Review

Income levels and prevalence of smoking in Latin America: a systematic review and meta-analysis*

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ABSTRACT

Objective. *Determine the relationship between the prevalence of current tobacco use and smoker income levels in Latin America and the Caribbean (LAC).*

Methods. *A systematic search was conducted in MEDLINE, EMBASE, CENTRAL, SOCINDEX, and LILACS databases. Studies from LAC published from January 1989 to December 2015 were included and analyzed by subgroups disaggregated by decade of data, country, bias risk, sex, and age group.*

Results. *Of 1,254 studies evaluated by full text, 29 articles were included, of which 25 were chosen for meta-analysis. All included studies were cross-sectional or surveillance, and were primarily from Brazil and Mexico.*

Low income was associated with a higher prevalence of active tobacco use (odds ratio [OR] 1.62; 95% confidence interval [95% CI] 1.34–1.96 than high income (reference). A dose-response effect trend was observed: middle income (OR 1.23; 95% CI 1.00-1.52) and low income (OR 1.64; 95% CI 1.17-2.30). This association was greater in men (OR 2.22; 95% CI 1.77-2.78) than in women (OR 1.6; 95% CI 1.11-2.47).

Conclusions. *An inverse relationship was observed between income and tobacco use prevalence. Further efforts are required to determine this relationship in special populations, such as adolescents and pregnant women. This research may be useful to policymakers by improving tobacco control strategies and characterizing public health equity issues.*

Key words   Tobacco use; equity; health economics.

Tobacco use is the world's leading cause of preventable death. Approximately six million people die from consequences related to smoking, both from the direct as well as the indirect use (passive smoking) of cigarettes (1, 2). From 2010 to 2050, 400 million people are projected to die from diseases attributable to smoking, particularly lung cancer, chronic respiratory disease, and cardiovascular disease (3, 4). It is estimated that the majority of deaths will take place in low- and middle-income countries (5). In Latin America and the Caribbean (LAC), the proportion of disability-adjusted life years (DALY) that are lost every year as a result of tobacco use is still too high (6).

In addition to its significant impact in terms of death and morbidity, tobacco consumption imposes a significant economic burden: worldwide, the estimated cost exceeds US$500,000 million a year (7), primarily from direct medical costs and lost productivity.

Tobacco use in low-income populations is related to a higher frequency of associated diseases and patients who have limited access to health services and fewer possibilities for purchasing medicines (8-10). The greatest incidence of tobacco use (onset of habit) occurs in men from low- and middle- income countries, but the prevalence of tobacco use is higher in middle- to high-income countries (8, 9).

According to a widely cited epidemiological model, in the first stages of the epidemic, tobacco use and associated diseases predominate in men, with limited use among women, regardless of the type of country (10). Later on, the prevalence in males declines, with a shorter delay in the onset of disease in men; women follow a similar progression, albeit in lower proportions. Based on this trend, higher income societies are initially involved, since they are more open to adopting new habits, with low-income societies following suit later on. However, since the dynamic varies by income, it has been recommended that the epidemic in developing countries be described via separate analyses of men and women (11).

In recent decades, a large body of evidence has described an inverse relationship between social status and tobacco use (12-16). In these studies, poverty and tobacco use were measured using different tools; however, income level was frequently shown to be a factor and was clearly and closely associated with poverty.

In a previous systematic review (17), a strong inverse relationship was found between the prevalence of tobacco use and lower income in most geographical areas of the world, for both sexes and all age groups. The review considered studies published since 1990. Furthermore, tobacco disproportionately impoverishes the poorest households, which have the highest prevalence due to the displaced consumption of basic goods, diminished capacity to afford healthcare costs, and premature deaths of breadwinners. A previous analysis had demonstrated that low-income smokers had worse results in terms of tobacco-related diseases and that the proportion of spending on tobacco was higher among low-income households, with the subsequent impact on finances (16).

The principal objective of this study was to evaluate the relationship between the prevalence of smoking and income levels in LAC.

METHODS

This meta-analysis of observational studies follows the MOOSE guidelines for reporting (18). It included studies published or reported between January 1989 and December 2015, which met two criteria. The first was the reporting of income level, which was determined through direct measurements (household income, minimum wage units, poverty line). Job status and educational level were excluded as substitute variables. When more than two categories of income level were reported in the study, an average category was selected for comparison with the highest and lowest income levels. The other criterion was the reporting of prevalence of current tobacco use. All definitions used by the authors were included and subsequently categorized in a later stage. Studies on both the general population and specific groups were considered (regional groups, ethnic groups, age group, etc.).

A systematic search was conducted in multiple databases, including MEDLINE, EMBASE, CENTRAL, SOCINDEX, and LILACS. Gray literature was evaluated through personal contact with the principal authors, tobacco control agencies, specific Web pages, and consultations with the principal investigators. The strategy that was used can be found in the online supplementary information.

Study selection and data extraction

The studies were selected using EROS® (Early Review Organizing Software, Instituto de Efectividad Clínica y Sanitaria [Institute for Clinical Effectiveness and Health Policy - IECS], Buenos Aires), a Web platform designed to facilitate performing systematic reviews (19).

Two independent investigators reviewed all of the identified studies by title and abstract. Any disagreements were resolved by consensus of the review team. The full text of all articles that could potentially be included was obtained. Two independent investigators evaluated the full text of the selected articles to determine whether they met the criteria for inclusion. Any disagreements were resolved by consensus of the review team. If the data in the included studies were unclear or insufficient, the author was consulted. If the matter was not resolved in the consultation with the author, the article was excluded. Annex 1 shows the search strategies that were employed.

