# Educational Inequalities in Cardiovascular Risk Factor and Blood Pressure Control in the Elderly

## Comparison of MESA Cohort and Chilean NHS Survey Outcome Measures

Carolina Nazzal*, Steven Shea[†,‡], Cecilia Castro-Diehl[†,‡], Tania Alfaro*, Patricia Frenz*, Carlos J. Rodriguez[§,‖]

*Santiago, Chile; New York, NY, USA; and Winston Salem, NC, USA*

## ABSTRACT

**Background:** Social determinants differ between countries, which is not always considered when adapting health policies and interventions to face inequalities in noncommunicable diseases and their risk factors.

**Objectives:** The study sought to analyze educational inequalities in controlled blood pressure (CBP), obesity, and smoking in study populations from Chile and the United States in 2 periods, both countries with large social inequalities.

**Methods:** The study used data from the first and fifth waves of the MESA (Multiethnic Study of Atherosclerosis) cohort, and the 2003 and 2009 to 2010 Chilean National Health Survey (CNHS) survey outcome measures. The study compared cardiovascular risk factors prevalence as well as relative index of inequality (RII) and slope index of inequality (SII) between the 2 samples.

**Results:** In the CNHS 67.9% and 52.6% of participants had below primary education in 2003 and 2009 to 2010, respectively, compared with 12.3% and 8.1% in the first and fifth waves of the MESA study, respectively. Smoking prevalence was higher and increased in the CNHS compared with the MESA study, concentrated in better-educated women in both years (RII: 0.34; 95% confidence interval [CI]: 0.17 to 0.68; and RII: 0.55; 95% CI: 0.34 to 0.89, respectively). In contrast, smoking decreased over time in the MESA study in all socioeconomic strata, although relative inequalities increased in both sexes (for women, RII: 2.32; 95% CI 1.36 to 3.97; for men, RII: 3.34; 95% CI 2.04 to 5.47). CBP prevalence in both periods was higher in the first and fifth waves of the MESA study (69.7% and 80.2%) compared with the 2003 and 2009 to 2010 CNHS samples (34.2% and 52.3%), but only for the MESA study RII, favoring the better educated, was it significant in both periods and sexes. Obesity inequalities for Chilean women decreased slightly between 2003 and 2009 as prevalence grew in the most educated (RII: 2.21 to 1.68; SII: 0.29 to 0.22, respectively); conversely, they increased for both sexes in the MESA study.

**Conclusions:** The study findings confirm that patterns and trends in prevalence, and absolute and relative inequalities vary by country, suggesting that context and cultural issues matters.

The prevention and control of noncommunicable diseases (NCDs) is a global priority, shared by countries of all income levels. In the Americas region, NCDs are the leading causes of preventable premature death and illness [1]. Their global burden and the significant inequalities in risk, disease status, and access to preventive and therapeutic services—within and between countries—are major challenges [2].

Effectively addressing the large and inequitable burden of NCDs demands accelerated national policy action through scaling up effective, evidence-based, and cost-effective individual prevention and control interventions, together with public health measures and wider health in all policy approaches [1,3]. Because the contextual social determinants may differ widely, understanding these differences and generating national knowledge is critical to inform contextually relevant and effective NCD interventions and policies [3,4].

Our aim is to analyze educational inequalities in controlled blood pressure (CBP), obesity, and smoking in 2 studies in Chile and the United States, in 2 periods. Social inequalities in both countries are marked: Chile showed a Gini coefficient of 0.50, much higher than the Organization for Economic Cooperation and Development average (0.31) and that of the United States (0.38) [5].

In Chile, cardiovascular disease (CVD) is the first death cause [6] and the third specific cause of disease burden [7].

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From the *School of Public Health, Faculty of Medicine, University of Chile, Santiago, Chile; †Department of Medicine, Columbia University College of Physicians & Surgeons, New York, NY, USA; ‡Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA; §Department of Medicine (Cardiology), Wake Forest School of Medicine, Winston-Salem, NC, USA; and the ‖Department of Epidemiology & Prevention, Wake Forest School of Medicine, Winston-Salem, NC, USA.

