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Pulmonary tuberculosis and associated factors in areas of high levels of poverty in Chiapas, Mexico

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Objectives To estimate the prevalence of pulmonary tuberculosis (PTB) and factors associated with PTB in areas of high levels of poverty in Chiapas, Mexico.

Methods In 1998 active case-finding was carried out among those aged over 14 years who had a cough of ⩾15 days duration, in a convenience sample of 1894 households in 32 communities selected at random based on the level of poverty and on the level of access to health services, measured by travelling time (<1 hour, ⩾1 hour) from the community to the nearest health care unit**.** Of the 277 identified with a productive cough, we obtained sputum samples from 228 for the purposes of detecting PTB through acid-fast smears and cultures. Mycobacteria characterization was carried out using the BACTEC method. The identification of factors associated with PTB was performed using bivariate analysis and via logistic regression models.

Results A PTB rate of 276.9 per 100 000 persons aged ⩾15 years was found (95% CI : 161–443). Blood in sputum was the only factor associated with PTB (none of the demographic or socioeconomic characteristics were). Of 16 positive cultures, 14 became contaminated. The two cultures characterized were *Mycobacterium tuberculosis* (one being multiresistant).

Conclusion The high prevalence of PTB detected indicates the need, both in the area studied and in others with similar conditions, to develop PTB control programmes which give priority to early diagnosis and to the provision of adequate treatment.

Keywords Pulmonary tuberculosis, Mexico, risk factors, diagnosis, poverty

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Chiapas is the Mexican state with the highest mortality associated with pulmonary tuberculosis (PTB), with figures at least twice those of the country as a whole.[1] For example, the death rate recorded for PTB in Mexico for 1996 was 4.3, and for Chiapas 9.2 per 100 000 inhabitants.[2] In Chiapas, PTB is the twelfth most important cause of death and, as in the rest of the country, it is the primary cause of deaths due to a single infectious agent.[1,3]

According to official statistics, in Mexico, the annual incidence rate of tuberculosis in all its forms has risen over the last 10 years, from 14.4 cases per 100 000 inhabitants in 1986 to 18.2 in 1996, even though Garcia-Garcia *et al.*[3] estimate the annual incidence rate at 50/100 000. With respect to PTB, in 1998, the incidence rate recorded in Mexico was 19.1, while that for Chiapas was 34.2 per 100 000 inhabitants per year.[4] However, according to World Health Organization figures[5] the recorded number of cases of tuberculosis, based on the estimated number of cases is around 20%. In the case of Chiapas, several studies have also shown that there are important problems in the diagnosis and reporting of PTB cases.[6–8]

The fact that Chiapas is one of the states with high poverty levels[9–11] and the considerable shortage of health resources in the country[1,10,12] suggests that PTB is, and will continue to be a serious public health problem in terms of morbidity, mortality and costs of care. There are high levels of poverty and marginalization in the large population nuclei,[11–13] which usually have less access to health services[14] and among which—given the associated conditions of malnutrition, overcrowding and other factors—PTB is more common than among other groups.

A previous study in the only hospital in one of the nine regions of the state, the Border Region (Región Fronteriza), characterized by high levels of poverty and marginality,[6,15] showed the necessity of carrying out studies which would provide a panorama

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closer to the true PTB situation in the communities located in the region. The objective of this study is to analyse the PTB situation in areas of extreme poverty in Chiapas, Mexico, through the following indicators: prevalence of PTB; factors associated with PTB; smear-status among PTB cases detected; resistance to drugs and characterization of mycobacteria.

Methods

A cross-sectional survey of households was carried out, from March to October 1998, in 32 localities of the Border Region (Chiapas state, Mexico) chosen at random based on the poverty level ('high', 'very high') of the municipality to which they belonged,[11] and on the level of access to health services, measured by travelling time (<1 hour, ⩾1 hour) from the community to the nearest health care unit (by the most usual means of transport for the community), in accordance with the classification of health services accessibility suggested by the WHO.[15] Sample size was determined based on the expected number of PTB cases, the estimated mean number of inhabitants per home, expected non-response rate (10%), and the budget and resources available.

According to the Chiapas State Health Institute (Ministry of Health),[16] the Border Region includes 12 of the 111 municipalities in the state with an estimated population of 425 300 inhabitants (a density of only 32.2 inhabitants/km^2) (Figure 1).[17] Of the 12 municipalities, one is considered as having a 'medium' poverty level, nine as 'high', and two as 'very high' poverty levels.