To collect the aforementioned data, a web-based spreadsheet was used. The first reviewer extracted data from the included studies and a second reviewer checked them. The following data were included: continent and country, date of publication, sex, definition of current smoking, percentage prevalence of smoking, enrollment dates, odds ratio (OR) for the relationship between income level and smoking, monetary unit, income of the smoker and family, number of cigarettes per day, handling of confounding and adjusting variables, age category, the study's epidemiological design type, rural or urban scenario, special population groups (pregnant women, workers), sampling type (probabilistic or non-probabilistic), education category, ethnic group, and religion.

Observational epidemiological, surveillance, and quasi-experimental studies, and experimental control studies were included. The methodological quality of the studies was evaluated using a tool based on the STROBE checklist (20), the Cochrane Handbook for Systematic Reviews of Intervention (21), and two methodological documents: Sanderson et al. (22), and Fowkes and Fulton (23). An algorithm was prepared to estimate the risk of bias in the observational studies. Four major criteria were considered (methods used to select study participants, methods used to measure exposure and variable results, methods to control for confounding, and comparability between groups), as well as two minor criteria (statistical methods, except for confounding, and conflict of interest). Two independent reviewers evaluated methodological quality. Any disagreements were resolved by consensus of the entire team. Annex 1, item 2.2 provides additional information on the tool used and a detailed methodological evaluation of each article included.

Statistical analysis

For studies that only reported data on prevalence, descriptive statistics were used. For studies that reported odds ratios (OR) or coefficients (β), a meta-analysis was conducted to obtain a summary measurement and the respective confidence intervals. Only the studies that reported ORs adjusted for a minimum of age and sex were eligible for the meta-analysis. Stata 12.0® (StataCorpLP, College Station, Texas) was used.

The DerSimonian-Laird random-effects model was selected, taking into account potential differences in design, exposure, comparison groups (countries, scenarios, cultures, religions), and measurement of results as possible sources of heterogeneity (24). Statistical

heterogeneity was evaluated using the I^2 statistical test, and subgroups were analyzed to further explore it: decade of the data set (1990-1999 and 2000-2009), and gender and age groups (children under the age of 15 and adults). Furthermore, a sensitivity analysis was conducted considering only studies with a lower bias risk. In each summary analysis, the confidence interval obtained with this method approximates reality better than the core value, since it is the most conservative approach for addressing potentially high heterogeneity.

RESULTS

The search strategy identified a total of 14,327 studies. A flow chart of the review process is shown in Figure 1. After

eliminating duplicate and irrelevant studies by title and abstract, 1,254 studies were obtained, for subsequent evaluation by full text. Of the studies selected by full text, 29 studies were ultimately chosen that met the criteria for inclusion. Most of the studies came from Brazil, with three from Argentina, one from Nicaragua, a joint study from Mexico and Uruguay, and one more from Mexico only. Information related to the general characteristics of the studies, the monetary unit used, income thresholds, adjusting variables, and the ORs with their confidence intervals, are mentioned in Table 1.

With regard to methodological quality and bias risk, of the 29 studies included, 28 had a cross-sectional design and one was a surveillance report. The bias risk

was considered low in 50% of the included studies, moderate risk in 20%, and high or very high risk in 30% of the studies (Table 2).

Finally, 25 studies were included in the quantitative analysis. In LAC, a low-income level was highly associated with a higher prevalence of active smoking (OR 1.62; 95% CI: 1.34–1.96) (Table 3; Figure 2). This relationship was present in all the included countries, with a strong association in the Mexico and Brazil studies (OR 1.72; 95% CI: 1.48–2.01), which is where most of the included studies came from (Table 3; Figure 2). This relationship was consistent but less pronounced in middle-income populations (OR 1.23; 95% CI: 1.00-1.52). When analyzing risk by gender, this association was consistent in women and men, but was greater for males (OR 2.22; 95% CI: 1.77-2.78) and adults over 15 years of age. In children under 15, no association could be demonstrated, given the limited number of studies (OR 1.00; 95% CI: 0.56-1.78), as shown in Annex 2. Based on year of publication, it can be seen that data from the decade 2000-2009 show an increased association (OR 1.82; 95% CI: 1.60-2.05%), which was not the case in the data from 1990-1999 or 2010-2012. The information is also available in Annex 2.

DISCUSSION

This study synthesizes the information identified in LAC on the association between the prevalence of current smoking and the smoker's income level. The principal finding was a strong association between a higher prevalence of current smoking and lower income levels. In LAC, being in the low-income category entails nearly twice the probability of being a current smoker, compared to a high- income category. This finding was consistent for the majority of the countries studied, for adults and young people, as well as for both men and women, with the highest association found in men. A prevalence gradient of smoking was also identified throughout different income levels when three levels were considered: high, average, and low.

This analysis included studies with three decades of data and showed a stable trend over time in the link between smoking prevalence and poverty levels. The majority of data came from Brazil and Mexico.

