Chronic obstructive pulmonary disease in five Latin American cities (the PLATINO study): a prevalence study

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Summary

Background **Both the prevalence and mortality attributable to chronic obstructive pulmonary disease (COPD) seem to be increasing in low-income and middle-income countries, but few data are available. The aim of the PLATINO study, launched in 2002, was to describe the epidemiology of COPD in five major Latin American cities: São Paulo (Brazil), Santiago (Chile), Mexico City (Mexico), Montevideo (Uruguay), and Caracas (Venezuela).**

Methods **A two-stage sampling strategy was used in the five areas to obtain probability samples of adults aged 40 years or older. These individuals were invited to answer a questionnaire and undergo anthropometry, followed by prebronchodilator and postbronchodilator spirometry. We defined COPD as a ratio less than 0·7 of postbronchodilator forced expiratory volume in the first second over forced vital capacity.**

Findings **Complete information, including spirometry, was obtained from 963 people in São Paulo, 1173 in Santiago, 1000 in Mexico City, 885 in Montevideo, and 1294 in Caracas. Crude rates of COPD ranged from 7·8% (78 of 1000; 95% CI 5·9–9·7) in Mexico City to 19·7% (174 of 885; 17·2–22·2) in Montevideo. After adjustment for key risk factors, the prevalence of COPD in Mexico City remained significantly lower than that in other cities.**

Interpretation **These results suggest that COPD is a greater health problem in Latin America than previously realised. Altitude may explain part of the difference in prevalence. Given the high rates of tobacco use in the region, increasing public awareness of the burden of COPD is important.**

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Introduction

Chronic obstructive pulmonary disease (COPD) is an important cause of morbidity and mortality worldwide. However, it is often underdiagnosed and undertreated, resulting in underestimation of the burden of this disease.[1] The prevalence of COPD in many developed countries seems to be increasing.[2–4] There is also some evidence from Latin American countries that COPD is a growing cause of death,[5] but population-based prevalence data are virtually non-existent.[6] To obtain a detailed picture of the global distribution of this severe condition, it is necessary to estimate its prevalence in less developed countries. Prevalence surveys could also help to identify new risk factors and measure the prevalence of known determinants.

The prevalence of the main risk factor for COPD—smoking—is high in Latin America. Mean annual cigarette consumption per person in most countries of Latin America ranges from 500 to 1499.[7] As in most high-income countries, there is some evidence that smoking prevalence in men is slightly declining, whereas for women it is rising.[7] Even if smoking prevalence rates fall slightly, the absolute number of smokers could increase because of population growth. The relative importance of other known risk factors for COPD has not been adequately assessed in Latin America.

The Latin American Project for the Investigation of Obstructive Lung Disease (PLATINO) was launched in 2002 with the objective of measuring COPD prevalence and associated risk factors in five major cities in Latin America: São Paulo (Brazil), Santiago (Chile), Mexico City (Mexico), Montevideo (Uruguay), and Caracas (Venezuela). These sites were chosen because of their geographical position, population size, and the availability of local collaborating research centres. They represent the different geographical areas of Latin America and the largest metropolitan area in each participating country. Their combined population is about 50 million, of whom around a third are 40 years or older. We report COPD prevalence in these five areas.

Methods

Study design

A similar multistage sampling strategy was used in all five areas. Metropolitan areas were first stratified into the main city and surrounding municipalities. These two subsets were further stratified by socioeconomic status. We selected 68 census tracts at each site, taking stratification into account and using a probability of selection proportionate to the number of households in each tract. Within each tract, we counted the number of people in each household and every count was updated from the most recent census. We chose an average of 15 households using systematic sampling within each tract. All adults aged 40 years or more living in selected households were invited to participate. The sample was self-weighted in each city.

Sample-size calculations suggested that 800 people would be needed in each area to estimate a prevalence of

For the **Latin American Project for the Investigation of Obstructive Lung Disease (PLATINO)**, see http://www.platino-alat.org

	São Paulo (Brazil)	Santiago (Chile)	Mexico City (Mexico)	Montevideo (Uruguay)	Caracas (Venezuela)
Eligible households	1039	773	1065	921	888
Household contact failures	6 (0·6%)	0 (0)	45 (4·2%)	15 (1·6%)	178 (20·0%)
Eligible individuals	1150	1476	1452	1106	1527
Refusals or contact failures	150 (13·0%)	268 (18·2%)	389 (26·8%)	163 (14·7%)	170 (11·1%)
Individuals interviewed	1000 (87·0%)	1208 (81·8%)	1063 (73·2%)	943 (85·3%)	1357 (88·9)
Eligible for spirometry	984	1175	1017	911	1315
Refusals or contact failures	21 (2·1%)	2 (0·2%)	17 (1·7%)	26 (2·9%)	21 (1·6%)
Spirometric tests performed	963 (97·9%)	1173 (99·8%)	1000 (98·3%)	885 (97·1%)	1294 (98·4%)
Overall response rate (including spirometry)	83·7%	79·5%	68·9%	80·0%	71·7%

Data are number, %, or number (%).