Since the region under study includes areas involved in the armed conflict which began in 1994, and also due to the existing difficulties of accessing many communities (geographical and military), particularly those of greater socioeconomic marginalization, in order to carry out the study, a two-stage convenience sample design was employed. The last sample unit [the household] was selected after two stages: stratification (high and very high marginalization; <1 and ⩾1 hour from the nearest health care unit) and by conglomerates in communities of over 2500 inhabitants (households were selected in compact segments of size 10).

Initially municipalities were selected in accordance with the marginalization levels proposed by the National Population Council.[11] These are based on an index constructed from 1990 census information, using nine indicators considered to be structural in nature (with little change over time), such as educational level, dwelling conditions, size of community, and monthly income, and by which all municipalities in the country are classified in five levels of poverty (from very high to very low). Since only two municipalities in the study area were classified as having 'very high' poverty levels, it was decided to include them both in the sample. Municipalities classified as 'high' were selected by simple random sampling.

Subsequently, communities were selected, each classified according to the poverty level of the municipality to which it belonged and by distance to the nearest primary health care unit (<1 hour, ⩾1 hour). In order to achieve this, a list of communities was elaborated, based on information about regionalization of health services in the region,[18,19] complemented by informal interviews with health service personnel, local Public Works Departments (where registries are maintained of constructions, communication routes, etc), and with inhabitants of the communities. Thirty-two communities were selected: 16 of very high poverty (7 <1 hour to the nearest health unit; 9 ⩾1 hour) and 16 of high poverty (7 <1 hour to the nearest health unit; 9 ⩾1 hour).

Finally, the households were selected as follows: in communities of <1000 inhabitants a census was made of all households; in those with 1000–2499 inhabitants, one of every two households was chosen at random; and in those with ⩾2500 inhabitants, a random sample of conglomerates was made, selecting compact segments of 10 households (n = 115 households per community). During the study, a full census was made of all the inhabitants of selected households.

Data collection procedures

The number of households selected was 1894, of which 1878 (99.2%) provided information about 11 274 individuals. The fieldwork team was composed of a field supervisor and seven interviewers (four women and three men): four graduate students (two chemistry graduates, one social worker and one biologist) and three people from the region who spoke the main Mayan language of the region (Tojolabal): one local health worker and two experienced fieldworkers who acted as translators in those households where Spanish was not spoken. All of them underwent training in conducting interviews and collection of samples.

The interview respondents were the adult members of the households studied. Through this survey, active case-finding of those with a cough (affirmative response when asked whether they had a cough) was carried out among people aged over 14 years, who were asked to provide three sputum samples.

Collection and bacteriological analysis of sputum samples

A list of 'orienting symptoms and diseases' was read to the households so that family members themselves could indicate who had been ill or felt poorly in the 15 days prior to the survey. This list included 'cough' as one of the possible health problems. People aged ⩾15 years who declared that they had a cough, or had had a cough in the last 15 days, were asked about the duration of a cough and the presence of sputum. Three sputum samples were requested from those who declared having had a productive cough for the last 15 days or longer. The collection of samples started on the morning after the interview. The second and third samples were collected at successive intervals of 24 hours after collection of the first sample (patients were provided with 'copropac' type sputum collectors and told to start collection on the morning after the interview).

Smear tests were processed using the Ziehl-Neelsen method. Samples of sputum were preprocessed in communities. Staining and reading was carried out in the laboratory of the Hospital de Comitán. Cultures were performed following the Petroff method, using Lowenstein-Jensen culture media. Both types of tests were processed in accordance with current Mexican legislation.[20,21]

Pulmonary tuberculosis definition

Subjects were considered PTB positive cases if one or more bacillus was found in 100 microscopic fields observed or if any colonies had developed in the cultures.[15] Referring to the smear PTB status of identified positive cases, they were considered as being 'smear positive' if a positive result was obtained for any of the smears taken, and 'smear negative' when the culture result

Figure 1

was positive and the three smears yielded negative results. Those with a cough who provided only one or two sputum samples were considered 'smear-indeterminate' if they were culture-positive but smear-negative.[22]