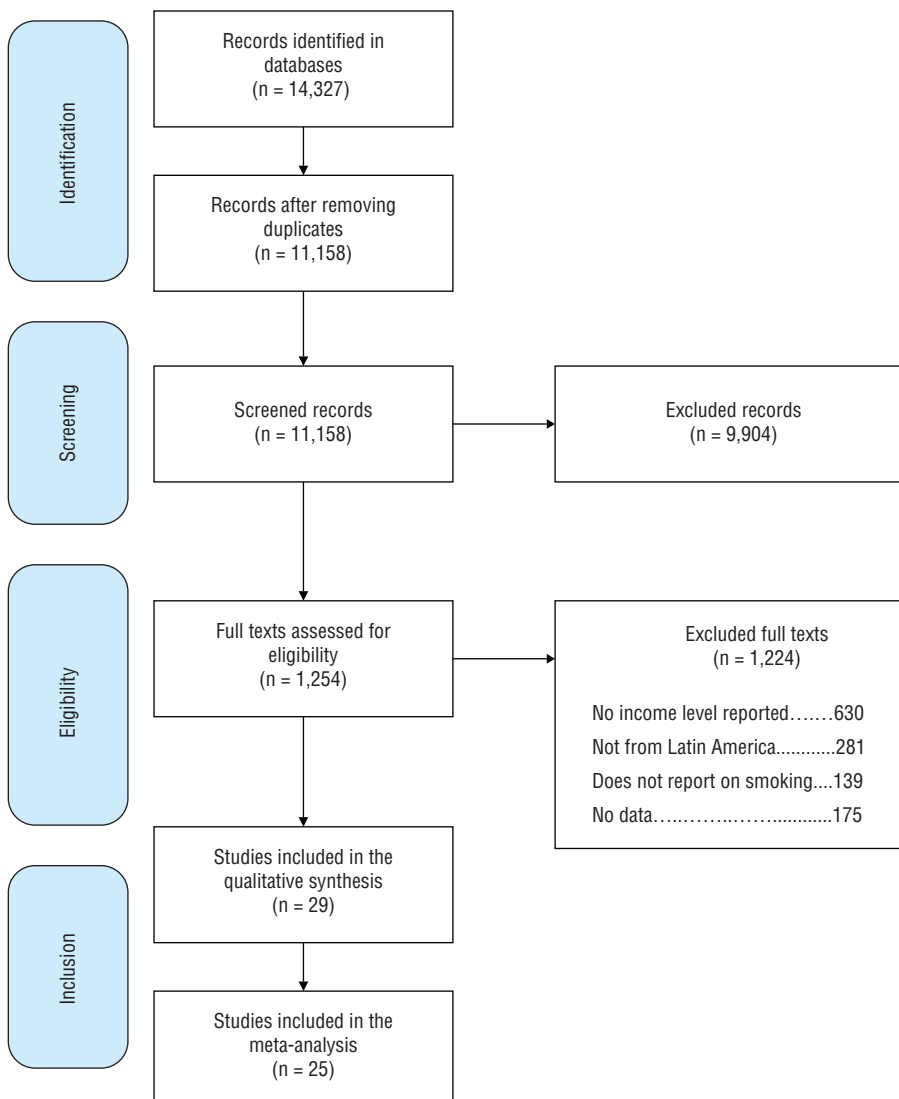**FIGURE 1. Study Selection Flow Chart**

TABLE 1. Characteristics of the included studies on smoking and income level

Country	ID	Enrollment year(s)	Definition of smoking [a]	Age range (years)	Smoking Current N	Smoking %	Men (%)	Special population
Argentina	Ferrante, 2007 (a)	2005	4	ND	41 392	29.5	47.5	ND
Argentina	Ferrante, 2011 (b)	2009	2	≥ 18	34 372	27.1	ND	ND
Argentina	Abeldaño, 2014 (c)	2008	7	ND	6 122	31.5	ND	ND
Brazil	Barros, 2011 (d)	2008	1	≥ 15	252 768	15.1	48.20	ND
Brazil	Barreto, 2013 (e)	2008	10	17-19	3 536	6.2	ND	ND
Brazil	Batista, 2013 (f)	2007-2009	10	ND	1 815	28.9	52.39	ND
Brazil	Bortoluzzi, 2009 (g)	2005	4	≥ 15	707	17.3	40.00	ND
Brazil	Dall'Agnol, 2011 (h)	1998	3	10-17	3 269	6.3	51.00	Adolescents
Brazil	De Lima, 2003 (i)	1995	5	ND	3 219	21.6	ND	ND
Brazil	Dias-Damé, 2001 (j)	2001-2010	3	≥ 20	9 814	Varies with the year	43.20	ND
Brazil	Dos Santos, 2013 (k)	2011	1	ND	366	8	ND	Tobacco growers
Brazil	Farias, 2009 (l)	2001	3	15-19	5 463	6.8	6.80	Adolescents
Brazil	Gonçalves-Silva, 2005 (m)	2005	6	ND	2 037	37.7	51.00	ND
Brazil	Kuhnen, 2009 (n)	2007	4	20-59	2 022	30.1	52.20	ND
Brazil	Lima, 2013 (o)	2011	4	18-50	711	7.6	100.00	Firemen
Brazil	Marinho, 2008 (p)	2008	4	≥ 60	6 961	18.8	44.00	ND
Brazil	Martinelli, 2014 (q)	2007-2008	9	18-60	1 516	19.85	43.20	ND
Brazil	Menezes, 2008 (r)	2000-2005	3	20-25	5 914	Varies with the year	51.00	ND
Brazil	Momino, 2003 (s)	2000	4	ND	412	ND	0.00	Pregnant Women
Brazil	Monteiro, 2007 (t)	1989	4	ND	39 808	33.2	ND	ND
Brazil	Moreira, 1995 (u)	1991	1	ND	1 091	34.9	ND	ND
Brazil	Sandin, 2010 (v)	2009	1	18-72	91 000	32	50.80	ND
Brazil	Santos, 2008 (w)	1982, 1993, 2004	5	ND	15 332	Varies by year	0.00	Pregnant Women
Brazil	Senger, 2011 (x)	2006	8	> 60	832	15.3	28.00	Elderly
Brazil	Soussa, 2013 (y)	2010	10	ND	1 084	ND	ND	ND
Brazil	Zaitune, 2012 (z)	2001-2002	1	≥ 60	1 954	12.2	47.40	Advanced age
Mexico	Anaya Ocampo 2006 (aa)	1998-2001	1	11-24	2 568	ND	34.00	Adolescents and young adults
Mexico	Borges, 2014 (ab)	2012	11	69-79	2 098	9.5	ND	Elderly
Mexico	Palipudi, 2012 (ac)	2010	1	15-65	13 617	16	ND	ND
Nicaragua	Laux, 2012 (ad)	2007-2009	4	20-60	1 355	31.3	ND	ND
Uruguay	Palipudi, 2012 (ae)	2010	1	15-65	5 581	25	ND	ND

ID = identification of the study; ND = no data.

