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Prevalence of Cardiovascular Risk Factors in Three Andean Countries: Systematic Review with Meta-Analysis 2000-2017

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Abstract

Background and Objective: A systematic review of the epidemiology of cardiovascular risk factors such as hypertension, diabetes, hypercholesterolemia, obesity and smoking in three Latin American countries was carried out. Reliability and local representativeness of this information is fundamental for tailoring non-communicable disease control strategies to the context. **Materials and Methods:** Electronic databases and gray literature were searched for descriptive and cross-sectional population studies reporting prevalence of the above-mentioned risk factors in populations aged over 18 years in Peru, Ecuador and Bolivia, published between January 2000 and December 2017. **Results:** 29 articles, which together included a population of 38,271 individuals, were incorporated in the synthesis. A pooled prevalence was obtained for each risk factor: smoking in men 37.60% [31.56 - 43.63] was the most frequent risk factor, followed by hypercholesterolemia 26.45% [18.89 - 34.02] and obesity in women 25.53% [19.78 - 31.29]. The Global prevalence of hypertension was 19.54% [15.34 - 23.74], similar for men and women (23.11; 23.26 respectively). **Conclusions:** Estimated pooled prevalence for the main cardiovascular risk factors is high and similar to the ones reported by international estimates, especially for hypertension and obesity. Estimated prevalence of diabetes was lower than the previously reported whereas for smoking it was higher. Although prevalence can be a useful indicator for monitoring the epidemiological situation of NCCD in a country, other indicators, especially those allowing visualizing the results of interventions at local level are needed.

Keywords

Cardiovascular, Hypertension, Risk Factors

1. Introduction

Over the last years, non-communicable chronic diseases (NCCD) are one of the leading topics in every global health discussion. The United Nations General Assembly held in September 2011 was dedicated to them, being this the second time in history that a specific health subject was the topic of such a high-level intergovernmental discussion (the first was HIV/AIDS) [1]. Global consensus regarding the challenges posed by NCCD prioritizes cardiovascular (CV) diseases, in consideration of the burden that these conditions impose on wellbeing and development. Some key features of this consensus are:

1) The wealth of data, though not always consistent nor reproducible, describing the extension and the forecasted dramatic consequences of the problem (both in terms of public health and economic burden), coincides with an absence of serious attempts to envisage and test possible responses or solutions [2].

2) The variability of the social determinants of a "cardiovascular tsunami" across and within countries and regions is recognized and well-known [3]. However one can only witness a repetition of modeling exercises were the same, mostly medical, interventions-strategies are assumed as "fit for all", while the non-medical determinants of risk and care are downgraded to qualitative optional variables [4].

3) The coincidence between the awareness (and its inclusion in the models of evaluation) of the economic burden associated with the extension of the right to care of the populations at risk, and the growing pressure of policies of a so-called "universal coverage". In the hands of private actors which assume health as a market, the universal right to (access to) health represents a variable that depends on the degree of economic sustainability [5].

Global epidemiological studies on events and cardiovascular risks, and reports with grouped data lacking differentiation between regions, have been limited mainly to wealthier countries [6]. Some recent studies have included medium and low income countries [7]; however, limitations of representativeness and high variability in economic, social and cultural factors still persist. Contrasting with a "cardiovascular tsunami" of global diagnoses from outside the countries based on secondary information, there is a dramatic scarcity of local level field studies compounded with a marginalization of less developed countries in the international literature.

The Latin American region is fully representative of the above mentioned coexistence of opposite trends. In some countries, this is aggravated by the fact that reliable epidemiological data are far less available than those which quantify and qualify the degree, and consequent gaps in health services and resources accessibility [8] [9]. Ecuador, Bolivia and Peru could be considered the most sensi-

tive indicators of the urgency of facing "global" challenges with policies designed to ensure personalized strategies considering the broad spectrum of their constitutional conditions. Due to the presence of indigenous, rural, cultural and economically marginalized populations, social determinants and their implications on health inequalities are more evident in these countries [10].

Periodically provided estimates in "global reports" can't substitute direct country targeted profiles of unmet needs referring to accessibility to diagnostic, therapeutic, socioeconomic resources. The availability of direct and country specific epidemiological information is mandatory to integrate an adequate planning of effective interventions, making them more suitable to the local context. This study aims to synthesize this information.

2. Methods

This study concentrates on field studies measuring the burden of hypertension (as the expectedly most frequent and easily assessed risk factor) and other major CV risk factors in the three countries of interest. Prevalence was adopted as the closest and most regularly used term reflecting (obviously not expressing) the burden of risk/diseases.

Search strategy was restricted to descriptive cross sectional studies focusing on the prevalence of hypertension and cardiovascular risk factors, including diabetes, dyslipidemia, hypercholesterolemia, hypertriglyceridemia, HDL, obesity, metabolic syndrome and smoking, in population aged 18 or more from Peru, Bolivia and Ecuador.