Characterization and drug resistance test

Characterization of the mycobacteria was carried out by means of primary (colony morphology, stain affinity and morphology of bacilli, speed of development and pigmentation of colonies, niacin production), and secondary level differentiation tests (nitrate reduction—Virtanen test—activity of catalase at ambient temperature and at 68°C, hydrolysis of Tween 80, photochromogenicity and sensitivity to tiophen-2-carboxyl acid hydraze). Finally, drug resistance tests (for isoniazid, streptomycin, rifampin, ethambutol, and pyrazinamide) were also carried out using the BACTEC Radiometric Method.[8,21]

Statistical data analysis

The prevalence of PTB was calculated using the formula for prevalence rate estimation. The Epi Info Statistical Package was used to determine 95% CI.[23] The variables which were measured in order to identify factors associated with PTB were: (1) demographic: sex, age and whether or not they spoke any indigenous language; (2) socioeconomic: size and social stratum of the locality, education level, type of occupation (agricultural, other), social security and indicators related to the households —number of inhabitants and rooms, type of floor (earthen, covered), cooking facilities (wood, gas), wastewater disposal system (yes, no), electricity (yes, no); (3) access to health services (<1 hour, ⩾1 hour travelling time to the nearest primary health care unit); and (4) PTB-related clinical history: perceived duration of the cough, weight loss, fever in the last 15 days, BCG vaccinations, PTB among family members, presence of blood in sputum.

For the crude analysis of the relationship between PTB and the factors under study, χ^2 independence tests, odds and odds ratios (OR) were calculated using the statistics packages SPSS and StatXact.[24,25] In all statistical analyses the significance level used was $P < 0.05$.

Results

Demographic and socioeconomic characteristics of the population studied

A total of 11 274 inhabitants were involved in this study (51% men). The average age was 20.8 years (SD 17.7), with no differences by sex. Of the 11 274 subjects, 54.5% were aged ⩾15 (n = 6140). An indigenous language, mainly Tojolabal, was spoken by 19% of the population aged ⩾5, among whom almost 4 of every 10 did not speak Spanish. With regard to socioeconomic characteristics, the study population exhibits notable poverty and marginalization levels, as well as a high proportion of inhabitants without social security (Table 1).

Identification of those with a cough and number of sputum samples obtained

Among the 6140 people aged ⩾15, 878 reported having a cough, or having had a cough in the 15 days prior to the survey. Of these 878, 538 had a cough of less than 15 days duration, and 340 (39%) had a cough of ⩾15 days duration.

Of these 340 subjects, 277 (81.5%) had a productive cough at the time of the study. Of these 277 with a productive cough, one or more sputum samples were obtained from 228 (82%). Samples were not obtained from the rest, the majority reporting no longer having a productive cough the day they were supposed to start sputum collection (generally the day after the interview). Some cases did not want to hand in their samples, the most common reason being that they 'had provided samples before to the health services but never received the results'.

Pulmonary tuberculosis positivity

Seventeen of the 228 (7.5%) who provided at least one sputum sample, were identified as having PTB. They were from 13 different communities (in no household was there more than one case identified. Neither were there cases with members of households in close proximity or members of the same families).

Only 8 of the 17 positives would have been identified had smear testing alone been used. Furthermore, it was only possible to process the cultures of 197 people with a cough (86% of those from whom at least one sample was obtained). The remainder of the samples could not be processed due to problems in their storage and transportation. Five of the 197 cultures became contaminated. Of the 192 from which a result could be obtained 176 (91.7%) were negative and 16 (8.3%) positive. The PTB rates by smear tests, cultures and by both methods are shown in Table 2.

Of the 192 with a cough for whom it was possible to obtain cultures and smears, the results of 182 were in agreement for both

Table 1 Socioeconomic indicators of Mexico, Chiapas and the study population

Indicator (year)	Mexico (1995)	Chiapas (1995)	Study population (1998)
No. of inhabitants	91 158 290	3 584 786	11 274
Education level (subjects aged ⩾15)			
Mean no. of years of schooling	7.2[a]	4.99[b]	3.54
% who never attended school	10.6[c]	26.0[c]	21.4
% with ⩾7 years of schooling	49.7[a]	28.9[b]	10.7
Occupation (subjects aged ⩾12)			
% in agricultural work	21.8[d]	48.6[d]	47.1
Social security			
% of inhabitants with Social Security	50.1[e]	14.5[b]	3
Indicators of households			
Inhabitants per home (average)	4.7[f]	5.2[f]	6.0
% with own water supply (on the household)	85.7[f]	67.1[f]	60.0
% with floor covered	84.6[f]	61.2[f]	42.8
Inhabitants per bedroom (average)	2.32[d]	3.20[d]	4.46
% with wastewater disposal system	72.4[d]	52.6[d]	25.3
% with electricity	92.8[d]	77.2[d]	76.6
% with gas cooking facilities	82.2[g]	48.4[g]	16.9
% consuming beef one or more times per week	not available	not available	18.0