Table 1: **Response rates at the household, questionnaire, and spirometry levels**

up to 30% with a margin of error of less than 4 percentage points. We aimed to locate about 1020 eligible participants per site, with a predicted 20% refusal rate.

Procedures

For copies of **questionnaires**, see http://www.platino-alat.org

All interviews and examinations took place at home, and proxy information was not acceptable. We obtained data about several factors potentially associated with COPD, including age, sex, ethnic origin (self-reported), years of formal education, smoking habits, hospital admissions due to pulmonary problems in childhood, exposure to domestic biomass and coal pollution, occupational exposure to dust, and body-mass index. The questionnaire included sections of the American Thoracic Society Division of Lung Diseases (ATS/DLD),[8] European Community Respiratory Health Survey II,[9] and Lung Health Study[10] instruments. Questions from the SF12[11] (a 12-item short form health survey) were also included to assess overall health status. Copies of the questionnaires used in each site are available at the PLATINO website. Next, anthropometric measurements were taken. We measured height with a portable Seca stadiometer (Curitiba, Brazil; precision 0·1 cm), using the technique recommended by Lohman and colleagues.[12] Weight was measured with an electronic Tanita scale (precision 200 g, Curitiba).

	São Paulo (Brazil)	Santiago (Chile)	Mexico City (Mexico)	Montevideo (Uruguay)	Caracas (Venezuela)
Sex					
Men	16·6%	24·5%	35·1%	17·7%	14·4%
Women	10·0%	14·1%	19·8%	12·6%	9·2%
Age (years)					
40–49	11·3%	14·1%	27·1%	11·1%	11·2%
50–59	13·0%	22·1%	23·9%	12·7%	12·1%
⩾60	15·4%	20·4%	28·8%	17·6%	11·7%
Current smoking status					
No	12·5%	15·9%	26·4%	14·9%	10·0%
Yes	14·8%	21·0%	27·4%	14·3%	13·8%

*Projected rates of non-response based on information obtained from 63% of the non-respondents in São Paulo, 72% in Santiago, 50% in Mexico City, 57% in Montevideo, and 29% in Caracas.

Table 2: **Percentage of non-response by sex, age, and smoking status***

A portable, battery operated, ultrasound transit-time based spirometer (Easy-One; NDD Medical Technologies, Chelmsford MA, USA, and Zurich, Swizerland) was used for pulmonary function testing of eligible people. Calibration was checked daily with a 3-L syringe. Participants did up to 15 forced expiratory manoeuvres (average five or six) to obtain three American Thoracic Society (ATS)[13] acceptable manoeuvres, with forced vital capacity (FVC) and forced expiratory volume in the first second (FEV_1) reproducible within 150 mL (the ATS-recommended margin of error is up to 200 mL). A bronchodilator (salbutamol 200 μg) was then administered by inhalation through a 500-mL spacer, and the test was repeated 15 min later (average four or five manoeuvres). All spirometric examinations were done with the person seated and wearing a nose clip and a disposable mouthpiece. During data collection, spirometry results were sent weekly to Mexico by e-mail, where they were analysed and quality control reports prepared for each individual interviewer. Overall, 89% of all tests in the five sites achieved an acceptable result, and 94% fulfilled ATS criteria of quality. These results were fed back to each fieldworker on a weekly basis and retraining was undertaken as necessary.

Exclusion criteria for the study were mental illness and admission to an institution. Exclusions for spirometry included recent thoracic or abdominal surgery, myocardial infarction, eye surgery (or retinal detachment), admission to hospital for any cardiac condition, tuberculosis, or pregnancy. Those with a pulse rate above 120 beats per min were also excluded. Approval was obtained from the ethics committee of the institutions involved in the study, and written informed consent was obtained from each individual. The results of spirometric tests were mailed to each participant and those with abnormal results were offered a free consultation at a hospital or rehabilitation centre.

In the present analyses, we used the definition of COPD proposed by the Global Initiative for Chronic Obstructive Lung Disease (GOLD):[14] a ratio of the post-bronchodilator FEV_1 over FVC below 0·70. This definition is consistent with recent European Respiratory Society and ATS recommendations.[15] We also show

severity strata, according to GOLD stages, using predicted values for normal lung function derived from the data from the present study.