A comprehensive search of articles and abstracts related to the topic and published between January 2000 and December 2017 was conducted in the following electronic databases: MEDLINE; Virtual Health Library (BVS), PAHO Online Library, and WHOLIS. Manual or electronic search of grey literature was also conducted in main national journals of scientific societies, professional associations, hospital or health services publications, undergraduate and postgraduate thesis from libraries of the three countries. Search strategies were adjusted to the different databases.

The search initially considered all studies carried out in Latin America, it was then restricted to the already mentioned three Andean countries. The following search terms were used:

Prevalence studies [MeSH] OR ("cross-sectional studies" [MeSH Terms]) AND hypertension AND latin America

Prevalence studies [MeSH] OR ("cross-sectional studies" [MeSH Terms]) AND diabetes AND latin America

Prevalence studies [MeSH] OR ("cross-sectional studies" [MeSH Terms]) AND Dyslipidemias AND latin America

Prevalence studies [MeSH] OR ("cross-sectional studies" [MeSH Terms]) AND (Obesity OR Overweight) AND latin America

Prevalence studies [MeSH] OR ("cross-sectional studies" [MeSH Terms]) AND (tobacco OR smoking) AND latin America

Figure 1 summarizes the evaluation process and results of the selection which led to the inclusion of the 29 papers that were analyzed in this article.

The classical standard criteria for the selection and analysis of documents to be included in a systematic review, and therefore their capacity of yielding reliable information, were adopted and implemented by two independent reviewers [11]. In case of controversy, decision was taken by a senior researcher acting as supervisor.

In addition to the identification of articles/reports to be included in the final analysis, a pooling process was adopted to explore the yield of providing summatory data for all issues being scrutinized in this study.

Statistical processing included a meta-analysis using the Review Manager Program (version 5.2) developed by the Cochrane Collaboration. An estimated pooled prevalence was calculated for each risk factor based on the reported data in all cases where this procedure was feasible and allowed the comparison among the same condition. Considering the small number of studies and the fact

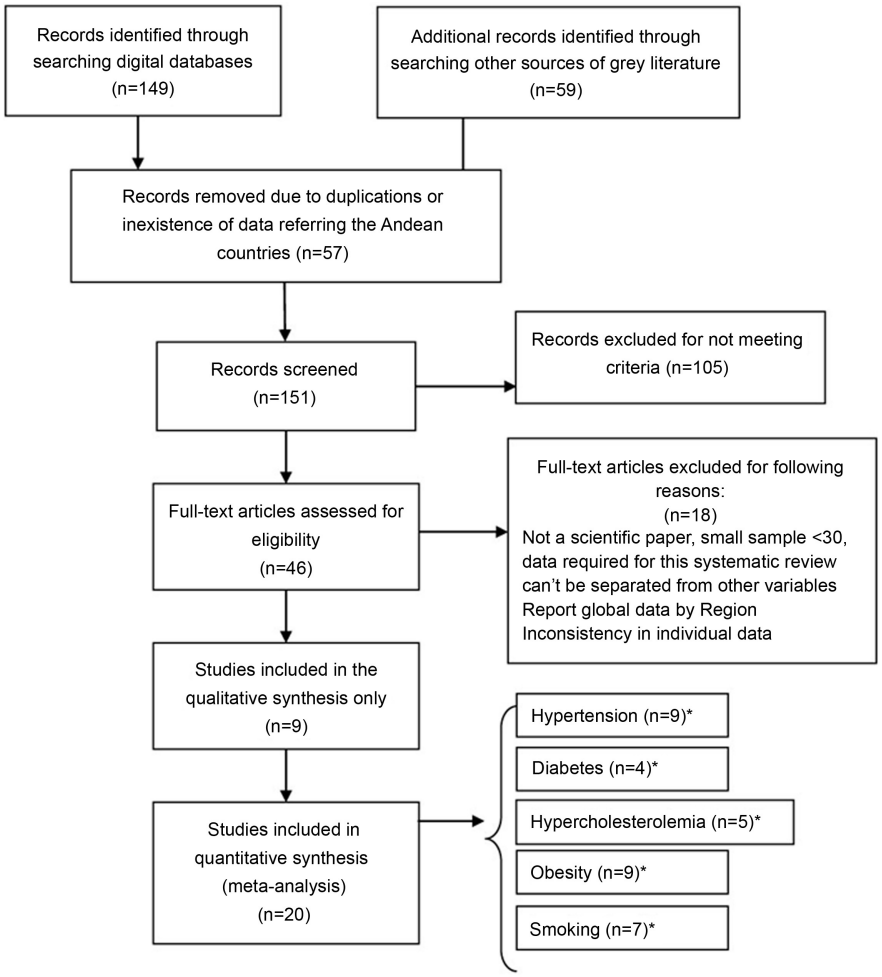

Figure 1. Selection process of articles to be included in this systematic review. *The sum of the articles included in the meta-analysis is greater than 20 because 17 papers report on more than one risk factor.

that the fixed effects model provided abnormally narrow confidence intervals (CI) a random effects model was applied [12] [13]. This also takes into account the high heterogeneity of researchers and their study designs.