[a] Instituto Nacional de Estadística, Geografía e Informática (INEGI). Anuario Estadístico de los Estados Unidos Mexicanos, 1998. México: INEGI, 1999.

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[e] INEGI. Estadísticas históricas de México. Tomo I. México: INEGI, 1999.

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[g] INEGI. Conteo de Población y Vivienda 1995. Resultados definitivos, tabulados complementarios. México: INEGI, 1997.

positive (7) and negative (175). One was negative on culture but positive on smear, and nine were positive on culture but negative on smear. Using the culture results as the gold standard, these results yield the following parameters for the smear tests carried out: sensitivity, 43.8%; specificity, 99.4%; positive and negative predictive values, 87.5 and 95.1, respectively.

Factors associated with pulmonary tuberculosis

The only variable which showed a statistically significant association with PTB was the presence of blood in sputum: among those with a cough who reported having had this condition, the PTB rate was 3.7 times higher than among those without (Table 3).

Bacteriological characteristics of mycobacteria and drug resistance

Of the 16 positives identified by culture, 14 became contaminated and 2 cultures corresponded to *Mycobacterium tuberculosis*. With regard to the smear PTB status, of the 17 PTB cases identified, 8 (47%) were smear-positive, 3 were smear-negative and 6 were classified as smear-indeterminate.

Finally, with respect to the drug resistance, one of the two cultures analysed was drug-susceptible to the five drugs studied, and the other showed resistance to isoniazid, rifampin and ethambutol, most probably of a secondary nature (there was a history of TB treatment).

Discussion

The PTB rate in those with a cough of ⩾15 days duration (277 per 100 000) is one of the highest of the world.[26] It is also extremely high in relation to official statistics for incidence of cases notified during 1998 both for the state of Chiapas, and for the country as a whole (34.2 and 19.1 per 100 000 inhabitants per year, respectively).[4] However, the following aspects require

Table 2 Prevalence of pulmonary tuberculosis (95% CI) in the study area (rates per 100 000 inhabitants)

Study population subgroup	By smear test (8 positives)	By culture (16 positives)	By both methods (17 positives)
Aged ⩾15 years (n = 6140)	130.3 (56.3–256.6)	260.6 (149.0–422.8)	276.9 (161.4–442.9)
All identified with cough (n = 878)	911.1 (394.2–1787.4)	1822.3 (1045.1–2942.5)	1936.2 (1113.1–3082.0)
Subjects with cough ⩾15 days duration (n = 340)	2352.0 (1021.2–4583.4)	4705.9 (2713.4–7529.7)	5000.0 (2959.3–7885.3)
Cough of ⩾15 days, with ⩾1 sample (n = 228)	3508.8 (1526.8–6796.4)	8333.3[a] (4838.3–13 180.0)	7456.1 (4403.3–11 670.0)
Cough of ⩾15 days, with ⩾1 sample, with blood in sputum (n = 52)	7400.0 (2135.7–18 539.7)	19 100.0[b] (9 149.2–33 259.7)	17 300.0 (8232.6–32 280.0)

[a] n = 192 with cough for whom it was possible to carry out culture test.

[b] n = 47 with cough for whom it was possible to carry out culture test.