[a] Definitions of smoking: 1. at least one cigarette per day; 2. at least 100 cigarettes in their entire life and now smokes once a day or a few days; 3. active adolescent smoker; 4. variable definition by the author; 5. active pregnant smoker; 6. active tobacco use at home; 7. smoking in the past month; 8. no data available; 9. at least one cigarette in the last six months (World Health Organization definition); 10. current smoker regardless of number; 11. at least one cigarette in the last twelve months.

(a)   Ferrante D, Virgolini M. The 2005 National Risk Factor Survey: Principal Results: Prevalence of Cardiovascular Disease Risk Factors in Argentina. Rev Argent Cardiol. 2007;75(1):20-9.

(b)   Ferrante D, Linetzky B, King A, Virgolini M, Laspiur S. 2009 National Risk Factors Survey: evolution of the epidemic of chronic non communicable diseases in Argentina. Cross sectional study. Rev Argent Salud Publica. 2011;2(6):34-41.

(c)   Abeldaño RA, Fernández AR, Estario JC, Ventura CAA. Consumption of psychoactive substances and the relation with vulnerability and poverty in Argentina. SMAD. 2014;10:111-8.

(d)   Barros AJD, Cascaes AM, Wehrmeister FC, Martínez-Mesa J, Menezes AMB. Tabagismo no Brasil: desigualdades regionais e prevalência segundo características ocupacionais [Smoking in Brazil: regional inequalities and prevalence according to occupational characteristics]. Ciência & Saúde Coletiva. 2011;16:3707-16.

(e)   Barreto SM, de Figueiredo RC, Giatti L. Socioeconomic inequalities in youth smoking in Brazil. BMJ Open. 2013;3(12).

(f)   Batista J, Albuquerque FP, Ximenes RA, Miranda-Filho D, Melo HR, Maruza M, et al. Prevalence and socioeconomic factors associated with smoking in people living with HIV by sex, in Recife, Brazil. Rev Bras Epidemiol. 2013;16:432-43.

(g)   Bortoluzzi MC, Kehrig RT, Loguercio AD, Traebert JL. Prevalência e perfil dos usuários de tabaco de população adulta em cidade do Sul do Brasil (Joaçaba, SC) [Prevalence and profile of tobacco users in adult population in a city in southern Brazil (Joaçaba, SC)]. Ciência & Saúde Coletiva. 2011;16:1953-9.

(h)   Dall'Agnol MM, Fassa ACG, Facchini LA. Child and adolescent labor and smoking: a cross-sectional study in southern Brazil. Cadernos de Saude Publica. 2011;27:46-56.

(i)   De Lima Garcias G, Schuler-Faccini L. Community diagnosis of maternal exposure to risk factors for congenital defects. Community Genetics. 2003;6(2):96-103.

(j)   Dias-Damé JL, Cesar JA, Silva SM. Tendência temporal de tabagismo em população urbana: um estudo de base populacional no Sul do Brasil [Time trends in smoking in an urban population: a population-based study in southern Brazil]. Cadernos de Saude Publica. 2011;27:2166-74.

(k)   Dos Santos M. Perfil demográfico, socioeconômico e de saúde de famílias de fumicultores de um município da região sul do Brasil [Demographic, socioeconomic, and health profile of families of smokers in a municipality in the southern region of Brazil]. Masters thesis for the Universidades Federal do Rio Grande do Sul, Brazil. Available at: http://www.bibliotecadigital.ufrgs.br/da.php?nrb=000891381&loc=2013&l=a9ccde931443e670 Access in December 2015.

(l)   Farias Júnior J, Nahas MV, Barros MV, Loch MR, Oliveira ES, De Bem MFL, et al. Comportamentos de risco à saúde em adolescentes no Sul do Brasil: prevalência e fatores associados [Health risk behaviors among adolescents in southern Bracil: prevalence and associated factors]. Rev Panam Salud Publica. 2009;25:344-52.

TABLE 1. (Continued)...Characteristics of the included studies on smoking and income level

(m)   Gonçalves-Silva RMV, Valente JG, Lemos-Santos MGF, Sichieri R. Tabagismo no domicílio e baixa estatura em menores de cinco anos [Household smoking and stunting of children under five years]. Cadernos de Saude Publica. 2005;21(5):1540-9.

(n)   Kuhnen M, Boing AF, Oliveira MCd, Longo GZ, Njaine K. Tabagismo e fatores associados em adultos: um estudo de base populacional [Smoking and associated factors in adults: a population-based study]. Rev Brasil Epidemiol. 2009;12:615-26.

(o)   Lima E, Assunção AA, Barreto SM. Tabagismo e estressores ocupacionais em bombeiros, 2011 [Smoking and occupational stressors in firefighters, 2011]. Rev Saude Publica. 2013;47:897-904.

(p)   Marinho V, Blay SL, Andreoli SB, Gastal F. A prevalence study of current tobacco smoking in later life community and its association with sociodemographic factors, physical health and mental health status. Social Psych Psych Epid. 2008;43(6):490-7.