Statistical analysis

Prevalence rates by city were standardised for age with the reference World Population.[16] In addition to descriptive analyses, Poisson regression models were used to examine the effects of different factors on observed differences in COPD prevalence between study sites. These factors included age, sex, ethnic origin, education, smoking intensity (measured in pack-years), hospital admissions due to pulmonary problems in childhood, exposure to domestic biomass and coal pollution, occupational exposure to dust, body-mass index, and altitude. For these regression models, ethnic origin was collapsed into three categories (white, mixed, and other). Statistical analyses were done with the STATA program (version 8.0; STATA Corporation, College Station TX, USA, 2004), which allows for the clustered nature of the

	São Paulo (n=1000)	Santiago (n=1208)	Mexico City (n=1063)	Montevideo (n=943)	Caracas (n=1357)	p*
Sex						0·0001
Men	442 (44·2%)	465 (38·5%)	431 (40·5%)	380 (40·3%)	474 (34·9%)	
Women	558 (55·8%)	743 (61·5%)	632 (59·5%)	563 (59·7%)	883 (65·1%)	
Age (years)†	55·2 (11·3)	57·0 (12·0)	55·9 (11·9)	60·3 (12·7)	5·1 (11·2)	0·0001
						0·0001
40–49	390 (39·0%)	407 (33·7%)	420 (39·5%)	248 (26·3%)	523 (40·4%)	
50–59	320 (32·0%)	380 (31·5%)	300 (28·2%)	247 (26·2%)	378 (29·2%)	
⩾60	289 (28·9%)	421 (34·8%)	343 (32·3%)	448 (47·5%)	393 (30·4%)	
Ethnic origin						0·0001
White	575 (57·5%)	838 (69·5%)	272 (25·7%)	845 (89·6%)	482 (35·5%)	
Mixed	276 (27·6%)	295 (24·5%)	555 (52·5%)	56 (5·9%)	707 (52·1%)	
Black	104 (10·4%)	12 (1·0%)	35 (3·3%)	20 (2·1%)	152 (11·2%)	
Indians	23 (2·3%)	52 (4·3%)	184 (17·4%)	9 (1·0%)	9 (0·7%)	
Asians	22 (2·2%)	9 (0·7%)	12 (1·1%)	4 (0·4%)	5 (0·4%)	
Education in years†	5·87 (4·87)	9·25 (4·64)	7·06 (4·97)	7·88 (4·47)	7·36 (4·26)	0·0001
						0·0001
0–2	233 (23·4%)	87 (7·2%)	204 (19·2%)	62 (6·6%)	147 (10·8%)	
3–4	308 (30·9%)	119 (9·9%)	124 (11·7%)	146 (15·5%)	161 (11·9%)	
5–8	226 (22·7%)	361 (29·9%)	349 (32·8%)	365 (38·9%)	581 (42·8%)	
⩾9	230 (23·1%)	641 (53·1%)	385 (36·2%)	366 (39·0%)	468 (34·5%)	
Body mass index (kg/m^2)†	27·3 (5·56)	28·5 (5·03)	28·8 (5·04)	28·5 (7·95)	27·4 (5·10)	0·0001
						0·0001
<25	372 (37·3%)	299 (24·9%)	219 (21·0%)	281 (29·9%)	426 (31·4%)	
25–29·9	371 (37·2%)	514 (42·9%)	465 (44·5%)	342 (36·3%)	587 (43·3%)	
⩾30	253 (25·4%)	386 (32·2%)	360 (34·5%)	318 (33·8%)	343 (25·3%)	
Smoking status						0·0001
Never smoker	429 (42·9%)	402 (33·3%)	591 (55·8%)	405 (43·0%)	572 (42·6%)	
Former smoker	330 (33·0%)	341 (28·3%)	202 (19·1%)	273 (29·0%)	397 (29·6%)	
Current smoker	240 (24·0%)	465 (38·6%)	270 (25·5%)	264 (28·0%)	387 (28·8%)	
Smoking exposure (pack-years)†	11·9 (18·8)	9·42 (15·0)	5·14 (12·3)	15·9 (25·2)	10·8 (19·8)	0·0001
						0·0001
0–9·9	636 (64·0%)	815 (67·6%)	887 (83·8%)	552 (58·6%)	911 (67·8%)	
10–19·9	128 (12·9%)	200 (16·6%)	90 (8·5%)	108 (11·5%)	186 (13·8%)	
⩾20	229 (23·1%)	191 (15·8%)	82 (7·7%)	282 (29·9%)	246 (18·3%)	
Hospital admission due to pulmonary problems in childhood	29 (2·9%) 38 (3·2%)	8 (0·8%)	21 (2·2%)	25 (1·8%)	0·001	
Indoor exposure to coal for cooking or heating	150 (15·0%)	652 (54·1%)	206 (19·4%)	130 (13·8%)	131 (9·7%)	0·0001
Indoor exposure to biomass for cooking or heating	490 (49·1%)	651 (53·9%)	397 (37·5%)	532 (56·5%)	397 (29·3%)	0·0001
Exposure to dust at the workplace						0·0001
Never	428 (43·0%)	610 (50·5%)	593 (55·9%)	405 (43·0%)	804 (59·3%)	
<10 years	238 (23·9%)	272 (22·5%)	209 (19·7%)	174 (18·5%)	283 (20·9%)	
⩾10 years	330 (33·1%)	326 (27·0%)	259 (24·4%)	364 (38·6%)	269 (19·8%)	
Pulmonary function						
FEV_1†	2·68 (0·79)	2·70 (0·78)	2·59 (0·74)	2·63 (0·82)	2·55 (0·71)	0·0001
FEV_1 % of predicted†	95·4 (19·4)	99·4 (18·4)	98·2 (16·7)	96·5 (19·3)	93·7 (18·8)	
FVC†	3·44 (0·95)	3·52 (0·97)	3·23 (0·89)	3·43 (1·02)	3·24 (0·84)	0·0001
FVC % of predicted†	96·8 (18·5)	103·5 (16·0)	97·1 (15·3)	99·4 (16·6)	93·8 (16·3)	
FEV_1/FVC†	0·78 (0·09)	0·77 (0·09)	0·80 (0·07)	0·77 (0·09)	0·78 (0·08)	0·0001
FEV_1/FVC % of predicted†	98·6 (12·0)	95·6 (10·5)	100·8 (8·9)	96·6 (11·4)	99·5 (10·6)	

