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Extending the income inequality hypothesis: Ecological results from the 2005 and 2009 Argentine National Risk Factor Surveys

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A consensus on income inequality as a social determinant of health is yet to be reached. In particular, we know little about the cross-sectional versus lagged effect of inequality and the robustness of the relationship to indicators that are sensitive to varying parts of the income spectrum. We test these issues with data from Argentina's 2005 and 2009 National Risk Factor Surveys. Inequality was operationalised at the provincial level with the Gini coefficient and the Generalised Entropy (GE) index. Population health was defined as the age-standardised percentage of adults with poor/fair self-rated health by province. Our cross-sectional results indicate a significant relationship between inequality (Gini) and poor health ($r = 0.58$, $p < 0.01$) in 2005. Using the GE index, a gradient pattern emerges in the correlation, and the r values increase as the index becomes sensitive to the top of the distribution. The relationship between 2005 inequality and 2009 health displays a similar pattern, but with generally smaller correlations than the 2005 cross-sectional results. Further advances in the income inequality and health literature require new theoretical models to account for how inequalities in different parts of the income spectrum may influence population health in different ways.

Keywords: Argentina; income inequality; correlation; Gini coefficient; Generalised Entropy index

Introduction

The income inequality hypothesis has been examined through a variety of statistical approaches – from ecological to multi-level – and through both positivist and critical realist epistemologies (Coburn 2004, Wilkinson and Pickett 2008, 2009b, De Maio 2010). Despite a large empirical and theoretical literature (Wilkinson and Pickett 2009a, De Maio 2012), little agreement exists on its overall validity. Researchers have raised questions about the geographical level in which the hypothesis should be tested, the regions in the world where the hypothesis might apply (Lynch *et al.* 2003, 2004, Subramanian and Kawachi 2003) and which health indicators should be used (De Maio 2007a, 2008).

Lending credence to the idea of a 'threshold' effect, wherein income inequality has a detectable effect on health but only at or above a certain level of inequality,

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significant effects have been detected in the relatively unequal countries of China (Pei and Rodriguez 2006), Italy (De Vogli *et al.* 2005), Brazil (Cavalini and de Leon 2008), Chile (Subramanian *et al.* 2003) and Argentina (De Maio 2008). This contrasts with null findings from the relatively equal areas/countries of Scandinavia (Böckerman *et al.* 2009), Germany (Breckenkamp *et al.* 2007), Denmark (Osler *et al.* 2002, 2003), Canada (Veenstra 2002, Auger *et al.* 2009) and Japan (Shibuya *et al.* 2002). Recently, Dunn *et al.* (2007) have argued that instead of dismissing the income inequality hypothesis, because it does not appear to hold true in all cases under all conditions, research should focus on the particular question of 'under what conditions does the relationship between income inequality and population health hold?'.

Most ecological analyses of the income inequality hypothesis have been static in the sense that they have analysed data from one particular point in time. This is partly attributable to the relative paucity of historical data on income inequality (Leigh and Jencks 2007), particularly at levels of geography lower than the nation state. However, there is reason to believe that the health effect of income inequality may lag, and income inequality in year 1 may influence health in year $1 + n$ (Laporte and Ferguson 2003, Lynch *et al.* 2005, Leigh and Jencks 2007), with some authors suggesting that a lag of up to 15 years may be appropriate (Blakely *et al.* 2000). This is particularly relevant for the neo-material pathway, which asserts that income inequality is associated with systematic underinvestment in social infrastructure (e.g., education, health services, transportation, the availability of nutritious food, occupational health controls and housing) (Kahn *et al.* 2000). In effect, the neo-material explanation sees income inequality as a result of historical, cultural, political and economic processes that manifest themselves by influencing public infrastructure. From this perspective, it is plausible to posit that it may take years for inequality to 'get under the skin'. The psychosocial pathway, which sees a more direct link between inequality and health, is also consistent with the idea of a lagged effect. From this perspective, inequality is experienced as a stress-inducing stimulus activating both the allostatic load model (McEwen 1998) and the 'fight or flight' syndrome (Brunner 1997, Wilkinson 2000). A lagged effect is also compatible with this perspective, as the health effects of exposure to high inequality may take years to manifest in the body. More detailed accounts of the neo-material and psychosocial perspectives are offered by Kawachi *et al.* (1999) and De Maio (2010).