In all cases where the available information allowed the creation of subgroups, analysis was performed separately by sex. If data did not permit the calculation of a combined prevalence this information was included in the qualitative description of the results. In all included articles hypertension was defined as blood pressure values ≥ 140/90 at the time the study was performed, or a self-reported previous diagnosis of hypertension by medical staff.

Some of the articles included in this review reported on more than one of the researched risk factors and six articles referred to only two different studies. In these cases, prevalence of reported risk factors was included only once in the meta-analysis. For multi-center studies risk factor's prevalences were calculated for each of the three selected countries, nevertheless they were counted as just one reference in the list of reviewed articles (**Table 1**).

3. Results

Descriptive synoptic profiles of studies included in the analysis.

Table 1 provides the key characteristics of the 29 [14]-[42] studies included in this analysis and in the calculus of pooled prevalence, as well as a synoptic indication of the risk factors referred to in each article.

A key indicator of the overall substantially unsatisfactory informative content of the retrieved material is the cumulative number of the population groups for which data needed a more detailed analysis. A scarce sample of 38,271 individuals (46.2% males, 53.8% females) was obtained. Thus, it was not possible to undertake further stratifications by age groups, and, importantly, by rural or urban areas. These stratifications are most important for countries with major diversity as the ones considered here.

Prevalence of risk factors

To provide a more detailed profile on each of the risk factors dealt with in this study, we organize them in the following modules (or blocks):

Hypertension

Relevant data is summarized in **Table 2** showing the overall weighted prevalence estimated for the whole population, and **Table 3(a)** & **Table 3(b)** present a comparison of prevalence according to sex. Note that not all the 29 studies could be included in the weighted analyses because of the incompleteness of the data; moreover, not all papers (12/29) reported the prevalence of hypertension in general population or by sex. Due to limitations in the different denominators, the weighted analyses provide broadly comparable prevalence estimates, with similar prevalence in the male and female sub-groups. Wider differences are found in the means of the raw prevalence available in the studies not included in the meta-analysis because of their large heterogeneity regarding characteristics of the sample population: prevalence in urban areas varied from 16% to 29% and

Table 1. Studies included in the synthesis.

No Ref	Reference	Study type	n	Reported Risk Factors					
				Hypertension	Diabetes	Hyper-cholesterolemia	Smoking	Obesity	Other risk factors
			Perú						
14	*Jacoby E; Goldstein J.* (2003)	Population survey in six cities of Peru	176 homes per city, with a total of 1176 families and 2237 subjects: 1172 males 1165 females					*	
15	*Soto V, et al.* (2005)	Observational, descriptive-analytical, transversal and prospective	1000 subjects: 242 males 758 females	*	*	*	*	*	
16	*Goldstein J; Jacoby E.* (2005)	Cross sectional in six cities of Peru	2337 subjects in 176 homes: 1172 males 1165 females	*	*	*		*	
17	*Romero Seclén, Gutemberg.* (2005)	Descriptive and cross-sectional	1200 homes and 957 subjects: 581 males 376 females				*		
18	*Ochoa Sosa, Salomé* (2005)	Cross sectional	1200 people of El Tambo, Huancayo and Chilca districts (Peru): 483 males 717 females				*		
19	*Segura Vega, et al.* (2006)	Descriptive and cross-sectional (STUDY TORNASOL)	14 256 valid surveys: 7059 males 7197 females	*	*	*	*	*	
20	*Agusti-Campos* (2006)	Cross sectional population-based study (STUDY TORNASOL)	14256 valid surveys: 7059 males 7197 females	*					
21	*Gamarra Contreras, Marco Antonio* (2006)	Cross sectional descriptive	266 subjects from the urban and rural population of the studied districts	*	*			*	
22	*Medina-Lezama, et al.* (2007)	Population Study (PREVENTION)	1878 subjects: 807 males 1011 females						*
23	*García Ramos Fredy* (2007)	Cross sectional descriptive	213 participants: 96 males 117 females	*	*	*	*	*	
24	*Medina-Lezama, et al.* (2007)	Population Study (PREVENTION)	1878 subjects: 867 male 1011 female	*	*			*	
25	*Dámaso, B., et al.* (2007)	Cross sectional analytic	620 subjects 285 male 335 female						*
26	*Medina-Lezama, et al.* (2008)	Population Study (PREVENTION)	1878 subjects: 867 male 1011 female				*		