Correspondence: T. Alfaro (tmalfaro@gmail.com).

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National studies show that CVD and associated risk factors present social gradients, especially affecting the poor and the less educated [8]. Although Chile has claimed universal health coverage for decades, inequities in access to care persist in its segmented, but predominately public, health system [9].

National Health Objectives were set with specific goals related to the reduction of risk factors, CVD and health inequities [10]. The main policy response was the creation in 2005 of a rights-based system of health care guarantees to provide services for priority health conditions. Public health strategies were implemented, including national enactment of the World Health Organization Framework Convention on Tobacco Control and nutritional content and labeling. To monitor NCD targets, the Ministry of Health regularly carries out national health surveys [8].

In the United States, heart disease is the first death cause and the Black-White gap in heart disease death rate in favor of Whites persists, declining only from 15% to 12% in the 2000 to 2010 period [11]. The United States has implemented new policies to protect especially the disadvantaged. In 2010, the Affordable Care Act was enacted to facilitate and increase accessibility to preventive services and to increase insurance coverage rates, especially among minorities aiming to reduce health disparities [12,13].

This paper examines absolute and relative educational inequalities for CBP, obesity, and smoking in study samples of U.S. and Chilean adults 55 to 79 years of age, using data from 2 waves (2000 to 2002 and 2010 to 2012) of the MESA (Multiethnic Study of Atherosclerosis) study cohort sample (MESA1 and MESA5, respectively) and the 2003 and 2009 to 2010 Chilean National Health Survey (CNHS) samples. We hypothesize that the baseline comparison of health status and inequalities in both samples reflects health system performance for the period, whereas the comparison at the second point in time, might reveal the results of active follow-up in the MESA study, serving as a counterfactual scenario of universal effective coverage in the United States in contrast to health policy changes after the intervening equity-oriented Chilean reform.

## METHODS

### Study population

The MESA study is a longitudinal study designed to investigate risk factors for subclinical CVD among the 4 major race or ethnic groups in the United States. In 2000 to 2002, 6,814 participants were recruited (Exam 1), who were 45 to 84 years of age, were free of clinically diagnosed CVD, and self-identified as White, Black, Hispanic, or Asian Chinese from 6 U.S. communities. Recruitment used several population-based approaches [14]. MESA1 and MESA5 took place between July 2000 to August 2002 and April 2010 to January 2012, respectively. Participants provided information on their medical history, behavioral habits, and psychosocial factors. Anthropometric and resting blood pressure (BP) was measured and blood samples were collected. The MESA study was approved by the institutional research board at each of the field centers, and all participants gave written informed consent.

The CNHS is a household survey of representative samples of the Chilean adult population, from all geographic regions, including urban and rural zones, repeated in 2003 and in 2009 to 2010, to determine the prevalence of priority adult health problems. Each survey selected participants from noninstitutional households, using a random, multistage, cluster design, stratified by area and region. Eligible adults (more than 16 years of age in 2003 and more than 14 years of age in 2009 to 2010) were randomly selected using the Kish method [15]. Procedures included a questionnaire about risk factors and self-reported health problems and symptoms; a trained nurse performed anthropometric measurements, BP readings, and blood and urine sampling. The Universidad Católica ethics committee reviewed and approved the study and all participants signed an informed consent.

In CHNS 2003 the response rate was 90.2% (n = 3,619), although biological samples were taken for 3,397 (93.9%). In CHNS 2009, the response rate was 75%; 12% were not contacted and 12% refused to participate. The total sample was 5,412 participants, with biological samples for 4,959 (91.6%) [8].

To ensure comparability, our analysis was restricted to respondents 55 to 79 years of age and excluded people with CVD. The CNHS samples consisted of 1,156 and 1,444 participants from the 2003 and 2009 to 2010 surveys, respectively. The MESA study samples included 4,579 subjects from MESA1 and 3,798 from MESA5.

