare facilities and the use of antibiotics for any of the symptoms.

Estimating prevalence and incidence

Prevalence and incidence were defined as follows: Prevalence is the percentage of family members reported to suffer from the symptom on the surveyed day, regardless of when the symptom appeared. Incidence is the percentage of family members reported to suffer from the symptom on the surveyed day when the symptom appeared initially on that same day.

For computing the crude prevalence and incidence rates, the number of family members reported to suffer from each questioned symptom were summed up and then divided by the overall family members. For age-specific and region-specific estimates, respective counts were used as numerators and denominators.

Statistical analysis

Data are presented as averages of estimates received during the surveys, including the respective standard deviations. The variances were computed taking into account two sources of variance, the variance originating in each of the surveys and that between the surveys. Pearson correlation coefficients were used to examine the association between the prevalence of different symptoms. Multiple logistic regression analysis was used to study possible household clustering of the prevalence of disease. For this purpose, we used the combined data of all the surveys, while defining two new dichotomous variables, which related to the presence of fever, at the household level. The dependent variable was the presence or absence of fever in at least one household member older than 6 years, and the independent variable was fever in, at least, one household member ≤ 6 years old. Three regression models were used: a) with only the basic two variables included, b) including a variable representing the household size (number of persons at the household), and c) including a variable related to the season of the survey. Fall and winter were regarded as one group, and spring and summer formed the second group which served as the reference group in the analysis.

ArcGIS™ version 8.3, Environmental Systems Research Institute (ESRI) software for Geographical Information System applications, was used to construct a map showing region-specific estimates for daily prevalence of selected symptoms. Analyses were carried out using the SAS statistical package version 9.1.

Results

On average, 910 households per survey (range 709–1005) were included in the 13 surveys, which represent an average of 3120 family members (range 2413–3417) per survey. The compliance rates for full interviews ranged from 72.3% to 86.0% (average 80.2%). The actual samples resembled the general population quite well. For example, children less than 15 years old constituted on average 26.0% and 28.7% in the samples and the general population, respectively. The eldest age group of 65 years constituted on average 10.3% in the samples, compared with 9.7% in the general population.

Prevalence and incidence by season

- *Fever*: The average daily prevalence of fever (≥ 38°C) during winter was 2.1% and lower estimates were obtained for the other seasons, ranging from 0.7% in the fall to 0.9% in summer [Figure 1A]. The average daily incidence of fever ranged from 0.16% in the fall to 0.43% in winter [Figure 1B]. At the household level, fever was prevalent in 6% of the households (at least one household member was febrile) during winter. For other seasons, the estimates are similar, ranging from 2.1% to 2.8%. Of those reported to have fever on the days that the surveys were carried out, 60.3% visited

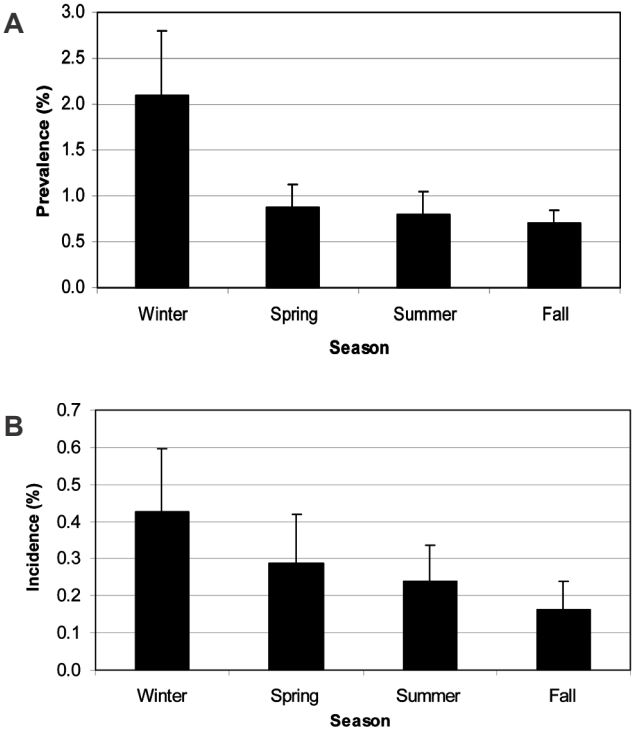

Figure 1. Fever (≥ 38°C) in Israel by season, based on 13 telephone surveys (the bar indicates standard deviation). **[A]** Mean daily prevalence. **[B]** Mean daily incidence.