*Wald test for categorical variables and one-way ANOVA for continuous variables. Both tests took account of sampling strategy. †Mean (SD).

Table 3: **Description of the samples in the five sites of the PLATINO study**

	São Paulo (Brazil)	Santiago (Chile)	Mexico City (Mexico)	Montevideo (Uruguay)	Caracas (Venezuela)
Sex					
Men	18·0% (14·6–21·4)	23·3% (19·7–27·0)	11·0% (7·6–14·4)	27·1% (22·8–31·5)	15·7% (12·4–19·0)
Women	14·0% (10·8–17·1)	12·8% (10·0–15·6)	5·6% (3·6–7·6)	14·5% (11·6–17·5)	10·2% (8·2–12·2)
Age (years)					
40–49	8·4% (6·1–10·6)	7·1% (4·9–9·2)	2·2% (0·5–3·9)	5·1% (2·3–7·8)	5·4% (3·3–7·4)
50–59	16·2% (12·8–19·7)	13·0% (9·6–16·4)	4·5% (1·9–7·2)	12·7% (8·9–16·4)	9·8% (7·1–12·5)
⩾60	25·7% (20·5–31·0)	30·3% (25·6–35·0)	18·4% (13·9–22·9)	32·1% (27·7–36·6)	23·4% (18·6–28·3)
Ethnic origin					
White	16·2% (13·1–19·3)	17·7% (15·0–20·3)	12·6% (7·6–17·7)	20·3 %(17·8–22·8)	13·4% (10·2–16·7)
Mixed	12·8% (8·9–16·8)	13·6% (9·6–17·6)	5·3% (3·3–7·4)	11·5% (2·8–20·3)	12·0% (9·1–14·9)
Black	18·6% (11·2–25·9)	16·7% (0·0–46·0)	14·3% (0·4–28·2)	11·1% (0·0–24·0)	8·5% (3·5–13·4)
Indians	21·7% (8·9–16·8)	25·0% (11·7–38·3)	7·0% (2·7–11·2)	33·3% (1·7–64·9)	22·2% (0·0–51·0)
Asians	22·7% (4·3–41·2)	11·1% (0·0–32·5)	1·0% (0·0–29·1)	50·0% (0·0–100)	0·0
Education (years)					
0–2	22·1% (16·6–27·6)	33·3% (21·6–45·1)	11·3% (5·5–17·1)	29·4% (17·0–41·8)	16·2% (8·8–23·5)
3–4	16·3% (12·4–20·3)	21·4% (14·9–27·9)	12·1% (6·0–18·1)	23·5% (16·6–30·4)	13·7% (7·2–20·3)
5–8	14·4% (9·4–19·5)	17·7% (13·7–21·6)	6·1% (3·6–8·6)	21·4% (16·9–26·0)	12·0% (9·0–15·0)
⩾9	10·4% (5·9–14·8)	13·6% (1·6–16·5)	6·0% (3·7–8·3)	15·2% (11·8–18·6)	10·6% (7·6–13·6)
Body-mass index (kg/m²)					
<25	19·3% (15·5–23·2)	20·7% (16·4–25·0)	14·6% (8·8–20·5)	23·7% (18·8–28·6)	15·1% (11·6–18·6)
25–29·9	13·9% (10·1–17·7)	16·4% (13·2–19·7)	7·5% (5·0–9·9)	20·8% (16·5–25·1)	11·5% (8·8–14·2)
⩾30	13·2% (9·3–17·2)	14·4% (10·4–18·4)	4·3% (2·2–6·4)	15·0% (10·2–19·8)	9·6% (6·0–13·3)
Smoking status					
Never smoker	12·5% (9·4–15·6)	15·9% (11·7–20·0)	6·2% (4·.0–8·4)	15·3% (11·7–18·9)	6·6% (4·5–8·7)
Former smoker	15·6% (11·8– 19·3)	15·5% (11·6–19·4)	12·3% (7·3–17·3)	23·3% (18·3–28·2)	16·9% (13·1–20·7)
Current smoker	21·8% (16·5–27·2)	18·7 %(15·3–22·2)	8·0% (4·5–11·6)	22·5% (17·7–27·4)	15·4% (11·6–19·2)
Smoking exposure (pack-years)					
0–9·9	12·8% (10·0–15·7)	13·9% (11·5–16·3)	6·3% (4·5–8·2)	14·3% (11·3– 17·4)	8·1% (6·2–9·9)
10–19·9	15·3% (9·3– 21·3)	15·5% (10·2–20·7)	15·7% (8·4–23·0)	14·7% (8·0–21·4)	15·3% (9·8–20·8)
⩾20	24·6% (18·3–30·8)	30·8% (24·2–37·4)	15·4% (5·8–25·0)	32·0% (27·2–36·7)	24·8% (18·7–30·8)
Overall	15·8% (13·5–18·1)	16·9% (14·7–19·1)	7·8% (5·9–9·7)	19·7% (17·2–22·1)	12·1% (10·3–13·9)