### Study variables harmonization

The MESA study and CNHS have similar protocols for physical measurements and blood samples. For comparison, we harmonized CNHS variables to the MESA study variable criteria and structures. We described median of lipids, creatinine, glucose, and systolic and diastolic BP. CBP was defined as BP $<$140/90 mm Hg. Current smoker status considered individuals who smoke cigarettes at present or a smoker who had quit under a year. Obesity was defined as body mass index $\geq$30 kg/m$^2$.

### Education as a socioeconomic position measure

Education level is a measure that reflects family social status, mediated by education policies, and is a determinant of employment, income, and cognitive ability for self-care; also, it is a component of mechanisms associated with health and health care inequalities [16]. Education in the MESA study samples was regrouped as less than primary school, primary school completed, high school completed, and college and higher. For the CNHS, we used the variable study years to create the same categories.

### Statistical methods

For CBP, smoking, and obesity, age-standardized prevalence was calculated using 5-year age groups, stratified by

**TABLE 1.** Sociodemographic characteristics and risk factors of participants 55 to 79 years of age in the CNHS and MESA study

| | CNHS 2003 (n = 1,156) | MESA1 (n = 4,579) | CNHS 2009 (n = 1,444) | MESA5 (n = 3,798) |
|---|---|---|---|---|
| Sociodemographic variables | | | | |
| Age | 66.3 ± 7.0 | 66.2 ± 6.8 | 65.0 ± 6.9 | 67.0 ± 7.1 |
| Female | 58.7 | 52.4 | 60.1 | 53.0 |
| Education level | | | | |
| Less than primary school | 67.9 | 12.3 | 52.6 | 8.1 |
| Primary school complete | 19.0 | 8.0 | 24.2 | 5.3 |
| High school complete | 11.0 | 42.1 | 17.6 | 40.7 |
| College and higher | 2.1 | 37.6 | 5.6 | 45.9 |
| No health insurance | No data | 7.5 | 3.8 | No data |
| Health variables | | | | |
| Total cholesterol, mg/dl | 203 (177–232) | 193 (171–216) | 209 (182–236) | 182 (158–208) |
| LDL, mg/dl | 129 (108–155) | 115 (96-136) | 126 (105–153) | 104 (83–127) |
| HDL, mg/dl | 43 (34–53) | 49 (41–59) | 47 (40–56) | 53 (44–64) |
| Triglycerides, mg/dl | 123 (91–178) | 113 (79–161) | 134 (97–194) | 96 (71–132) |
| BMI, kg/m$^2$ | 28 (26–32) | 28 (25–31) | 29 (26–32) | 28 (25–32) |
| Waist circumference, cm | 94 (86–102) | 98 (89–107) | 96 (87–104) | 97 (90–107) |
| Fasting glucose, mg/dl | 96 (88–108) | 98 (91–108) | 95 (87–106) | 95 (89–105) |
| Creatinine, mg/dl | 0.9 (0.8–1.1) | 0.9 (0.8–1.1) | 0.8 (0.7–0.9) | 0.9 (0.7–1.0) |
| SBP, mm Hg | 145 (134–161) | 128 (115–143) | 138 (124–156) | 119 (109–135) |
| DBP, mm Hg | 86 (79–94) | 72 (65–79) | 77 (71–86) | 69 (62–75) |
| Current smoking* | 19.4 | 12.4 | 24.5 | 9.7 |
| Controlled blood pressure | 34.2 | 69.7 | 52.3 | 80.2 |
| Obesity† | 34.5 | 31.7 | 36.6 | 36.5 |

Values are mean ± SD, %, or median (25th to 75th percentile). Missing values were: educational level: 3.7% CNHS 2009, 0.4% MESA1, 0.2% MESA5; current smoking: 7.3% CNHS 2003, 8.0% CNHS 2009, 0.4% MESA1, 1.8% MESA5; control blood pressure: 9.3% CNHS 2009, 1.1% MESA5; obesity: 3.8% CNHS 2003, 8.7% CNHS 2009, 1.2% MESA5.