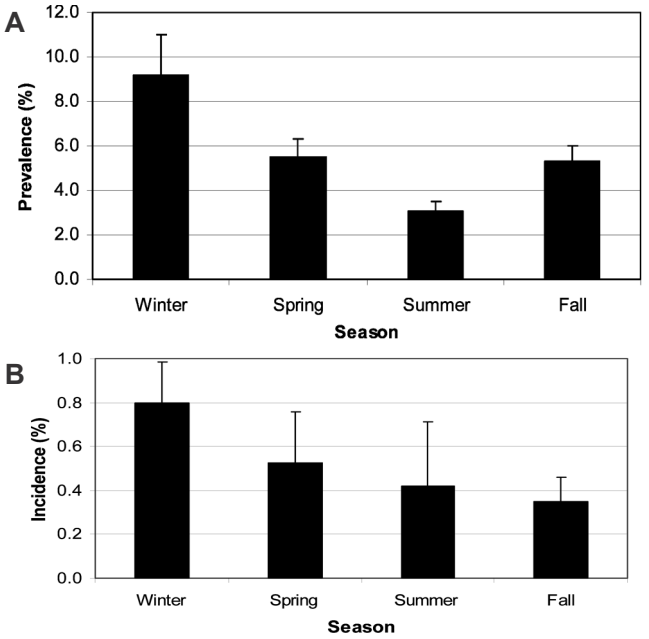

Figure 2. Cough in Israel by season, based on 13 telephone surveys (the bar indicates standard deviation). **[A]** Mean daily prevalence. **[B]** Mean daily incidence.

community clinics or emergency departments at least once during their illness. No significant seasonal effect was found in this respect.

- *Cough*: The average daily prevalence of cough was 9.2% in winter, declining to about 5.3% in the fall and 3% during summer [Figure 2A]. The average daily incidence of cough was 0.8% in winter and about 0.3% in the fall [Figure 2B]. The estimates computed for prevalence of cough could be an overestimation due to chronic cough that exists in the population.

Prevalence and incidence by age

- *Fever*: Generally, the highest estimates of daily prevalence of fever were in infants and children less than 5 years old. The prevalence declined with age, stabilizing in the older age groups. Figure 3A presents average estimates for winter and summer seasons. The average prevalence of fever for infants under 1 year old was about 9.7% and 4.8% during winter and summer, respectively. The respective estimates for the elderly group of 65+ years old are 1.0% and 0.7%. The average daily incidence of fever ranged from 0.2% to 1.4% and from 0.1% to 0.9% during winter and summer, respectively.

- *Cough*: The average daily prevalence of cough during winter for infants less than 1 year old was about 20% and was practically the same for children up to 5 years old [Figure 3B]. A similar trend manifested in both seasons, where the estimates decreased with age until the 18–24 age group,