Data are % (95% CI).

Table 4: **Prevalence of COPD (post-bronchodilator FEV1/FVC ,0·70) according to some relevant exposures**

data, due to the sampling procedure used in the five cities. Because the sampling scheme did not allow the estimation of a pooled prevalence of COPD for the region, the analyses were not weighted, nor were pooled prevalence values produced. Additional details of the PLATINO methodology are available elsewhere.[17]

Role of the funding source

The PLATINO study was funded by Boehringer Ingelheim GmbH. The funding source had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

The contact failure rate at the household level was highest in Caracas, and questionnaire completion was lowest in Mexico City (table 1). Completion of spirometry was uniformly high. Information about age, sex, and smoking were obtained from approximately 50% of individuals who were identified but refused to respond to the questionnaire. On the basis of this information, we estimate that non-response was consistently higher for men, but only slightly higher among older people and current smokers (table 2).

Women outnumbered men in all sites, and the Montevideo sample was older than the others (table 3). Schooling levels were highest in Santiago and lowest in São Paulo. The prevalence of current smoking was lower

	Prevalence				
	São Paulo (Brazil)	Santiago (Chile)	Mexico City (Mexico)	Montevideo (Uruguay)	Caracas (Venezuela)
Stage 0	25·3% (22·7–28·0)	33·6% (31·2–36·0)	23·2% (20·8–25·6)	19·1% (16·4–21·7)	23·1% (20·4–25·8)
Stage I	10·1% (8·0–12·1)	11·0% (9·2– 12·8)	5·2% (3·8–6·6)	12·5% (10·3–14·8)	6·4% (4·9–7·9)
Stage II	4·6% (3·3– 5·8)	4·9% (3·6–6·1)	1·9% (0·9–2·9)	6·4% (4·9–8·0)	4·9% (3·6–6·3)
Stage III	0·9% (0·4–1·5)	0·7% (0·2–1·1)	0·5% (0·0–0·9)	0·6% (0·0–1·0)	0·7% (0·2–1·2)
Stage IV	0·2% (0·0–0·5)	0·3% (0·0–0·7)	0·2% (0·0–0·5)	0·1% (0·0–0·3)	0·1% (0·0–0·2)

Data are % (95% CI). GOLD=Global Initiative for Chronic Obstructive Lung Disease.

Table 5: **Prevalence of COPD according to GOLD severity strata**

in São Paulo and highest in Santiago, and the total number of pack-years was lowest in Mexico City and highest in Montevideo. Distribution of ethnic origin was very different across the sites, with most people identifying themselves as white or mixed in all cities. Hospital admissions due to respiratory problems were lowest in Mexico City and highest in Santiago. Exposure to coal and biomass was highest in Santiago and lowest in Caracas, and exposure to dust at work was highest in Montevideo and lowest in Caracas. Because of the large sample sizes, significant associations were observed for all comparisons, even when the magnitude of the differences—as for BMI—was quite small. Mean FEV_1 was lowest in Caracas and highest in Santiago, whereas mean FVC was lowest in Mexico City and highest in Santiago. Mean FEV_1/FVC was highest in Mexico City and lowest in Santiago and Montevideo.