BMI, body mass index; CNHS, Chilean National Health Survey; DBP, diastolic blood pressure; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; MESA1, 2000 to 2002 Multiethnic Study of Atherosclerosis study sample; MESA5, 2010 to 2012 Multiethnic Study of Atherosclerosis study sample; SBP, systolic blood pressure.

*Includes people that quit <1 yr.

†BMI ≥30 kg/m$^2$.

gender. To measure relative and absolute educational inequalities we calculated the relative index of inequality (RII) and slope index of inequality (SII). Both consider the whole distribution and the education categories size. The SII estimates the absolute difference between the theoretically most- and least-educated individuals in the distribution; if it is negative, it means that the health outcome is higher in the lowest level. RII represents the predicted value of the health outcome in the least educated divided by the predicted value of the most educated. A higher ratio indicates higher levels of inequality [17]. Using both measures gives a better approximation of inequalities across populations and over time; we followed the procedures and Stata version 13 (StataCorp, College Station, Texas) codes for generalized linear, log-binomial regression methods described by Ernstsen et al. [18]. The RII rate ratio is specified using a log link function; the SII rate difference applies the identity link function. In this method, the education variable for each sample and time was scaled from 0 (highest) to 1 (lowest) and weighted by the sample share for each category. A modified ridit score, based on the midpoint of the range in the cumulative distribution was assigned to each category. For each binary outcome, separate logistic regression models for each MESA study and CNHS sample and sex included the corresponding ridit score variable and age.

## RESULTS

Sociodemographic and health variables are shown in Table 1. Mean age (±SD) and proportion of women were similar in both periods. Chilean subjects were less educated compared with those from the United States. In CNHS the proportion with less than primary education was 67.9% and 52.6% in 2003 and 2009 to 2010, respectively, compared with 12.3% and 8.1% in MESA1 and MESA5, respectively.

Chilean adults show higher—and increasing—prevalence of smoking in both periods compared with the MESA study samples (19.4% and 24.5% vs. 12.4% and 9.7%, respectively) (Table 1). Table 2 shows higher age-standardized prevalence for the MESA study and CHNS subjects who had completed primary and high school compared with college education,

**TABLE 2.** Unadjusted and age-standardized prevalence and educational inequalities of smokers among women and men 55 to 79 years of age in the CNHS and MESA study, by level of education

| | CNHS (n = 1,062) (2003) | | MESA1 (n = 4,560) (2000–2002) | | CNHS (n = 1,328) (2009, 2010) | | MESA5 (n = 3,721) (2010–2012) | |
|---|---|---|---|---|---|---|---|---|
| | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) |
| Women | | | | | | | | |
| Less than primary school | 12 | 13 (9-16) | 9 | 10 (6-13) | 18 | 20 (16-24) | 6 | 8 (3-13) |
| Primary school completed | 23 | 22 (15-29) | 16 | 18 (12-23) | 26 | 24 (18-30) | 11 | 14 (6-21) |
| High school completed | 25 | 24 (14-35) | 12 | 12 (10-14) | 26 | 23 (16-30) | 11 | 11 (9-13) |
| College and higher | 13 | 3 (0-9) | 9 | 8 (6-10) | 55 | 52 (35-70) | 7 | 6 (5-8) |
| RII | | 0.34 (0.17-0.68) | | 1.71 (1.12-2.60) | | 0.55 (0.34-0.89) | | 2.32 (1.36-3.97) |
| SII | | −0.20 (−0.33 to −0.07) | | 0.07 (0.02-0.11) | | −0.140 (−0.025 to −0.020) | | 0.05 (0.01-0.10) |
| Men | | | | | | | | |
| Less than primary school | 22 | 24 (18 to 29) | 16 | 16 (11-21) | 23 | 25 (20-31) | 15 | 14 (8-20) |
| Primary school completed | 28 | 28 (18 to 38) | 16 | 17 (11-23) | 30 | 28 (21-36) | 12 | 11 (5-18) |
| High school completed | 36 | 32 (22 to 42) | 18 | 18 (16-21) | 34 | 25 (18-32) | 15 | 16 (13-19) |
| College and higher | 15 | 10 (0 to 22) | 9 | 9 (7-11) | 27 | 26 (14-38) | 7 | 8 (6-9) |
| RII | | 0.71 (0.39 to 1.32) | | 2.63 (1.80-3.83) | | 0.91 (0.54-1.55) | | 3.34 (2.04-5.47) |
| SII | | −0.10 (−0.26 to 0.06) | | 0.14 (0.09-0.19) | | −0.05 (−0.16 to 0.15) | | 0.12 (0.07-0.18) |