Continued

27	*Medina-Lezama, et al.* (2009)	Population Study (PREVENTION)	1878 subjects: 867 male 1011 female	*	*		*	
28	*Pajuelo-Ramírez, J., et al.* (2010)	National Center for Food and Nutrition National Survey (CENAN)	4091 subjects: 2029 males 2062 females	*		*		*
29	Miranda J., *et al.* (2011)	Cross-sectional study in three groups: rural, urban and rural urban	989 subject: 467 males 522 females	*	*			*
30	Weygandt P., *et al.* (2012)	Cross-sectional survey Peri-urban area of Lima	316 adults ≥ 40 years: 149 males 167 females				*	
31	Prince MJ, *et al.* (2012)	Cross sectional population-based survey in urban and rural Peru	1933 adults > 65 years: 750 males 1183 females	*	*		*	
			Ecuador					
32	Guffanati (2000)	Descriptive	178 adults: 76 males 102 females			*		*
33	*Sánchez P, Lisanti N.* (2003)	Cross sectional descriptive	679 participants: 509 males 170 females				*	
34	*Hidalgo LA, et al.* (2006)	Cross sectional	325 Female	*	*	*		*
35	*Sempértegui F., et al.* (2010)	Cross sectional	352 participants > 65 years: 225 female 127 male	*	*			*
36	Torres M., *et al.* (2013)	Cross sectional study	318 adults: 136 males 182 females					*
37	Ortiz R., *et al.** (2014)	Cross sectional study		*				
38	Ortiz A., *et al.* (2017)	Cross sectional descriptive	374 adults: 126 males 248 females	*				
			Bolivia					
39	Tarifa (2006)	Cross sectional study in El Alto city	1200 adults: 597 males 603 female	*			*	*
40	Gutiérrez (2006)	Cross sectional	500 participants: 223 males 277 females			*		*
			Multicenter					
41	M. Royer, (2007)	Cross sectional study in 12 gynecological care centers in 3 large Latin America cities	999 postmenopausal women aged 45 - 64 years: Cochabamba (Bolivia):337 Cuzco (Peru): 350 Lima (Peru): 312	*	*			*
42	*Schargrodsky H. et al.* (2008) CARMELA	Cross sectional study in Lima y Quito	3290 subjects: 1652 Lima (768 M; 884 F) 1638 Quito (812 M; 826 F)	*	*	*	*	*

*Publication based on the same research population (Torres 2013) reporting different outcome variables.

Table 2. Global prevalence of hypertension.

				Global Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
García-Ramos 2007	27.3	3.0510204	8.70%	27.30 [21.32, 33.28]
Medina 2009	15.7	0.8673469	10.40%	15.70 [14.00, 17.40]
Ortiz R. 2014	25.79	2.53316327	9.20%	25.79 [20.83, 30.75]
Ortiz R. 2017	19	2.08928571	9.60%	19.00 [14.91, 23.09]
Pajuelo Ramírez 2006	21.1	0.6632653	10.50%	21.10 [19.80, 22.40]
Schargrodsky (Lima) 2008	12.6	0.7397959	10.50%	12.60 [11.15, 14.05]
Schargrodsky (Quito) 2008	8.6	0.6887755	10.50%	8.60 [7.25, 9.95]
Segura Vega 2006	23.7	0.3571429	10.60%	23.70 [23.00, 24.40]
Soto 2005	17.8	1.7857143	9.90%	17.80 [14.30, 21.30]
Tarifa 2006	25.8	1.293367	10.20%	25.80 [23.27, 28.33]
Total (95% CI)			**100%**	**19.54 [15.34, 23.74]**

Heterogeneity: $Tau^2 = 43.34$; $Chi^2 = 538.09$, df = 9 ($P < 0.00001$); $I^2 = 98\%$; Test for overall effect: Z = 9.12 ($P < 0.00001$).

Table 3. (a) Hypertension prevalence in women; (b) Hypertension prevalence in men.

(a)

				Women's Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Agusti Campos 2006	20.4	0.4846939	9.10%	20.40 [19.45, 21.35]
Goldstein 2005	47	1.4719388	8.70%	47.00 [44.12, 49.88]
Hidalgo 2006	38.8	2.7831633	7.60%	38.80 [33.35, 44.25]
Royer M. (Cusco) 2007	15.1	1.9897959	8.30%	15.10 [11.20, 19.00]
Royer M. (Cochabam) 2007	36.1	2.6989796	7.60%	36.10 [30.81, 41.39]
Royer M. (Lima) 2007	22.3	2.4234694	7.90%	22.30 [17.55, 27.05]
Medina 2009	15.4	1.07142857	8.90%	15.40 [13.30, 17.50]
Ortiz R. 2014	24.7	3.33673469	7.10%	24.70 [18.16, 31.24]
Ortiz R. 2017	19.4	2.6122949	7.80%	19.40 [14.28, 24.52]
Schargrodsky (Lima) 2008	10.7	0.9693878	8.90%	10.70 [8.80, 12.60]
Schargrodsky (Quito) 2008	10.1	1.1964286	8.80%	10.10 [7.76, 12.44]
Tarifa 2006	20.6	0.1020408	9.20%	20.60 [20.40, 20.80]
Total (95% CI)			**100%**	**23.26 [19.38, 26.72]**