The prevalence of COPD ranged from 7·8% (78/1000) in Mexico City to almost 20% (174/885) in Montevideo (table 4). There was a consistent pattern of higher prevalence in men, in older people, and in those with less education, lower body-mass index, and greater exposure to smoking. Prevalence was higher in white people than in those of mixed ethnicity, but results were inconsistent for other ethnic groups, possibly due to small sample sizes. Prevalence results were standardised for age and sex, with resulting figures for men and women of 11·4% and 6·5% in Mexico City, 16·7% and 11·2% in Caracas, 19·5% and 14·5% in São Paulo, 23·0% and 11·6% in Montevideo, and 24·2% and 12·1% in Santiago.

For GOLD severity stratum stage 0, defined by chronic cough and phlegm with an FEV_1/FVC of 0·70 or greater, prevalence ranged from approximately 20% (183/943) in Montevideo to around 33% (380/1173) in Santiago (table 5).

As noted, COPD prevalence was lowest in Mexico City and highest in Montevideo. There is a perfect correlation between the ranks of altitude in the five cities and the COPD rates (Spearman rank correlation coefficient –1·0, n=5; table 6). After adjustment for age, sex, ethnic origin, education, smoking exposure, exposure to domestic biomass and coal pollution, occupational exposure to dust, history of childhood admission due to pulmonary disease, and body-mass index, the lowest COPD prevalence was still in Mexico City and the ranking was maintained except that the adjusted prevalence in Sao Paulo was higher than that in Santiago. The correlation between altitude and adjusted prevalence was –0·9 (p=0·03). This association was also true when the analyses were restricted to individuals who classified themselves as white, but the relative differences were reduced.

	Mean altitude (m)	COPD prevalence		
		Crude	Adjusted *	White people only
Mexico City (Mexico)	2240	7·8% (5·9–9·7)	11·9% (11·3–12·5)	12·7% (7·6–17·7)
Caracas (Venezuela)	950	12·1% (10·3–13·9)	13·0% (12·3–13·6)	13·5% (10·2–16·7)
São Paulo (Brazil)	800	15·8% (13·5–18·1)	14·9% (14·1–15·7)	16·2% (13·1–19·3)
Santiago (Chile)	543	16·9% (14·7–19·1)	14·5% (13·8–15·1)	17·8% (15·0–20·3)
Montevideo (Uruguay)	35	19·7% (17·2–22·1)	19·4% (18·4–20·3)	20·3% (17·8–22·8)
p†		0·0001	0·0001	0·01

Data are % (95% CI). *Rates adjusted for age, sex, ethnic origin, education, pack-years of smoking, exposure to domestic biomass and coal pollution, occupational exposure to dust, and body-mass index. †Wald test, taking account of sampling strategy.

Table 6: **Mean altitude and adjusted COPD prevalence by site**

Discussion

In people aged 40 years and older, we measured a crude prevalence of COPD ranging from 7·8% in Mexico City to almost 20% in Montevideo. The public health effect of this disease has yet to be fully explored in the region, but the PLATINO study is an important first step.

These results are higher than the expected range of 4–10% from an international review of COPD prevalence.[18] Nevertheless, they are consistent with the only published population-based study of COPD in Latin America in which, using the same definition used in the present analyses, Menezes and colleagues measured a prevalence of COPD of 15·2% in Pelotas, Brazil.[6] Also using the same definition, Celli and others[19] reported a prevalence of 16·8% in US residents aged 30–80 years. In Greek people older than 35 years, Tzanakis and colleagues[20] reported a prevalence of 8·4%. However, this study was restricted to smokers and used a different and stricter definition of COPD. Recently, examining individuals aged 20–44 years, de Marco and colleagues[21] reported prevalence of COPD/GOLD of 11·8% (stage 0), 2·5% (stage I) and 1·1% (stages >II) in European countries. These results are not directly comparable with ours because of different age ranges. In IBERPOC, a multicentre survey in Spain,[22] the prevalence of COPD with an earlier European Respiratory Society criterion was 13·1% for men and 10·5% for women. All studies mentioned used spirometry to document COPD rates.

We recorded wide variability in crude COPD prevalence between sites, with the highest in Montevideo and the lowest in Caracas and Mexico City. One of the strengths of this study was the consistency of methods in all countries. The use of a single study protocol, with common questionnaires and equipment, identical standardisation and quality control procedures, and the same central team for training field workers in all sites ensured that the results from the five metropolitan areas are highly comparable. Furthermore, the distribution of our eligible sample in terms of sex and age was very similar to official data from all five metropolitan areas (data not shown). Thus, the differences between sites are unlikely to be due to methodological issues.