CI, confidence interval; RII, relative index of inequality; SII, slope index of inequality; other abbreviations as in Table 1.

except for Chilean women (52%). Absolute and relative educational inequalities of smoking are concentrated in the better educated in 2009 and 2010. In the MESA study samples, smoking rate was higher in the less-educated participants, especially among men.

CBP increased in all educational groups in both countries (Table 3). The unadjusted and age-standardized prevalence of CBP in both sexes was considerably higher in the MESA study samples. In 2009 and 2010 age-standardized CBP of Chilean women approached MESA1 levels, but Chilean men lagged behind. Chilean men in all education groups, except for the highest educational level in 2003, showed lower CBP prevalence than Chilean women. In contrast to the MESA study sample, men reached better CBP independent of their educational level. For the MESA study, RII favoring the better educated was significant for both sexes in both periods.

Obesity age-standardized prevalence in women was higher in less educated, especially in Chilean women. Compared with MESA1, absolute and relative educational inequalities for Chilean women in 2003 were significantly higher. However, these inequalities decreased in the second period in women. In the MESA study, relative educational inequalities were higher in men in both periods, compared with the CHNS (Table 4).

## DISCUSSION

During the last decade obesity prevalence was the only risk factor that shows a consistent increase both in the United States and Chile, across all educational levels. Yet absolute and relative disparities by education were lower in the second period comparison in Chilean women, driven by the increase in obesity prevalence in the educated; they were not significant for Chilean men. In contrast, inequalities in MESA study men and women were higher than in the CHNS. Although in the United States smoking prevalence decreased in both sexes, in Chile smoking increased in women, particularly in the most educated. Despite higher smoking prevalence in the CHNS than in the MESA study, educational inequalities are lower in Chile. CBP increased in all groups in both countries, and both sexes, but Chilean prevalence in the second period remained below the MESA1 levels.

The largest differences in trends for age-standardized prevalence and educational inequalities between the 2

**TABLE 3.** Unadjusted and age-standardized prevalence of controlled blood pressure among women and men 55 to 79 years of age in the CNHS and MESA study, by level of education