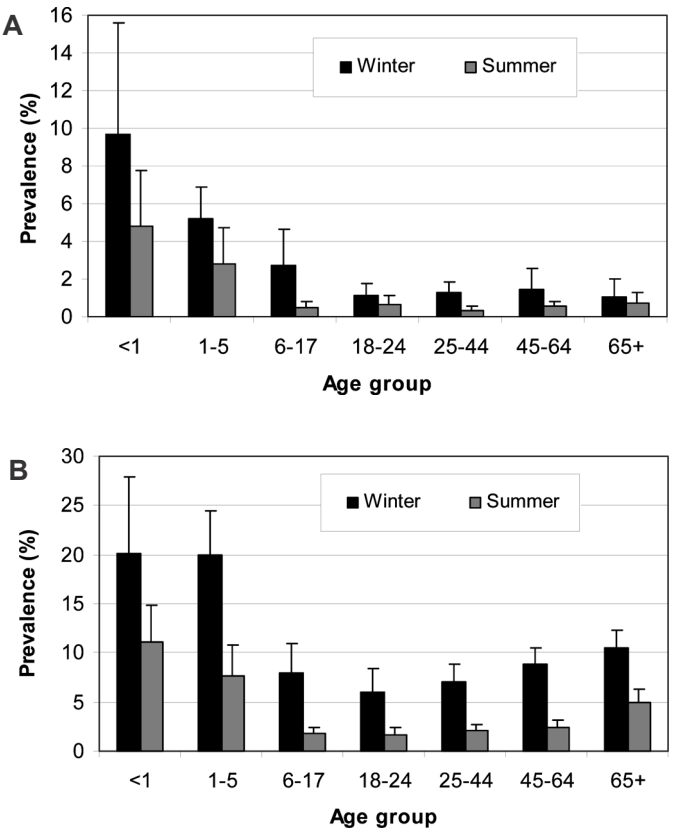

Figure 3. Mean daily prevalence of fever and cough in Israel during winter and summer seasons by age groups (the bar indicates standard deviation). **[A]** Fever $\geq$ 38ºC. **[B]** Cough.

and then increased toward the oldest age group (10.5% and 4.9% for the 65+ age group during winter and summer, respectively). The average estimates of daily incidence of cough ranged from 0.1% and 0.5% during summer and winter, respectively, to 1.4% in both seasons.

Region-specific prevalence

Figure 4A and B demonstrate the spatial variability of estimates computed for daily prevalence of fever and cough, based on a survey carried out in January 2003. The overall national estimates for fever and cough, based on that survey, were 1.3% and 7.4%, respectively. The region-specific estimates for fever ranged from 1.0% in the south to 1.9% in the Haifa region. The spatial variability of estimates computed for cough was lower compared to that of fever, varying between 6.8% and 8.7% [Figure 4B].

Correlations between prevalence of fever and other symptoms of acute morbidity

We examined correlations between prevalence of fever and other symptoms of acute morbidity, and found a high correlation between prevalence of fever and prevalence of cough (r^2 = 0.77, P = 0.0001) and sore throat (r^2 = 0.80, P = 0.002), but a low correlation with nausea and/or vomiting (r^2 = 0.26, P = 0.08).

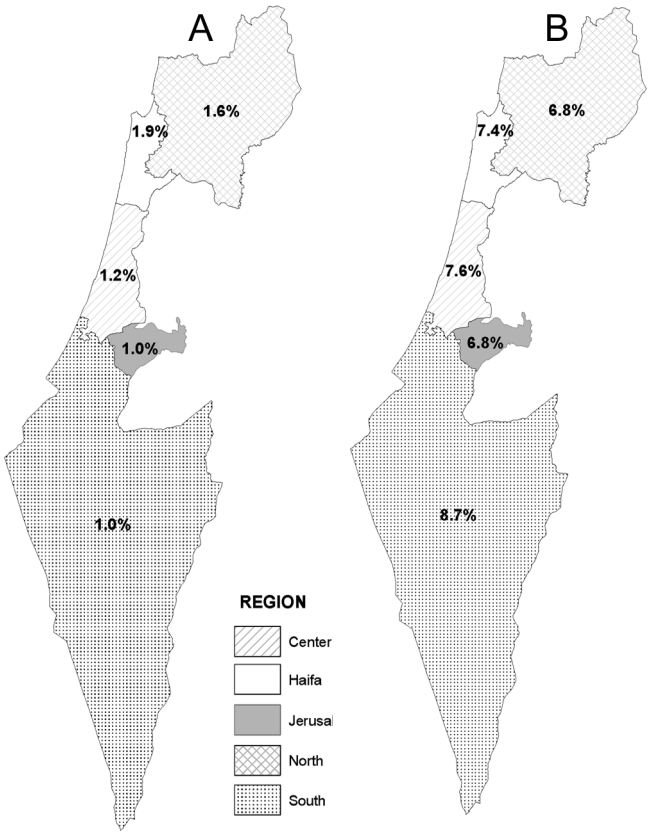

Figure 4. Region-specific estimates in Israel, January 2003, of daily prevalence of **[A]** fever (≥ 38ºC) and **[B]** cough.

Acute morbidity among household members

For characterizing possible clustering of acute morbidity among household members, we examined the association of illness in older persons in the household with that in the younger ones. Presence of fever among at least one household member older than 6 years was found to be significantly, positively associated with fever in younger members in all the three regressions described in the Methods section. The odd ratios and the 95% confidence intervals for the final model are as follows: OR = 4.8, 95% CI = 2.6–8.7 for the presence of fever among at least one young (age ≤ 6 years old) household member; OR = 1.2, 95% CI = 1.05–1.4 for the family size; and OR = 1.7, 95% CI = 1.06–2.7 for fall and winter seasons combined.