Table 3 Predictors of pulmonary tuberculosis (PTB) among identified as having a cough with one or more sputum samples[a]

Indicator	% PTB positive	*P*–value (χ^2)	Crude odds ratio	95% CI
Demographic				
Sex				
Female (n = 126)	9.5	0.187	2.04	0.64–7.64
Male (n = 102)	4.9		1.00	
Speak indigenous language				
No (n = 166)	9.0	0.137	2.98	0.66–27.55
Yes (n = 62)	3.2		1.00	
Socioeconomic				
Community size (inhabitants)				
⩾2500 (n = 18)	11.1	0.154	2.08	0.20–11.02
1000–2499 (n = 34)	14.7		2.86	0.71–9.96
<1000 (n = 176)	5.7		1.00	
Degree of marginalization				
High (n = 92)	10.9	0.107	2.25	0.75–6.86
Very high (n = 136)	5.1		1.00	
PTB-related clinical history				
Fever in the last 15 days				
Yes (n = 91)	11.0	0.098	2.29	0.77–7.00
No (n = 137)	5.1		1.00	
Blood in sputum				
Yes (n = 47)	19.1	0.001	5.12	1.68–15.79
No (n = 181)	4.4		1.00	

[a] Other variables analysed in which there was no difference in the proportions of PTB positives were demographic (age), socioeconomic (education level, type of occupation, social security and indicators related to the households—number of inhabitants and rooms, type of floor, cooking facilities, wastewater disposal system and electricity), access to health services (distance to the nearest primary health care unit) and PTB related clinical history (duration of cough, weight loss, BCG vaccinations, PTB among family members).

special consideration: firstly, the PTB rate obtained in this study corresponds to a prevalence rate; secondly, in this study active case-finding of those with a cough was carried out, circumstances which do not correspond to those of the health services, either in the area studied or in the country as a whole. The PTB rate obtained implies that the prevalence of tuberculosis, including the extrapulmonary form, would be over 400 per 100 000 inhabitants in the population aged ⩾15 years.

In this sense, it should be noted that confidence intervals estimated may be smaller than those which could have resulted if we had had the possibility of characterizing the sample in terms of fractions of strata studied (confidence intervals were calculated as though for simple random samples, due to the inaccessibility of update information and the situation of armed conflict).

Thirdly, PTB cases notified to the information systems of the health sector, and from which incidence rates are estimated, basically correspond to cases detected in health services by acid-fast bacilli. In this study, if only acid-fast smears had been performed, only 47% of the 17 PTB cases identified would have been detected. At the same time, several aspects suggest that the PTB rate obtained represents a 'bottom-line' figure indicative of the magnitude of the problem in the study area, and in consequence, discrepancies with figures reported by national information systems could be greater: the problems experienced in obtaining sputum samples in terms of both number and quality; the age used as the cutoff point for requesting sputum samples (in other studies which have reported higher prevalences of PTB, the cutoff point was 10 years of age);[27,28] no use was made of other diagnostic tools (e.g. chest radiography)[26] and there were several people with blood in sputum (n = 43) who, probably due to problems in their sputum samples, could not be identified as PTB positives.

The extremely difficult geographical access to the majority of the communities with high levels of socioeconomic marginalization, together with the fact that the systems for detection of PTB cases are based solely on smear testing, means that in the communities of this type, more than half the cases are not detected. This in turn means that in the area studied, and very probably in others in a similar situation, the proposed goals of detecting at least 75% of cases, and of treating 85% of the cases detected, needed in order to make control of the disease possible,[29,30] are far from being reached.

In this sense, carrying out studies of this type which contribute to better detection of cases (together with a suitable infrastructure for treatment of cases detected—for example by means of the DOTS strategy), could constitute a tool worth considering in order to diminish the high morbidity and mortality associated with the disease in populations of this type.

With respect to the factors associated with PTB, this was not found to be statistically associated with any of the demographic[27–29,31,32] and socioeconomic indicators.[7,15,33] Nevertheless, since there were few PTB cases, the study had very low power to detect associations (Table 3). In fact, the only variable statistically associated with PTB was the presence of blood in sputum (OR = 5.12). This very strong association suggests the possibility that the indicator 'blood in sputum' could be considered, along with the presence of cough of ⩾15 days duration, as an important predictive factor in the identification of groups at greater risk of suffering PTB in the area studied, as well as in other regions having similar socioeconomic conditions.