| | CNHS (n = 1,156) (2003) | | MESA1 (n = 4,560) (2000–2002) | | CNHS (n = 1,265) (2009, 2010) | | MESA5 (n = 3,752) (2010–2012) | |
|---|---|---|---|---|---|---|---|---|
| | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) |
| Women | | | | | | | | |
| Less than primary school | 35 | 36 (32-40) | 58 | 60 (55-65) | 52 | 55 (50-60) | 71 | 77 (71-83) |
| Primary school completed | 36 | 36 (27-44) | 66 | 68 (61-74) | 54 | 52 (47-59) | 69 | 74 (66-81) |
| High school completed | 53 | 51 (39-63) | 69 | 69 (66-72) | 69 | 65 (56-73) | 79 | 79 (77-82) |
| College and higher | 44 | 12 (4-20) | 70 | 69 (66-72) | 79 | 70 (57-84) | 82 | 81 (79-84) |
| RII | | 0.78 (0.53-1.16) | | 0.90 (0.82-1.00) | | 0.79 (0.62-0.99) | | 0.92 (0.84-0.99) |
| SII | | −0.09 (−0.25 to 0.08) | | −0.08 (−0.14 to −0.01) | | −0.14 (−0.28 to −0.001) | | −0.07 (−0.14 to 0.01) |
| Men | | | | | | | | |
| Less than primary school | 32 | 33 (28-38) | 66 | 66 (60-72) | 42 | 47 (40-53) | 84 | 86 (80-91) |
| Primary school completed | 26 | 25 (16-34) | 61 | 63 (55-70) | 50 | 47 (38-56) | 76 | 79 (71-87) |
| High school completed | 28 | 29 (18-40) | 70 | 70 (67-73) | 57 | 56 (44-69) | 81 | 82 (79-85) |
| College and higher | 33 | 32 (9-54) | 77 | 77 (74-79) | 49 | 46 (33-59) | 86 | 86 (84-89) |
| RII | | 1.45 (0.83-2.55) | | 0.79 (0.72-0.87) | | 0.88 (0.61-1.25) | | 0.92 (0.84-0.99) |
| SII | | 0.11 (−0.05 to 0.27) | | −0.17 (−0.24 to 0.10) | | −0.07 (−0.24 to 0.11) | | −0.07 (−0.14 to 0.01) |

Abbreviations as in Tables 1 and 2.

countries were found for smoking. MESA1 had lower prevalence than did CNHS 2003. CNHS measures show a marked increase in smoking prevalence in extreme educational levels, especially for college-educated women, in contrast with the results of Kim et al. [19], who found low socioeconomic status was associated with higher smoking prevalence in both sexes. In the MESA study smoking prevalence decreased in all educational levels, with no great gender differences.

During the MESA study period, in 2003, New York was the second state in the United States to implement a comprehensive smoke-free law that included prohibition of smoking in private-sector worksites, restaurants, and bars. Between 2007 and 2008, the law was implemented in Minnesota, Chicago, and Maryland, states where MESA study field centers are also located [20].

In developed countries, the historic pattern of both tobacco use and cessation first began in the well-educated elite and in men, and then spread to lower socioeconomic groups. In contrast, the trend in many middle-income countries is that the smoking epidemic occurs later in time with better-educated groups avoiding smoking altogether, perhaps due to widespread information about health risks [21]. However, the tobacco epidemic in Chile, a newly high-income country, continues to grow in the well educated, particularly in women. Similar results were found by Hughes et al. [22]. This pattern may be explained by contextual factors, including working conditions, tobacco products availability, cultural acceptance, higher emancipation in educated women than in men, and a greater adoption of egalitarian gender roles among women [23]. Although Chile implemented a tobacco law in 1995 and signed and ratified the Framework Convention on Tobacco Control in 2005, it is still the country with the highest prevalence of tobacco use in the Americas region [24]. In the absence of a truly comprehensive national tobacco policy and significant social pressure to discourage it use, the tobacco epidemiology will result in a greater proportion of female tobacco-related deaths that will lag 30 to 40 years after this growing spike in tobacco prevalence [25].

Otherwise, even though cigarette and tobacco taxes are recognized as one of the most efficient policies to reduce both the prevalence and inequalities in smoking, because lower

**TABLE 4.** Unadjusted and age-standardized prevalence of obesity among women and men 55 to 79 years of age in the CNHS and MESA study, by level of education