Discussion

Using the periodic telephone surveys carried out from 2000 to 2003, we estimated that the daily prevalence of fever in the population varied between 1% and 2%, depending on the season. The daily incidence of fever varied from 0.16% in the summer to 0.43% in the winter. At the household level, fever was prevalent in 6% of the households (at least one household member was febrile) during winter. For other seasons of the year the estimates were similar, ranging from 2.1% to 2.8%. Higher estimates were received for cough. Generally, estimates received for infants and children less than 5 years old are the highest compared to older age groups, for both symptoms and around the year. Only 60% of those who suffer from fever of ≥ 38ºC visited community clinics due to their illness.

To the best of our knowledge, estimates of daily acute morbidity have not been reported elsewhere. In community-based health surveys conducted in several countries, estimates of acute illness were given on an annual basis [9-13]. For example, according to the National Health Interview Survey in 1994, the national estimate for the annual prevalence of acute respiratory conditions for the United States was 80.5% [9]. The estimate for fever alone, not associated with other acute conditions, was 2.1% per year. For both respiratory conditions and unspecified fever, there was a decline in prevalence with age. In contrast to our study, conditions that did not require medical attention or activity restriction were excluded from the estimates computed for fever and for acute conditions.

These estimates of the background acute illness in the community can be used in preparedness programs for pandemic influenza, as well as for bioterrorism. Oseltamivir (Tamiflu™, Roche) is the antiviral drug of choice recommended by the WHO during 2005 for stockpiling by governments preparing their nations for possible pandemic influenza [14]. Tamiflu™ is recommended as both a prophylactic and a therapeutic measure. Its effectiveness as therapy is optimal in a time window of 48 hours after onset of symptoms. This limitation emphasizes the time constraints that will be imposed on healthcare workers when decisions will have to be based on symptoms and signs alone, since waiting for laboratory confirmation will become impractical. This uncertainty will also exist during bioterrorist events, when some will be offered treatment on the basis of signs and symptoms alone in an attempt to minimize serious morbidity and mortality. In addition, during bioterrorist-induced outbreaks, it may be difficult to distinguish breakthrough illness under antibiotic treatment (in case of bacterial pathogens) from acute incidental illness. Such cases will be referred to hospitals for more aggressive treatment. Thus, there may be a substantial number of people who will seek medical advice and require initial treatment, over and above that planned for the actual cases, both during pandemic influenza or bioterrorism.

Consequently, in order to prepare for the additional burden on the healthcare system due to the false positive cases, it is necessary to include the total number of such cases expected. In a bioterrorist-induced outbreak, where the agent is not contagious, this total is a combination of the prevalence on the day that the event is detected with the product of the daily incidence and the number of days during which new cases could occur during the incubation period. Estimating the time span for new cases to emerge during bioterrorist-induced outbreaks involved with contagious agents or during pandemic influenza is not so straightforward since it depends on the authorities' success in containing the epidemics. In these situations, educated assumptions need to be made. Estimates of acute illness at

OR = odds ratio
CI = confidence interval

the household level, and not just those regarding individuals, could be used in logistic planning for pandemic influenza and bioterrorism. For example, in order to determine the additional number of households that require treatment, illness estimates at the household level could be used.

The percentage of the general population that uses antibiotics due to acute illness is also one of the estimates produced from the periodic surveys. This estimate could be of important relevance in constructing response plans and in predicting possible interactions with prophylactic antibiotic treatment when handling pandemic influenza or a bioterrorist incident.

There are several possible limitations to this study. We used proxy interviews as a means to collect data on the health status of all the household members. However, in household-based studies where proxy interviews were used, the results were reasonably consistent with direct interview surveys [15-17]. In the present study, the interviewee could be any family member aged 18 years or older. However, we limited the interview to include only permanent members who live within the family at least 3 days a week. Thus we believe it is reasonable to assume that any adult in a family will be familiar with the health status and behavior of the other household members and there is unlikely to be substantial misclassification bias. A possible source of selection bias could be households where the respondents refused to be interviewed. Since most of the refusals were received in the opening statements of the interview, before the respondents had a chance to hear the specific questions, there is no reason to suspect a connection between the health status of the household members and the refusals. However, sick individuals who live alone, or others who reside with other members under 18 years could constitute a source for underestimation.