In relation to the tests for characterization and drug resistance, it should be pointed out that the low quality of samples obtained, the conditions of marginalization of many communities (without means of communication and at considerable distances from the nearest urban centres), as well as the environmental conditions (extreme climates and heavy rains), were important factors which impeded adequate storage and transportation of the samples. However, it is notable that one of the two cultures able to be tested for drug-susceptibility showed acquired resistance to three drugs. This aspect should be analysed more thoroughly due to the fact that there is evidence that Mexico has a primary resistance rate of around 18%[34,35] and an acquired resistance rate of 59–75%.[3,8]

At least 47% of the PTB cases identified were smear PTB positive and even if these represent the highest probability of transmission to other people, the remainder can be seen as having a lower probability of being diagnosed by the health services (since only smear testing is used for case detection). Hence there is a not unappreciable risk of transmission of PTB due to failure in detection and treatment, as well as long exposure time.[23]

In conclusion, it may be pointed out that, not only in the area studied but also in other regions with similar conditions of high PTB prevalence and marked poverty, it is necessary to develop PTB control programmes which give priority: (1) to early diagnosis, given that it is precisely in the groups of greatest socioeconomic marginalization where the longest delays in seeking health care occur;[14,36–38] (2) to adherence to treatment, due to the possible problems with resistance and the fact that it is in populations of this type where the lowest probabilities of adherence to tuberculosis treatment are found.

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KEY MESSAGES

- Previous studies showed the necessity of analysing the PTB situation in areas of extreme poverty in Chiapas.
- The region of the study includes areas involved in the armed conflict which began in 1994.
- The PTB rate in those with a cough (277 per 100 000) is one of the highest of the world.
- The proposed goals of detecting at least 75% of cases, and of treating 85% of the cases detected, are far from being reached.
- In regions with high PTB prevalence and marked poverty, it is necessary to develop PTB controls programmes which give priority to early diagnosis and to adequate treatment.

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Commentary: Sputum prevalence data suggest Mexican TB rates will explode on contact with HIV epidemic

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Tuberculosis (TB) is not under control in most developing countries. The World Health Organization and the International Union against Tuberculosis and Lung Diseases are co-ordinating the increasing global effort against the disease.[1] Among other elements, this programme proposes passive case finding (symptomatic patients will present spontaneously to care), a standardized approach to the diagnosis and clinical treatment of patients (under direct observation), and intense monitoring of patients to microbiologically proven cure. The belief is that complete implementation of these elements will obtain cure rates over 85%, after which the incidence of TB will fall due to the shrinking pool of infective patients. This plan has won widespread support from most developing countries and international funding agencies, with the only controversial issues being the need for direct observation of pill taking, and the role of second line therapies for multi-drug resistant TB.

The plan requires no population level monitoring of TB—this is replaced by the intense focus on using health services data to measure cure rates for newly diagnosed patients. This is a welcome improvement from a previous era in which the seriousness of the disease was hidden by unreliable population based annual risk of infection (ARI) studies. In these ARI studies conclusions about the prevalence of TB were drawn from models based on changes in prevalence of skin response to challenge with TB antigen. Immunological correlates of TB infection are not ideal parameters for assessing progress in dealing with the epidemic, because of the very confusing epidemiology of TB, with early childhood infection, and the unknown contribution that reactivation and reinfection make to the adult prevalence of the disease. During the 1980s in South Africa,[2] the ARI fell, in spite of the stagnation of the economy and society under apartheid, and in the face of the developing HIV/AIDS epidemic. This implausible scenario should warn us of the importance of designing surveys which use reliable patient relevant outcome measures (such as prevalence of cough with positive bacteriology), rather than biologically and epidemiologically elegant, derived parameters.

It is no small achievement that Sanchez–Perez *et al.*[3] have estimated the prevalence of TB in Chiapas, based on sputum positivity among adults with 15 days or more of cough. The parameter they have tried to estimate reflects symptomatic and infectious tuberculosis, and is therefore directly relevant both to health services planning, and to public health. Sanchez-Perez use gold standard techniques (three sputum samples, and culture) for diagnosis, and in this remote region, with its civil war these techniques do not work out as well as they might in Manhattan. As a result of geographical and political limitations to their otherwise meticulous random sampling strategy, some war torn communities may have been excluded from the study. Also, difficulties in transport from this remote locale to hospital laboratories seems to have resulted in many culture specimens becoming contaminated. It is likely that the authors are correct in arguing that these limitations mean that their prevalence estimate is lower than the true figure.

This admirable study gives us more reliable information on the state of the disease in Chiapas than would the much simpler ARI survey. Given the low prevalence of HIV in the Americas, the very high prevalence of TB should sound a loud wake-up call to public health practitioners and politicians. If they wish to avoid the situation in Africa, in which a tidal wave of TB is descending in the wake of rising HIV prevalence, health services for TB need to be immediately improved.

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