Heterogeneity: $Tau^2 = 38.27$; $Chi^2 = 611.78$, df = 11 ($P < 0.00001$); $I^2 = 98\%$; Test for overall effect: Z = 12.31 ($P < 0.00001$).

(b)

				Men's Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Agustí Campos 2006	27.1	0.532398	13.00%	27.10 [26.06, 28.14]

Continued

Goldstein 2005	44	1.4693878	12.70%	44 [41.12, 46.88]
Medina 2009	16	1.2755102	12.80%	16.00 [13.50, 18.50]
Ortiz R. 2014	27.2	4.00255102	11.30%	27.20 [19.36, 35.04]
Ortiz R. 2017	18.2	3.64285714	11.50%	18.20 [11.06, 25.34]
Schargrodsky (Lima) 2008	14.4	1.1479592	12.80%	14.40 [12.15, 16.65]
Schargrodsky (Quito) 2008	7.2	0.7908163	12.90%	7.20 [5.65, 8.75]
Tarifa 2006	30.9	0.255102	13.00%	30.90 [30.40, 31.40]
Total (95% CI)			**100%**	**23.11 [15.90, 30.32]**

Heterogeneity: $Tau^2 = 104.22$; $Chi^2 = 1178.20$, df = 7 ($P < 0.00001$); $I^2 = 99\%$; Test for overall effect: $Z = 6.28$ ($P < 0.00001$).

in rural areas from 4% to 19% [21] [29] [38]. In Peru these prevalences were reported to be 52.6% in urban and 42.5% in rural areas [31] and in Ecuador these prevalences were 25.7% and 19% for urban and rural areas respectively [37] [38]. Additionally, the prevalence among population aged 65 or more years in Ecuador was 50% (adopting a rigid cutoff of 130/85 mm) [35] whereas in Peru it reached 52.6% in urban and 42.6% in rural areas [31].

Diabetes

Only four studies (data from Schargrodsky was separated by county) could be included in the meta-analysis of pooled of prevalence; it was set as a rather stable value of 4.41% (IC 3.25 - 5.58) among a population of 18,759 individuals (**Table 4**). Potentially informative data quoted from the other studies suggests a strictly comparable prevalence in men (3.4%) and women (3.2%) [19], whereas the CARMELA study reported a difference in the men/women prevalence at the two urban settings in Lima (4.3/4.6) and Quito (4.6/7.3) [42].

Hypercholesterolemia

Table 5 summarizes the results of the prevalence of this variable (defined as total cholesterol ≥ 240 mg/dl) reported in five studies that included a total population of 22,815 individuals.

The pooled prevalence of 26.45% (IC 18.89 - 34.02) is clearly (but expectedly) heterogeneous depending on the type of study and the time of execution; values for men varied between 8.8% and 27%, whereas for women the range was 11.1% to 24% [16] [19]. A comparable heterogeneity was documented by the CARMELA results in Lima (10.1% in men and 13% in women) as compared to Quito (21.6% men and 18.8% women) [42].

Obesity

Table 6(a) and **Table 6(b)** provide the pooled prevalence of obesity (defined as BMI ≥ 30 Kg/m^2), in eight studies on men and nine studies on women (denominators: 13,730 and 15,244 respectively). A significantly higher pooled prevalence was found in women (25.53%) than in men (13.53%). The heterogeneity found across the included studies is comparable with the one reported in other few studies not included in the pooled weighted results (range: 7.5% to 21.6%) [19] [23] [28].

Table 4. Global diabetes prevalence.

				Diabetes Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
García-Ramos 2007	7.04	1.755102	8.10%	7.04 [3.60, 10.48]
Schargrodsky (Lima) 2008	4.4	0.5102041	22.70%	4.40 [3.40, 5,40]
Schargrodsky (Quito) 2008	5.9	0.58677347	21.50%	5.90 [4.75, 7.05]
Segura Vega 2006	3.3	0.127551	26.90%	3.30 [3.05, 3.55]
Soto 2005	3.3	0.6377551	20.70%	3.30 [2.05, 4.55]
Total (95% CI)			**100%**	**4.41 [3.25, 5.58]**

Heterogeneity: $Tau^2 = 1.29$; $Chi^2 = 26.45$, df = 4 ($P < 0.00001$); $I^2 = 85\%$; Test for overall effect: $Z = 7.43$ ($P < 0.00001$).