(q)   Martinelli PM, Lopes CM, Muniz PT, Souza OF. Smoking in adults in the municipality of Rio Branco, Acre, Brazil: a population-based study. Rev Bras Epidemiol. 2014;17(4):989-1000.

(r)   Menezes AMB, Minten GC, Hallal PC, Victora CG, Horta BL, Gigante DP, et al. Tabagismo na coorte de nascimentos de 1982: da adolescência à vida adulta, Pelotas, RS [Smoking prevalence in the 1982 birth cohort: from adolescence to adult life, Pelotas, Southern Brazil]. Rev Saude Publica. 2008;42:78-85.

(s)   Momino W, Minussi L, Woffchuck D, Palmero EI, Sanseverino MT, Guimaraes Fachel JM, et al. Reproductive risk factors related to socioeconomic status in pregnant women in Southern Brazil. Community Genetics. 2003;6(2):77-83.

(t)   Monteiro CA, Cavalcante TM, Moura EC, Claro RM, Szwarcwald CL. Population-based evidence of a strong decline in the prevalence of smokers in Brazil (1989-2003). Bulletin of the World Health Organization. 2007;85(7):527-34.

(u)   Moreira LB, Fuchs FD, Moraes RS, Bredemeir M, Cardozo S. Prevalência de tabagismo e fatores associados em área metropolitana da região Sul do Brasil [Prevalence of smoking and associated factors in a metropolitan area in the southern region of Brazil]. Rev Saude Publica. 1995;29(1):46-51.

(v)   Sandin GR, Dacoregio T, Sakae TM. Estudo comparativo entre tabagistas e não tabagistas em município no Sul de Santa Catarina [Comparative study between smokers and non-smokers in a municipality in southern Santa Catarina]. Rev Bras Clin Med Sao Paulo. 2010;8(5):382-5.

(w)   Santos IS, Barros AJD, Matijasevich A, Tomasi E, Medeiros RS, Domingues MR, et al. Mothers and their pregnancies: a comparison of three population-based cohorts in Southern Brazil. Cadernos de Saude Publica. 2008;24:s381-s9.

(x)   Senger AEV, Ely LS, Gandolfi T, Schneider RH, Gomes I, De Carli GA. Alcoolismo e tabagismo em idosos: relação com ingestão alimentar e aspectos socioeconômicos [Alcholism and smoking in the elderly: relation to dietary intake and socioeconomic aspects]. Revista Brasileira de Geriatria e Gerontologia. 2011;14:713-9.

(y)   Sousa TF, José HPM, Barbosa AR. Condutas negativas à saúde em estudantes universitários brasileiros [Risk behaviors to health in Brazilian college students]. Ciência & Saúde Coletiva. 2013;18:3563-75.

(z)   Zaitune MP, Barros MB, Lima MG, César CLG, Carandina L, Goldbaum M, et al. Fatores associados ao tabagismo em idosos: Inquérito de Saúde no Estado de São Paulo (ISA-SP) [Factors associated with smoking in the elderly: a health survey in the state of São Paulo (ISA-SP)]. Cadernos de Saude Publica. 2012;28:583-96.

(aa) Anaya-Ocampo R, Arillo-Santillán E, Sánchez-Zamorano LM, Lazcano-Ponce E. Bajo desempeño escolar relacionado con la persistencia del tabaquismo en una cohorte de estudiantes en México [Poor school performance associated with smoking persistence among Mexican students]. Salud Publica Mex. 2006;48(supl.1):s17-s29.

(ab) Guimaraes Borges GL, Mendoza Meléndez MÁ, López Brambila MA, García Pacheco JA, Velasco-Ángeles LR, Beltrán Silva MA, et al. Prevalencia y factores asociados al consumo de tabaco, alcohol y drogas en una muestra poblacional de adultos mayores del Distrito Federal [Prevalence and associated factors of use of tobacco, alcohol and drugs in a population sample of elderly individuals from Mexico City]. Salud mental. 2014;37:15-25.

(ac) Palipudi KM, Gupta PC, Sinha DN, Andes LJ, Asma S, McAfee T, et al. Social Determinants of Health and Tobacco Use in Thirteen Low and Middle Income Countries: Evidence from Global Adult Tobacco Survey. PLoS ONE. 2012;7(3):e33466.

(ad) Laux TS, Bert PJ, Gonzalez M, Unruh M, Aragon A, Lacourt CT. Prevalence of obesity, tobacco use, and alcohol consumption by socioeconomic status among six communities in Nicaragua. Rev Panam Salud Publica. 2012;32(3):217-25.

TABLE 2.   Risk of bias in the included studies[a]

Study	Selection bias	Measurement bias	Confounding bias	Comparability	Statistical method bias	Conflict of interest	Bias risk (summary)
Ferrante, 2007	Low	Low	Low	Moderate	Moderate	Low	Low
Ferrante, 2011	Low	Low	Low	Low	Low	Low	Low
Abeldaño, 2014	Low	Low	Low	Low	Low	Low	Low
Barros, 2011	Low	Low	Moderate	Low	Low	Low	Low
Barreto, 2013	Low	Low	Low	Low	Low	Low	Low
Batista, 2013	High	Low	Low	Low	Low	Low	High
Bortoluzzi, 2009	Low	Low	Low	Low	Low	Low	Low
Dall'Agnol, 2011	High	Low	Low	Low	Low	Low	High
De Lima, 2003	High	High	High	High	High	High	Very high
Dias-Damé, 2001	Not clear	Low	Low	Low	Low	Low	Moderate
Dos Santos, 2013	Low	Low	Low	Low	Low	Low	Low
Farias, 2009	High	Low	Low	Low	Low	Low	High
Gonçalves-Silva, 2005	Low	Low	Moderate	Moderate	Moderate	Low	Low
Kuhnen, 2009	Low	Low	Low	Low	Low	Low	Low
Lima, 2013	High	Low	Low	Low	Low	Low	High
Marinho, 2008	Low	Moderate	Low	Low	Low	Low	Moderate
Martinelli, 2014	Low	Low	Low	Low	Low	Low	Low
Menezes, 2008	Low	Moderate	Low	Low	Low	Low	Moderate
Momino, 2003	High	Low	Low	Low	Low	Low	High
Monteiro, 2007	Low	Low	Low	Low	Low	Low	Low
Moreira, 1995	Low	Moderate	Moderate	Low	Low	Low	Moderate
Sandin, 2010	Low	Low	Low	Low	Low	Low	Low