After adjustment for measured risk factors, Mexico City remained as an outlier, with rates well below those from the other four areas. This was not mainly because

FEV_1 and FVC were higher in Mexico City than in the other regions, but because of differences in the behaviour of these parameters, leading to an increased FEV1/FVC ratio. That is, relative to their lung sizes, Mexicans seemed to have better airway function than the other samples, evident also from a higher FEV_1/FEV_6 ratio, which is less susceptible than FEV_1/FVC to technical variations as it uses a fixed duration of expiration.

The reasons for the lower COPD prevalence in Mexico City remain to be established. One possible explanation is altitude, because other studies from the Himalayas reported similar findings.[23,24] Thus, altitude could induce a higher growth of airways relative to lung size, leading to an increased FEV_1/FVC ratio. Since altitude was available only as a mean value applied to all respondents within each city, the significant association with COPD prevalence should be interpreted with caution because it is based on only five data points. We emphasise that this hypothesis arose from the data and had not been defined a priori.

Other factors might explain the lower prevalence in Mexico City, such as a genetic or ethnic difference between Mexicans and residents of other cities. This notion is supported by a recent study in children that showed that FEV_1/FVC ratios were similar between Mexicans living in Mexico City and in the USA.[25] On the other hand, when our analyses were restricted to white people (table 5), the differences between the five areas were somewhat reduced but remained significant. Smoking rates were lower in Mexico than in the other cities, but adjustment for smoking did not change the ranking of the cities in terms of COPD prevalence, and the association between smoking and COPD was weaker in Mexico than elsewhere. Further studies are thus needed to clarify the relative roles of altitude and ethnic origin. Another possible explanation for the lower prevalence in Mexico City is selective out-migration of symptomatic people due to high air pollution levels. However, particulate air pollution in Santiago is of similar severity, although Mexico has higher levels of sulphur and nitrogen dioxide.[26] São Paulo also has high levels of pollution, although not as much as the other two cities. It is not clear how much worse out-migration in Mexico would be relative to the other areas studied. The lower prevalence of COPD in Mexico City could be due to other variables, such as exposure to coal, biomass, and dust, but the distribution of these variables (table 3) does not support this hypothesis.

Because non-response was highest in Mexico, this factor could account for part of the differences, but about half of all non-responders would need to present with COPD to reach the overall prevalence in Montevideo. Seasonal effects are unlikely because COPD prevalence was based on post-bronchodilator spirometry, which is less likely than evaluation of symptoms to be affected by seasonal changes. An interesting finding was the high prevalence of COPD in non-smokers; however, this result has been described before.[27] Also, the apparently low prevalence of smoking in Mexico is consistent with existing data.[28] As shown by De Marco and colleagues,[21] we recorded higher prevalence of COPD stage 0 than in more advanced stages, which is in agreement with the natural history of the disease in the age-group under study.

Our study also had limitations. Possibly because of concern with personal security, a common feature of Latin American cities, the response rates were relatively low in Mexico City and Caracas. In Mexico, it was possible to obtain information from nearly all households, but individual refusals were frequent. In Caracas, it was not even possible to contact the inhabitants from 20% of the households; this was probably due to political upheaval during the phase of fieldwork.

Although it is reassuring that there were relatively small differences in response rates by age and current smoking status, some degree of selection bias could be present if diseased individuals are less likely to respond. Also, our main definition of COPD was based on the documentation of postbronchodilator FEV_1/FVC below a fixed value. Although this definition of COPD is probably the most widely accepted now, it represents a simplified case definition for epidemiological purposes, rather than a definitive clinical diagnosis. Although these criteria do not completely exclude the possibility that some asthmatic individuals will be regarded as presenting COPD, it is not possible to use more discriminating tests such as methacholine challenge outside the hospital.[1]

Our results suggest that COPD is a much larger health problem in Latin America than has been previously realised. Given the generally high rates of tobacco use in the region, increasing public awareness of the burden of COPD is important. We hope that these results will stimulate increased attention and action towards this important disease.

Contributors

A M B Menezes co-ordinated the PLATINO study. R Perez-Padilla was responsible for spirometry quality control. The principal investigators were J R Jardim in São Paulo; R Perez-Padilla in Mexico City; A Muiño and M V Lopez in Montevideo; G Valdivia in Santiago; and M M Oca and C Talamo in Caracas. P C Hallal led the analyses. C G Victora contributed with ideas for the report and data analysis. The article was revised and approved by all contributors.

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Conflict of interest statement

We declare that we have no conflict of interest.