Table 5. Prevalence of hypercholesterolemia.

				Hypercholesterolemia Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Guffanti 2000	57	3.87755102	14.70%	57.00 [49.40, 64.60]
Pajuelo Ramírez 2010	17.5	0.58673469	17.20%	17.50 [16.35, 18.65]
Schargrodsky (Lima) 2008	11.6	0.76530612	17.10%	11.60 [10.10, 13.10]
Schargrodsky (Quito) 2008	20.2	1.09693877	17.00%	20.20 [18.05, 22.35]
Segura Vega 2006	10	0.25510204	17.20%	10.00 [9.50, 10.50]
Soto 2005	47.3	1.58163265	16.80%	47.30 [44.20, 50.40]
Total (95% CI)			**100%**	**26.45 [18.89, 34.02]**

Heterogeneity: $Tau^2 = 86.42$; $Chi^2 = 834.92$, df = 5 ($P < 0.00001$); $I^2 = 99\%$; Test for overall effect: $Z = 6.85$ ($P < 0.00001$).

Table 6. (a) Obesity prevalence in men; (b) Obesity prevalence in women.

(a)

				Men's Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Goldstein 2005	16	1.09693877	11.80%	16.00 [13.85, 18.15]
Gutiérrez 2005	3.5	1.35204081	11.40%	3.50 [0.85, 6.15]
Medina 2007	14	1.35204081	11.40%	14.00 [11.35, 16.65]
Pajuelo Ramirez 2010	10.3	0.68877551	12.40%	10.30 [8.95, 11.65]
Schargrodsky (Lima) 2008	21.1	1.60714285	10.90%	21.10 [17.95, 24.25]
Schargrodsky (Quito) 2008	10.3	1.09693877	11.80%	10.30 [8.15, 12.45]
Segura Vega 2006	10.8	0.38265306	12.70%	10.80 [10.05, 11.55]
Tarifa 2006	20.6	1.70918367	10.70%	20.60 [17.25, 23.95]
Torres 2013	18.4	3.51020408	7.00%	18.40 [11.52, 25.28]
Total (95% CI)			**100%**	**13.53 [10.82, 16.23]**

Heterogeneity: $Tau^2 = 14.90$; $Chi^2 = 130.73$, df = 8 ($P < 0.00001$); $I^2 = 94\%$; Test for overall effect: $Z = 9.81$ ($P < 0.00001$).

(b)

				Women's Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Goldstein 2005	24	1.2755102	8.50%	24.00 [21.50, 26.50]
Gutiérrez 2005	4.3	1.32653061	8.50%	4.30 [1.70, 6.90]
Royer M. (Cusco) 2007	30.4	2.5255102	8.10%	30.40 [25.45, 35.35]
Royer M. (Cochabam) 2007	23.8	2.39795918	8.20%	23.80 [19.10, 28.50]
Royer M. (Lima) 2007	55.7	2.90816326	8.00%	55.70 [50.00, 61.40]
Medina 2007	36.9	1.78571428	8.40%	36.90 [33.40, 40.40]
Pajuelo Ramírez 2010	18.1	0.84183673	8.60%	18.10 [16.45, 19.75]
Schargrodsky (Lima) 2008	23.4	1.50510204	8.50%	23.40 [20.45, 26.35]
Schargrodsky (Quito) 2008	22.4	1.86224489	8.40%	22.40 [18.75, 26.05]
Segura Vega 2006	12.2	0.38265306	8.70%	12.20 [11.45, 12.95]
Tarifa 2006	30.4	1.93877551	8.40%	30.40 [26.60, 34.20]
Torres 2013	27.5	3.44897959	7.70%	27.50 [20.74, 34.26]
Total (95% CI)			**100%**	**25.53 [19.78, 31.29]**

Heterogeneity: $Tau^2 = 99.36$; $Chi^2 = 690.67$, df = 11 ($P < 0.00001$); $I^2 = 98\%$; Test for overall effect: $Z = 8.70$ ($P < 0.00001$).

Smoking

Table 7(a) and Table 7(b) provide the comparative results for the pooled prevalence in men and women, as calculated from the seven studies which include 10,988 men and 11,135 women. The expected difference in the estimates by gender (37.60% and 15.12% respectively) compares well with the overall estimates not divided by sex reported in other three studies (26.1% to 32.4%) [19] [23] [33].

Other risk factors

As detailed in the method section, the preliminary search in databases included other CV risk factors. As reasonably expected however, documentation available for triglycerides, HDL/LDL, metabolic syndrome, and overall cardiovascular risk scores was scarce and could not be evaluated in comparative or cumulative terms (data not shown). On the other hand, the informative yield of the above-mentioned variables is more than controversial also in most of the best controlled international studies, where well pre-defined quality control procedures are rigidly enforced.