TABLE 2. (Continued)...Risk of bias in the included studies a

Santos, 2008	Moderate	Low	High	Low	Low	Low	Moderate
Senger, 2011	Low	Not clear	High	Low	Low	Low	Moderate
Soussa, 2013	Low	Low	High	High	Low	Low	High
Zaitune, 2012	Low	Low	Low	Low	Low	Low	Low
Anaya 2006	High	Low	Low	Low	Low	Low	High
Borges, 2014	High	Low	Low	Low	Low	Low	High
Palipudi, 2012	Low	Low	Low	Low	Low	Low	Low
Laux, 2012	Low	Low	Low	Low	Low	Low	Low

a All studies are cross-sectional, except for Days-Damé (2011), which is a surveillance study.

TABLE 3. Comparison of smoking data according to income level, date the study was conducted, country, mortality, and risk of bias in the studies

Category	Number of studies	OR	95% CI
General	25	1.62	1.34-1.96
Decade conducted			
1990-1999	16	1.03	0.85-1.25
2000-20009	2	1.82	1.60-2.06
2010-2012	5	1.48	1.33-1.64
Countries			
Brazil	19	1.72	1.48-2.01
Mexico	4	1.09	0.55-2.17
Nicaragua	1	1.10	0.65-1.86
Uruguay	1	2.91	2.00-4.23
Gender			
Female	4	1.65	1.11-2.47
Male	6	2.22	1.77-2.78
Bias risk			
Low	71	1.60	1.42-1.80
Moderate	49	1.28	1.14-1.43
High	42	1.32	1.25-1.40

OR = odds ratio; 95% CI = 95% confidence interval

In LAC, tobacco use represents the third leading risk factor for death and lost years of healthy life, just behind obesity and high blood pressure, and is responsible for approximately 1 million deaths per year (6). This risk factor is associated with decreased productivity and a significant impact on out-of-pocket expenses, which contribute to the poverty of individuals and their families (25).

The results are in line with the review conducted in 2014 on tobacco and poverty by the same group of authors, which explored the association at the international level. The review confirmed that South America has the highest association, with an OR of 1.63 and a 95% confidence interval of 1.17 to 1.94 (26). These data were updated in this paper. The limited number of studies conducted in populations of older adults or the elderly have also shown the same clear inverse relationship between low-income level and smoking, whereas studies in adolescents have not

(26). Previous reports suggest that adolescents from families in lower socioeconomic levels, including those who live in homes with a single parent, are at increased risk of starting to smoke (27). The result for the subgroup of studies with the lowest bias risk produced the highest degrees of association (OR 1.60; 95% CI 1.42-1.80).
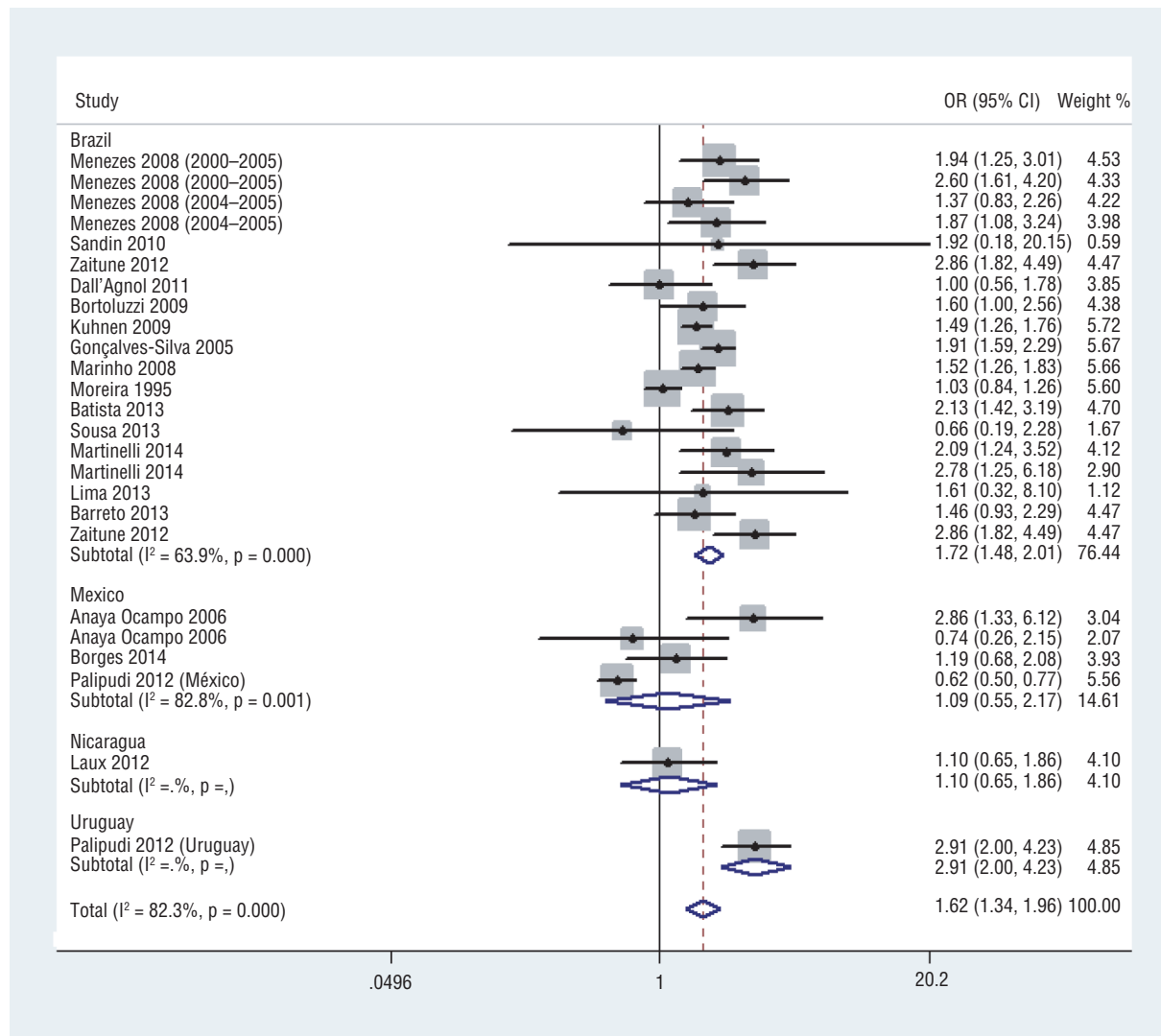
In response to the expansion of the smoking epidemic, the Framework Convention on Tobacco Control (FCTC) was established, promoted by the World Health Organization (WHO). At present, 180 countries are part of the FCTC and 168 countries have ratified it (28). The FCTC provides important and effective recommendations, such as taxation and price regulation, labeling and packaging, advertising, promotion, sponsorship, monitoring, and fighting the illicit trade of tobacco products. The highest level of tobacco use in low social classes can be explained by issues such as starting to