Our study uses new nationally representative survey data of 2005 and 2009 from Argentina to examine the ecological relationship between income inequality and population health with a 4-year time lag. This builds directly from the results of previous studies that suggest that an important place to examine the health effects of income inequality is the high-inequality countries of Latin America (Subramanian *et al.* 2003). Countries like Argentina have an epidemiological profile not unlike the countries of the Organization for Economic Co-Operation and Development (OECD), where the majority of studies of the income inequality hypothesis have been carried out. In Argentina, the leading causes of death are non-communicable diseases (Ferrante 2006), with cardiovascular diseases and cancers exerting the heaviest burdens. This 'post-transition' epidemiological profile is at the crux of Wilkinson's writings on the income inequality model and makes Argentina a relevant country in which to study the health effects of inequality.

Our work builds on the notion that income inequality may be operationalised using a number of different approaches (Jenkins 1991, De Maio 2007b, Chakravarty

2009). The most common approach has been to use the Gini coefficient. Building from an influential study by Kawachi and Kennedy (1997), which tested the robustness of the hypothesis using ecological data from US states and found a high correlation among income inequality measures and consistent correlations between income inequality indicators and mortality rates, researchers in this area have tended to ignore the subtleties that may be detected using myriad inequality indicators. The Gini coefficient has emerged as the default income inequality measure, and while this is appropriate in many cases, it does involve the loss of important information; much might be learned by examining how the income inequality–population health relationship is influenced by the sensitivity of the inequality indictor to inequalities in different parts of the income spectrum.

The Gini coefficient is incapable of differentiating different kinds of inequalities. Lorenz curves may intersect, reflecting differing patterns of income distribution, nevertheless resulting in very similar Gini coefficient values (Atkinson 1975, Cowell 1995). This troubling property of the Lorenz framework complicates comparisons of Gini coefficient values and may confound tests of the income inequality hypothesis. In addition, it is known that the Gini coefficient is most sensitive to inequalities in the middle part of the income spectrum (Hey and Lambert 1980, Ellison 2002). This may be appropriate in many studies, but in some cases, researchers will have valid reasons to emphasise income gaps in the top or bottom of the spectrum (Wen *et al.* 2003). For example, Weich *et al.* (2002), in their study of income inequality and self-rated health using the British Household Panel Survey, found important differences between the Gini coefficient and the Generalised Entropy (GE) index. They observed that regional income inequality, operationalised using the Gini coefficient, was significantly associated with poor health among respondents from low income groups, but that this relationship was not significant for GE indicators sensitive to inequalities at the top or bottom of the income spectrum. The extent to which the Gini coefficient differs from other measures of income distribution can therefore be an important source of insight into the health effects of income inequality.

Building from this existing body of literature, the present study tests two methodological aspects: (1) the cross-sectional versus lagged effect of income inequality and (2) the robustness of the income inequality–population health relationship to inequality indicators that are sensitive to inequalities in different parts of the income spectrum.

Methods

Data from Argentina's 2005 and 2009 National Risk Factor Surveys (*Encuesta Nacional de Factores de Riesgo* – ENFR) are used in these analyses. Both are nationally and provincially representative surveys. The 2005 ENFR has a sample size of 41,392 adults and a response rate of 86.7% (Ferrante and Virgolini 2007), whereas the 2009 ENFR has a sample size of 34,732 and a response rate of 79.8% (MSAL 2011). Both surveys were carried out by Argentina's Ministry of Health in cooperation with the *Instituto Nacional de Estadística y Censos* (INDEC; National Institute of Statistics and Census) and provincial authorities. Methodological features of the ENFR have been presented in previous reports (Ferrante and Virgolini 2007, Fleischer *et al.* 2008, De Maio *et al.* 2009).