4. Discussion

This paper provides a closer look to the main determinants of the cardiovascular risk profile in three Andean countries, with the purpose to contribute to the availability of good quality epidemiological data capable of not only describing the public health challenge faced by these countries but delivering useful information for planning and evaluation of locally adapted interventions.

Table 7. (a) Smoking prevalence in women; (b) Smoking prevalence in men.

(a)

				Women's Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Gutiérrez 2005	13	2.1173469	11.80%	13.00 [8.85, 17.15]
Medina 2008	12.6	1.30102041	13.60%	12.60 [10.05, 15.15]
Sánchez 2003	24.1	3.44387755	8.80%	24.10 [17.35, 30.85]
Schargrodsky (Lima) 2008	15.4	1.42857143	13.40%	15.40 [12.60, 18.20]
Schargrodsky (Quito) 2008	10.5	1.37755102	13.50%	10.50 [7.80, 13.20]
Tarifa 2006	26.9	1.8367347	12.50%	26.90 [23.30, 30.50]
Weygandt 2012	7.8	2.2193878	11.60%	7.80 [3.45, 12.15]
Total (95% CI)			**100%**	**15.12 [11.98, 18.25]**

Heterogeneity: $Tau^2 = 17.11$; $Chi^2 = 75.65$, df = 7 ($P < 0.00001$); $I^2 = 91\%$; Test for overall effect: Z = 9.45 ($P < 0.00001$)

(b)

				Men's Prevalence
Study or Subgroup	**Prevalence**	**SE**	**Weight**	**IV, Random, 95% CI**
Gutiérrez 2005	22.4	2.9081633	11.90%	22.40 [16.70, 28.10]
Medina 2008	32.2	2.01530612	12.60%	32.20 [28.25, 36.15]
Sánchez 2003	35.2	2.16836734	12.50%	35.20 [30.95, 39.45]
Schargrodsky (Lima) 2008	38	1.9132653	12.70%	38.00 [34.25, 41.75]
Schargrodsky (Quito) 2008	49.4	0.89285714	13.20%	49.40 [47.65, 51.15]
Segura Vega 2006	38.9	0.58673469	13.30%	38.90 [37.75, 40.05]
Tarifa 2006	56.8	2.0663265	12.60%	56.80 [52.75, 60.85]
Weygandt 2012	25	3.7244898	11.20%	25.00 [17.70, 32.30]
Total (95% CI)			**100%**	**37.60 [31.56, 43.63]**

Heterogeneity: $Tau^2 = 71.14$; $Chi^2 = 247.77$, df = 7 ($P < 0.00001$); $I^2 = 97\%$; Test for overall effect: Z = 12.20 ($P < 0.00001$).

Confronted with the increasing worries documented in the global reports of the unmet challenges posed by NCCD in LMIC [43] [44] it is clear that the initial results of our search reflect a substantial information gap regarding the needed knowledge about CV risks prevalence in three Andean countries (**Figure 1** & **Table 1**). The paucity and heterogeneity of studies found by this bibliographic search is strongly suggestive of a failure of institutional and academic public health actors as active protagonists in the pursuit of a fundamental change in policy's planning and implementation. Therefore, it is also not surprising that there is no trace of data on the economic burden of CV diseases even if this issue is stressed in generic terms across the official literature [45].

A detailed presentation of the substantially scarce and fragmented data found in this literature review regarding the prevalence of hypertension and other key

components of the CV risk profile can be found in Table 2 & Table 3 and Tables 4-7 respectively. Some of the pooled prevalences coincide with the internationally available estimates which have been produced on the basis of in-depth surveys or secondary data. This is the case of the hypertension's prevalence whose estimate for the Region of the Americas was 18.7% in 2013 [46] being higher in males than in females in some sub-regions. Moreover, the PURE study estimates a much higher prevalence of hypertension for 2012: 40.1% in urban and 39.2% in rural areas; in upper-middle-income countries (such as Argentina, Chile and Brazil) the hypertension prevalence reached 45.2% in urban and 46.9% in rural areas [7]. In 2015 Diabetes prevalence was estimated to be 9.4% in the South and Central America region [47] considerable higher than the one calculated by this meta-analysis.

The overall apparent substantial coincidence in raw prevalence rates cannot be considered completely satisfactory. The most urgent recommendation, common to all global report, is to stress the priority of a more generalized involvement of the health systems which would allow a key step forward: to evolve from description of hardly representative populations in hospital-based studies to systematic monitoring strategies focused not on mean values of coverage, but on reliable epidemiological outcome data. This information should include avoidable determinants of mainly socioeconomic factors and therefore life conditions of undeserved and structurally discriminated populations [5] [48]. In this sense, it is worrying that main recommendations on how to deal with CV risks continue to be those formulated on the basis of a "consensus" that reflects the situation of the countries where the evidences on the best strategies have been produced. Contributions of actors working in LMIC in these trials is minimal and unrepresentative.