In summary, in this report we present relevant data on the incidence and prevalence of incidental acute illness symptoms by age, season and geographic region, and on characteristic behavior related to this illness. These data, estimated from community-based surveys, can be used to help construct national preparedness programs for pandemic influenza, as well as for bioterrorism.

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References

1. Centers for Disease Control and Prevention. Biological and Chemical Terrorism: Strategic Plan for Preparedness and Response. Recommendations of the CDC Strategic Planning Workgroup. *MMWR* 2000;49(No. RR-4).
2. World Health Organization. Public health response to biological and chemical weapons: WHO guidance (2004). Available from: URL: http://www.who.int/csr/delibepidemics/biochemguide/en/index.html Accessed 1 November 2005.
3. Sagi R, Robenshtok E, Katz LH, et al. Preparedness of the Israeli health system for a biologic warfare event. *IMAJ* 2002;4:495–7.
4. World Health Organization. WHO global influenza preparedness plan. Available from: URL: http://whqlibdoc.who.int/hq/2005/WHO_CDS_CSR_GIP_2005.5.pdf Accessed 1 November 2005.
5. United States Department of Health & Human Services. Draft Pandemic Influenza Response and Preparedness Plan. Available from: URL:http://www.hhs.gov/nvpo/pandemicplan/index.html Accessed 1 November 2005.
6. Israel Ministry of Health. A working paper on national preparedness for pandemic influenza. Available from: URL:http://www.health.gov.il/download/forms/a2762_mk35_05.pdf Accessed 1 November 2005 (Hebrew).
7. Ireland Department of Health and Children. A Model Plan for Influenza Pandemic Preparedness, 2002. Available from: URL:http://www.dohc.ie/publications/pdf/panflu.pdfAccessed 1 November 2005.
8. Statistical Abstract of Israel. Jerusalem: Israel Central Bureau of Statistics, 2002, No. 53.
9. Centers for Disease Control and Prevention. Vital and Health Statistics. Current estimates from the National Health Interview Survey, 1994. Series 10, no. 193. Available from: URL: http://www.cdc.gov/nchs/data/series/sr_10/10_193_1.pdf
10. Lachman PI, Zwarenstein MF. Child health and health care utilization. A community-based survey in Mitchell's Plain, CP. *S Afr Med J* 1990;77:467–70.
11. Saxena S, Eliahoo J, Majeed A. Socioeconomic and ethnic group differences in self reported health status and use of health services by children and young people in England: cross-sectional study. *Br Med J* 2002;325:520–6.
12. Ihlebaek C, Eriksen HR, Ursin H. Prevalence of subjective health complaints (SHC) in Norway. *Scand J Public Health* 2002;30:20–9.
13. Yu TS, Wong TW, Liu JI, Lee NL, Lloyd OL. Health care needs in the Tai Po district of Hong Kong; initial indications from a population-based study. *Hong Kong Med J* 1997;3:34–42.
14. World Health Organization. WHO interim guidelines on clinical management of humans infected by influenza A(H5N1). Available from: URL: http://www.wpro.who.int/NR/rdonlyres/1C7719E3-7462-43BF-953A-72272B8DB56B/0/WHOinterimguidelinesonclinicalmanagementofhumansinfectedbyinfluenzaAH5N1.pdf Accessed 1 November 2005.
15. Halabi S, Zurayk H, Awaida R, Darwish M, Saab B. Reliability and validity of self and proxy reporting of morbidity data: a case study from Beirut, Lebanon. *Int J Epidemiol* 1992;21:607–12.
16. Rothman ML, Hedrick SC, Bulcroft KA, Hickam DH, Rubinstein LZ. The validity of proxy-generated scores as measures of patient health status. *Med Care* 1991;29:115–24.
17. Mosely RR, Wolinsky FD. The use of proxies in health surveys. Substantive and policy implications. *Med Care* 1986;24:496–510.

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Hatred – the anger of the weak

Alphonse Daudet (1840-97), French novelist and rabidly right-wing journalist