smoke at a younger age, fewer resources available to stop smoking, and greater difficulties in successfully quitting (29, 30).

Increasing the price of a pack of cigarettes is commonly used as a financial disincentive to begin the habit, and it is known that in poorer countries cigarettes continue to be widely affordable (3). This strategy demonstrated the ability to reduce tobacco use and improve the health of the population; however, its impact may differ depending on income level.

Although in this study the association was greater in men, the findings also point to women as an especially vulnerable group in terms of the effect of poverty on the habit. These regional findings contrast with those observed at the global level (26). For decades, tobacco companies have used various marketing strategies that target women in low socioeconomic brackets, such as price discounts at the point of sale that focus on the most inexpensive brands, and the use of images depicting luxury. Other factors, such as low-paying jobs, living in single-parent households, low educational levels, lack of social support, violence, and increased exposure to second-hand smoke could even further entice women in poorer societies to start and continue smoking (31, 32). A recent study by Hosseinpoor et al., which included a broad population from 48 low- and middle-income countries that completed the Global Adult Tobacco Survey (GATS), showed a smoking distribution that differs between countries and socioeconomic groups and is similar to what this meta-analysis demonstrates (8).

Some of the strengths of this study include an exhaustive bibliographic search using multiple databases, and strict criteria for evaluating the quality of the studies. To explore whether studies with lower methodological quality reported different ORs, sensitivity analyses were

FIGURE 2. Meta-analysis of studies that report an association between the prevalence of current smoking and income level (high versus low), by country.

Study	OR (95% CI)	Weight %
Brazil		
Menezes 2008 (2000–2005)	1.94 (1.25, 3.01)	4.53
Menezes 2008 (2000–2005)	2.60 (1.61, 4.20)	4.33
Menezes 2008 (2004–2005)	1.37 (0.83, 2.26)	4.22
Menezes 2008 (2004–2005)	1.87 (1.08, 3.24)	3.98
Sandin 2010	1.92 (0.18, 20.15)	0.59
Zaitune 2012	2.86 (1.82, 4.49)	4.47
Dall'Agnol 2011	1.00 (0.56, 1.78)	3.85
Bortoluzzi 2009	1.60 (1.00, 2.56)	4.38
Kuhnen 2009	1.49 (1.26, 1.76)	5.72
Gonçalves-Silva 2005	1.91 (1.59, 2.29)	5.67
Marinho 2008	1.52 (1.26, 1.83)	5.66
Moreira 1995	1.03 (0.84, 1.26)	5.60
Batista 2013	2.13 (1.42, 3.19)	4.70
Sousa 2013	0.66 (0.19, 2.28)	1.67
Martinelli 2014	2.09 (1.24, 3.52)	4.12
Martinelli 2014	2.78 (1.25, 6.18)	2.90
Lima 2013	1.61 (0.32, 8.10)	1.12
Barreto 2013	1.46 (0.93, 2.29)	4.47
Zaitune 2012	2.86 (1.82, 4.49)	4.47
Subtotal (I² = 63.9%, p = 0.000)	1.72 (1.48, 2.01)	76.44
Mexico		
Anaya Ocampo 2006	2.86 (1.33, 6.12)	3.04
Anaya Ocampo 2006	0.74 (0.26, 2.15)	2.07
Borges 2014	1.19 (0.68, 2.08)	3.93
Palipudi 2012 (México)	0.62 (0.50, 0.77)	5.56
Subtotal (I² = 82.8%, p = 0.001)	1.09 (0.55, 2.17)	14.61
Nicaragua		
Laux 2012	1.10 (0.65, 1.86)	4.10
Subtotal (I² =.%, p =,)	1.10 (0.65, 1.86)	4.10
Uruguay		
Palipudi 2012 (Uruguay)	2.91 (2.00, 4.23)	4.85
Subtotal (I² =.%, p =,)	2.91 (2.00, 4.23)	4.85
Total (I² = 82.3%, p = 0.000)	1.62 (1.34, 1.96)	100.00

conducted. These studies demonstrated that the low-risk group of studies showed significantly higher associations between current smoking and poverty than the moderate- or high-risk group, with no overlapping confidence intervals. The random-effects model was used, which anticipated high levels of heterogeneity.