The literature and reports produced in the framework of the global initiatives, such as the MDG and the SDH, the GBD revision, and the UN Summit on NCCD, documents very well how fast the situation has moved towards a condition which could hardly be considered in the same terms in the '90s of the XX century [49] The "epidemiological transition" can be assumed, although with substantial inter-intra countries variability, specifically in the area of determinants of cardiovascular risks [50].

Results from clinical trials and systematic reviews carried out in "developed" countries may not always be applicable or relevant to other environments such as developing countries [51]. Reseach data can only be considered generalizable if different contexts are taken into account; it is essential to develop and implement appropriate health and sanitary research interventions for the developing countries' context [45].

The increasing participation of some Latin American countries in the global market of clinical trials has not systematically included the least developed regions such as the Andean countries. Even more important, it did not translate into public health oriented and well-targeted epidemiological monitoring of the existing as compared to the unmet needs [52]. This unfavorable situation is even

more impressive for the two countries which went through an important constitutional evolution during the last decade [53] [54] *i.e.* Bolivia and Ecuador. Even real field data from Peru, the leading country in the production of this kind of epidemiological research (**Table 1**) does not go beyond those derived from the most important international projects carried out in the Andean Region, whose reports tend to be more globally oriented. A different, but equally important caveat must be applied to the comparison of these data with the one referring to the Andean Region obtained by the CARMELA project [55].

All these studies document well the cardiological capacity of the academic communities of Bolivia, Ecuador, and Peru to meet the standards of academic quality needed to be an active member of these international efforts. At the same time, the academic origin of the most visible research projects and their degree of representativeness of their countries' populations are far from being a satisfactory source of public health oriented and useful epidemiological information. Each of the three highland countries is characterized by a variability of subpopulations in terms of expected determinants of CV risk profile such as ethnicity, lifestyles, accessibility to diagnosis and therapy, cultural acceptability of medical long-term controls, etc. This makes more or less precise data on point-estimates of prevalence in terms of clinical indicators hardly relevant for public health decision making, teaching, guidelines production, and for launching culturally adapted and well-targeted information campaigns addressing more than only a generic invocation of risks' avoidance.

Local, real population-based data oriented to outcomes, where causes are not simply described but assessed for their availability, must be a mandatory complementary source of information with respect to those produced by national and international clinical, epidemiological, administrative research. Information obtained from qualitative research represents a key input for this goal. In this sense, the community-based methodology used by the CECOMET group in the coastal area of Ecuador could certainly be a useful, though provoking model for future developments [56] [57].

The critical importance of making substantial steps towards the direction of a well-planned integration of approaches is certainly a "must", specifically for and in the Andean countries. If recommendations of the United Nation Summit and the Convention focused on Social Determinants of Health [58] [59] are seriously taken into account, real populations and their lives must have a protagonist role in the production of medical-epidemiological knowledge. If this knowledge is meant to be an essential component of development programs, they should be based on, and promote health rights as an expression and marker of accountable and democratic societies.

The last several years have seen a tremendous change in visibility, autonomy, economic and political role of Latin America in the global scenarios. These countries have experimented large institutional evolutions which have specifically interested—with obvious heterogeneity which is not here the place to discuss—many health's fields.

Available data, though not always consistent nor reliable, forecasts dramatic consequences. Serious attempts to respond to this situation are scarce. Variability in the social determinants is not considered; interventions are mostly medically oriented and not adapted to local conditions. Awareness of the (economic) consequences and the right to care excerpts pressure on health policies such as the "universal coverage" strategy; the private sector assumes health as a market where NCCD might be highly profitable [60] [61].

Limitations of this study are derived from the quality of the included studies: some of them do not describe in detail the methods used, thus impeding a proper assessment of their quality. Moreover, many studies have small samples and are probably not representative of the cultural, social or economic diversity of the populations of these countries, especially those most marginalized and far from the centers of development. Lack of data makes it impossible to perform a geographically based analysis of the variables; certainly an important aspect to consider in assessing any epidemiological situation within the Andean countries.

5. Conclusion

Estimated pooled prevalence for the main cardiovascular risk factors is high, especially for hypertension, obesity and smoking. Considering the high costs of implementing population-based studies pooled prevalence may become a benchmark in these countries, but limitations in these values' reliability and validity should always be considered. Although prevalence can be a useful indicator for monitoring the epidemiological situation of NCCD in a country, other indicators, especially those allowing visualizing the results of interventions at local level, are also needed.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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