| | CNHS (n = 1,112) (2003) | | MESA1 (n = 4,560) (2000, 2002) | | CNHS (n = 1,271) (2009, 2010) | | MESA5 (n = 3,746) (2010–2012) | |
|---|---|---|---|---|---|---|---|---|
| | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) | Crude Prevalence | Age-Standardized Prevalence (95% CI) |
| Women | | | | | | | | |
| Less than primary school | 43 | 43 (39-48) | 37 | 36 (31-42) | 45 | 45 (40-50) | 43 | 42 (34-50) |
| Primary school completed | 33 | 31 (23-39) | 37 | 38 (31-45) | 45 | 44 (37-51) | 41 | 45 (35-55) |
| High school completed | 27 | 26 (15-38) | 39 | 39 (36-42) | 31 | 29 (22-37) | 47 | 47 (44-50) |
| College and higher | 22 | 6 (0-14) | 29 | 28 (25-31) | 25 | 23 (8-37) | 32 | 32 (29-35) |
| RII | | 2.21 (1.37-3.55) | | 1.47 (1.21-1.79) | | 1.68 (1.19-2.36) | | 1.75 (1.44-2.12) |
| SII | | 0.29 (0.14-0.45) | | 0.17 (0.08-0.23) | | 0.22 (0.09-0.36) | | 0.25 (0.17-0.33) |
| Men | | | | | | | | |
| Less than primary school | 25 | 25 (20-30) | 28 | 29 (23-35) | 30 | 29 (23-35) | 28 | 28 (21-36) |
| Primary school completed | 38 | 36 (26-47) | 28 | 27 (19-34) | 33 | 32 (23-40) | 36 | 34 (23-44) |
| High school completed | 35 | 35 (24-47) | 32 | 32 (29-35) | 28 | 30 (18-42) | 40 | 40 (37-44) |
| College and higher | 0 | 0 (0-0) | 24 | 23 (21-26) | 27 | 24 (12-36) | 28 | 28 (25-31) |
| RII | | 0.71 (0.41-1.23) | | 1.45 (1.13-1.86) | | 1.09 (0.64-1.84) | | 1.52 (1.19-1.94) |
| SII | | −0.11 (−0.28 to 0.54) | | 0.12 (0.04-0.19) | | 0.03 (−0.13 to 0.19) | | 0.16 (0.07-0.24) |

Abbreviations as in Tables 1 and 2.

socioeconomic status groups are more sensitive to price increases, some authors have argued that the decrease in prevalence could be reverted in the short run. For example, people from lower socioeconomic levels keep on smoking to alleviate their stressful lives and could compensate for higher prices by substituting cheaper cigarette brands [26]. Consistent with this, despite increases in tobacco taxes in Chile, in the last 2 years there was a slight increase in the monthly prevalence of tobacco use especially in lower educational levels [27]. Moreover, despite decreased overall smoking prevalence, educational inequalities have increased in the MESA study, particularly affecting men with lower education, which is consistent with other studies [26]. Quitting smoking is particularly difficult for this group because the cost of pharmacological treatments for cessation is not always covered by health insurances.

CBP prevalence increased across all education groups over time in both samples, which is consistent with other studies that have reported decreases in hypertension in the education gradient [28]. However, CBP levels were higher for the MESA study at baseline and overtime compared with the CNHS. Another difference was the higher CBP prevalence for men in the MESA study and women in the CNHS; although relative educational inequalities increased in the MESA study for both genders. In contrast, in CHNS 2009 and 2010, educational differences favoring the most educated were present only for women. Since 2002, a Cardiovascular Health Program was implemented in public primary care, used by 80% of the population [29], to improve control and adherence to treatment and healthy lifestyle for patients with cardiovascular risk factors. A study ended in 2006 estimated an average CBP of 59.7% in hypertensive patients followed in this program. However, fewer hypertensive men than women were captured by it, resulting in differential coverage especially for working men. The study also associated low education level to worse CBP [30]. Our findings of persisting gender differences in CBP, together with emerging educational inequalities in women, probably reflect cultural differences in health-seeking behavior, as well as health system barriers, such as opening hours, that continue to limit access by working people, affecting men more than women given the gender differences in labor participation in Chile.