For the exposure variable, measurements of direct monetary income were used. This variable was measured by income category (low, medium, and high, or at least low and high if the number of categories was even) at the individual or family level (i.e., total household income, minimum wage, a more complex index that included income in its measurements, among

others). As mentioned above, the definitions varied by author, which means that income level strata should be interpreted more as an income gradient than as precisely defined categories. The poverty line was also considered a direct measurement of poverty, since it reflects the income needed to purchase a basket of goods and services considered essential to live (33).

There are some limitations in this review. The observational nature of the studies and the different definitions of exposure and results gave rise to significant heterogeneity in the majority of the analyses. Nevertheless, pre-specified subgroups were analyzed to address this issue. Determining socioeconomic level can be a challenge, since income levels

could act as a limited indicator due to fluctuations over time. Different substitute indicators could be used to overcome these limitations, such as figures on cigarette consumption, the level of smoker studies, asset indices, and other measurements related primarily to standard of living. Consumption data may also be susceptible to measurement errors, whereas data on assets and housing are not (34). Several studies found that a lower educational level was associated with higher tobacco use in low- and middle-income countries (8, 35), but this type of analysis was beyond the proposed scope of this work.

In conclusion, the results of an exhaustive systematic review that includes data from different sources are presented.

The results confirmed and quantified an inverse relationship between income level and the prevalence of current smoking in the countries of LAC. These results support the evidence that tobacco inflicts greater harm among the most disadvantaged groups. Policies and interventions focusing on smoking prevention are an important component of national and international efforts to improve the health and wellbeing of the most vulnerable populations.

It is clear that more needs to be done to reduce tobacco use among the poor. Tobacco use varies depending on income level, which means that proactive control of social inequality also benefits this aspect of health. These findings may be useful to set priorities in tobacco control policies. Efforts to help low socioeconomic groups quit smoking will have a positive long-term effect on quality of life and life expectancy, as well as an immediate effect on household expenditure, which will increase available resources.

IECS estimates (Pichón-Riviere et al., personal communication) show that each year, smoking accounts for nearly 34,000 million dollars of the health budgets of Latin American countries. This by itself represents an enormous quantity of resources, but also accounts for a significant proportion of the health budgets of each country, ranging from 5.2% in Brazil to 12.7% in Bolivia.

Even though the international evidence is clear with regard to the benefits of increased tobacco taxes, many countries, especially in LAC, have not been able to sufficiently implement or expand upon this measure. This may be partly due to the lack of specific evidence at the country level, which could lead to uncertainty among decision makers regarding the potential impact of this measure, whether positive or negative.

The association between tobacco and poverty should be regularly evaluated over several decades, starting when the effects of the policies suggested by the WHO's FCTC are expected to change the situation. The standardization of the design and criteria used for definitions should be agreed upon in order to decrease the heterogeneity of studies. The field open to future research includes evaluating countries with limited data and recognizing the effect of poverty on tobacco use in certain poorly studied subgroups, such as adolescents and pregnant women.

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Niveles de ingreso y prevalencia de tabaquismo en América Latina: revisión sistemática y metaanálisis

RESUMEN

Objetivo. Determinar la relación entre la prevalencia de consumo actual de tabaco y los niveles de ingresos monetarios de fumadores en América Latina y el Caribe (ALC).

Métodos. Se realizó una búsqueda sistemática en bases de datos incluyendo MEDLINE, EMBASE, CENTRAL, SOCINDEX y LILACS. Se incluyeron estudios de ALC publicados desde enero 1989 hasta diciembre de 2015. Se realizaron análisis de subgrupos planeados por década calendar de los datos, país, riesgo de sesgo, sexo y grupos de edad.

Resultados. De un total de 1 254 estudios evaluados por texto completo se incluyeron 29 artículos, de los cuales 25 fueron incorporados en metaanálisis. Todos los estudios incluidos fueron de corte transversal o de vigilancia, la mayoría provenientes de Brasil y de México.
Un bajo nivel de ingresos se asoció con una mayor prevalencia de tabaquismo activo (odds ratio [OR] 1,62; intervalo de confianza de 95% [IC95%] 1,34–1,96) con respecto al nivel alto (referencia). Se observó una tendencia de efecto dosis-respuesta: nivel medio de ingresos (OR 1,23; IC95% 1,00-1,52) y nivel bajo de ingresos (OR 1,64; IC95% 1,17-2,30). Esta asociación fue mayor en hombres (OR 2,22; IC95% 1,77-2,78) que en mujeres (OR 1,6; IC95% 1,11-2,47).

Conclusiones. Se observó una relación inversa entre el nivel de ingresos y la prevalencia de consumo de tabaco. Se requieren mayores esfuerzos para determinar esta relación en poblaciones especiales como adolescentes o embarazadas. Esta investigación puede ser útil para los decisores políticos al mejorar las estrategias de control del tabaco y para caracterizar cuestiones de equidad en la salud pública.

Palabras clave   Uso de tabaco; equidad; economía de la salud.