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References

1 Pauwels RA, Rabe KF. Burden and clinical features of chronic obstructive pulmonary disease (COPD). *Lancet* 2004; **364:** 613–20.

2 Hurd S. The impact of COPD on lung health worldwide: epidemiology and incidence. *Chest* 2000; **117** (2 suppl)**:** 1S–4S.

3 Pauwels R. COPD: the scope of the problem in Europe. *Chest* 2000; **117** (5 suppl 2)**:** 332S–5S.

4 Petty TL. Scope of the COPD problem in North America: early studies of prevalence and NHANES III data: basis for early identification and intervention. *Chest* 2000; **117** (5 suppl 2)**:** 326S–31S.

5 Ministério da Saúde. Informações em saúde: Mortalidade. http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sim/cnv/obtuf.def (accessed July 25, 2005).

6 Menezes AM, Macedo SC, Gigante DP, et al. Prevalence and risk factors for Chronic Obstructive Pulmonary Disease according to symptoms and spirometry. *J Chron Obstr Pulm Dis* 2004; **1:** 173–79.

7 World Health Organization. Tobacco Atlas. http://www.who.int/tobacco/global_data/country_profiles/amro/en/ (accessed April 15, 2005).

8 Ferris BG. Epidemiology standardization project (American Thoracic Society). *Am Rev Respir Dis* 1978; **118:** 1–120.

9 European Community Respiratory Health Survey II Steering Committee. The European Community Respiratory Health Survey II. *Eur Respir J* 2002; **20**: 1071–79.

10 BC Cancer Research Centre. Lung Health Study Questionnaire. Vancouver: BC Cancer Research Centre, 2004.

11 Ware JE, Kosinski M, Keller SD. How to score the SF12 Physical and Mental Health Summary Scales. 2nd edition. Boston: The Health Institute, New England Medical Center, 1995.

12 Lohman TG, Roche AF, Martorell R, Eds. Anthropometric Standardization Reference Manual. Champaign: Human Kinetics Books, 1988.

13 Standardization of spirometry, 1994 update. American Thoracic Society. *Am J Respir Crit Care Med* 1995; **152:** 1107–36.

14 Global Initiative for Chronic Obstructive Lung Disease. Guent: GOLD Documents and Resources: GOLD, 2005.

15 Celli BR, MacNee W. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. *Eur Respir J* 2004; **23:** 932–46.

16 Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: A new WHO standard. http://www.emro.who.int/ncd/publications/WHO_pop_standard.pdf (accessed March 5, 2004).

17 Menezes AM, Victora CG, Perez-Padilla R. The Platino project: methodology of a multicenter prevalence survey of chronic obstructive pulmonary disease in major Latin American cities. *BMC Med Res Methodol* 2004; **4:** 15.

18 Halbert RJ, Isonaka S, George D, Iqbal A. Interpreting COPD prevalence estimates: what is the true burden of disease? *Chest* 2003; **123:** 1684–92.

19 Celli BR, Halbert RJ, Isonaka S, Schau B. Population impact of different definitions of airway obstruction. *Eur Respir J* 2003; **22:** 268–73.

20 Tzanakis N, Anagnostopoulou U, Filaditaki V, Christaki P, Siafakas N. Prevalence of COPD in Greece. *Chest* 2004; **125:** 892–900.

21 de Marco R, Accordini S, Cerveri I, et al. An international survey of chronic obstructive pulmonary disease in young adults according to GOLD stages. *Thorax* 2004; **59:** 120–25.

22 Pena VS, Miravitlles M, Gabriel R, et al. Geographic variations in prevalence and underdiagnosis of COPD: results of the IBERPOC multicentre epidemiological study. *Chest* 2000; 118: 981–89.

23 Havryk AP, Gilbert M, Burgess KR. Spirometry values in Himalayan high altitude residents (Sherpas). *Respir Physiol Neurobiol* 2002; **132:** 223–32.

24 Wood S, Norboo T, Lilly M, Yoneda K, Eldridge M. Cardiopulmonary function in high altitude residents of Ladakh. *High Alt Med Biol* 2003; **4:** 445–54.

25 Perez-Padilla R, Regalado-Pineda J, Rojas M, et al. Spirometric function in children of Mexico City compared to Mexican-American children. *Pediatr Pulmonol* 2003; **35:** 177–83.

26 The World Bank Group. World Development Indicators. http://www.worldbank.org/data/wid2005/wditext/Section3.htm (accessed July 25th, 2005).

27 Trupin L, Earnest G, San Pedro M, et al. The occupational burden of chronic obstructive pulmonary disease. *Eur Respir J* 2003; **22:** 462–69.

28 Instituto Nacional de Estadistica, Geografia e Informática. Encuesta Nacional de Adicciones 2002. Ciudad de Mexico, Mexico, 2004.