Although the prevalence of hypertension has been steady between the periods of 1999 to 2002 and 2005 to 2008 (±30%) in the United States, the prevalence of pharmacologic treatment as well as CBP increased significantly during the same period among those with hypertension [31], consistent

with our findings in the MESA study sample. We also found that increases in CBP prevalence occurred across all levels of education, but it was even higher in participants with lower education compared with those with higher education. Yet, the differential was not sufficient to eradicate educational inequalities. Even though absolute inequalities for women found in MESA1 were not significant in MESA5, and men showed no significant absolute inequalities, relative inequalities have increased especially for men. In the United States, despite increased hypertension awareness and access to treatment, addressing the high prevalence of hypertension still remains a challenge, especially among minority groups [32]. An issue to consider is that the average consumption of sodium per day per person in both countries is higher than the recommendations (3,400 mg for the United States and 3,600 mg for Chile) [8,33].

Studies have shown that overweight and obesity increase with the economic development, especially in lower socioeconomic levels, with larger prevalence in women [34,35]. Our results for the CNHS are consistent. Nevertheless, we observed a narrowing of both the RII and SII over time due to a larger increase in obesity prevalence in the highest educational level. For men, the RII and SII were not significant, suggesting the absence of an educational gradient for obesity.

During the study period, Chile developed policies aimed to reducing obesity in children and pregnant women and physical inactivity in the adult population 15 years of age and older [10]. An intersectoral health promotion strategy was implemented [36], but the health impact targets were not met [37,38], which is consistent with our findings. In fact, Chile has experienced increased consumption of energy-dense foods and decreased consumption of whole grains, legumes, vegetables, and fruit in the 2 last decades, which has driven a new law regulating nutritional labeling [37,39], implemented in 2016.

The MESA study data show that obesity prevalence increased for both genders across all education levels. This is consistent with other studies in the United States, finding that the obesity prevalence in adults increased significantly from 1999 to 2010 for men and for non-Hispanic black and Mexican American women [40]. In the last decade, several state and local nutrition programs have been implemented to prevent obesity such as healthier food retail initiatives and food service guidelines or nutrition standards [41]. Programs to motivate physical activity were also implemented by providing and promoting places to exercise [42]. Although studies investigating the effectiveness of interventions to reduce inequalities in obesity have shown that several strategies are effective for specific groups, long term effects need to be better studied [35]. Most of these interventions deal with barriers at different levels related to development as well as social and working environments, including food industry regulations [43].

### Study limitations

There are constrains in comparing studies of different design. Although the CNHS is a periodic cross sectional study, the MESA study is a longitudinal study, which could lead to greater control of the risk factors over time due to cohort follow-up. Therefore, we used only cross-sectional comparisons in 2 different periods, as Hughes et al. did [22]. Second, the participation of higher socioeconomic groups in CNHS was low, which could have biased the results, underestimating educational inequalities. Third, we only used education as a measure of socioeconomic position; nevertheless, it is useful especially in cross-country comparisons, when no other indicators are available, because it is a determinant of occupation and income [44]. However, these limitations do not invalidate our aim to compare changes in baseline health status outcomes in different contexts with varying degrees of follow-up. Particularly in CBP, the MESA study cohort shows levels of control that can be achieved more than 5 phases of follow-up, which could approximate a scenario of universal effective coverage. Nevertheless, the improvement in CBP in Chile is a notable result, which may be attributed to the combined effects of societal transformation and equity-oriented health reform.

As strengths, it should be noted that BP and anthropometric measurements in both studies were carried out by health professionals using standardized protocols; only educational attainment and smoking were self-reported. For all variables, a rigorous process of harmonization was performed emphasizing the lack of resources for international comparison.

### Future directions

Although men in Chile showed no significant educational inequalities, gender differences may reflect cultural variation in health care-seeking behavior, and barriers to access faced by Chilean working men, which should be addressed in future research.

## CONCLUSIONS

The large improvement in CBP in Chile is notable. Nevertheless, the levels reached in 2010 are similar to the MESA study baseline (2002 to 2003) and considerably below the fifth-wave (2010 to 2012) results. Educational inequalities favoring the most educated were similar for the MESA study men and women at both periods. Context matters to understand trends in health status and health inequalities must be considered in designing appropriate policies, strategies, and programs.

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