Five different income inequality indexes are used in this study: the Gini coefficient and four categories of the GE Index: GE(-1), GE(0), GE(1) and GE(2), with the latter also known in the economics literature as Theil's measure. The Gini coefficient is derived from the Lorenz curve of the plot of cumulative percentage of the population by socio-economic status and cumulative percentage of total income; a Gini coefficient of 0 reflects a perfectly equal society in which all income is shared equally, and a Gini coefficient of 1 represents a perfectly unequal society wherein all income is earned by one individual. The Gini coefficient's main weakness as a measure of income distribution is that it is incapable of differentiating different kinds of inequalities; Lorenz curves may intersect (reflecting differing patterns of income distribution) but may nevertheless result in the same Gini coefficient value.

In contrast, the GE index incorporates a sensitivity parameter to help differentiate different patterns of inequality: the more positive α is (the sensitivity parameter: -1, 0, 1, or 2), the more sensitive GE(α) is to inequalities at the top of the income distribution, whereas lower values of α indicate that the GE index is sensitive to differences at the bottom of the distribution (Jenkins 1999). The idea behind the sensitivity parameter is that inequality can grow because of income gaps in the middle of the spectrum (and the Gini coefficient is most sensitive to this) as well as income gaps in the top (richest) and bottom (poorest) tails of the distribution. These are qualitatively different patterns of inequality and something that the Gini coefficient cannot detect. The GE index is therefore a valuable tool that allows the measurement of qualitatively different patterns of inequality. Regardless of the choice of α, the GE index produces results that can range from 0 to ∞, with 0 being a state of equal distribution and values greater than 0 representing increasing levels of inequality.

Household income data were available in the 2005 ENFR dataset in 19 categories, with 100 peso intervals for incomes below 1,000 pesos, 250 peso intervals for incomes between 1,000 and 2,000 and 1,000 peso intervals for incomes between 2,000 and 5,000 pesos. The last category included incomes of more than 5,000 pesos per month, with no upper bound. Following De Vaus (2002), we assigned the mid-point value to each category (e.g., respondents with household income of 301–400 pesos were coded as having 350 pesos). Given that the last category had no upper bound, we followed a conservative strategy of coding 5,000 and above as 5,500.

Income inequality indices were generated using Stata's ineqdeco programme (Jenkins 1999). Gini estimates from the ENFR were compared to estimates derived using Argentina's *Encuesta Permanente de Hogares* (EPH), a long-running survey of income and labour in the country. National and sub-national levels of inequality were similar in both datasets (results not shown). The EPH, however, is not designed for provincial-level analysis and we therefore used the inequality estimates from the ENFR itself. Self-rated health, an indicator derived from the SF-36 questionnaire, was measured using a five-point scale: excellent, very good, good, fair or poor. Following conventional practice, this variable was recoded as a binary outcome (excellent, very good, or good versus fair or poor).

Along with our income inequality indices, we considered associations between poor health and provincial poverty, as indicated by the percentage of homes in a province with at least one unmet basic need (UBN). UBN is defined in the 2005 ENFR by the following household characteristics: (1) a lack sufficient dwelling space

(defined as more than 3 people per room), (2) inadequate housing/building material (e.g., dirt floor), (3) a lack of proper sanitary conditions (e.g., a working toilet) or (4) the presence of school-age children (6–12 years) who are not enrolled in school. UBN is a widely used measure of absolute poverty in Argentina (Javier *et al.* 1995, INDEC 2003, Marín *et al.* 2008) and other countries in Latin America (Peña *et al.* 2000, Montilva *et al.* 2003).

Both the 2005 and 2009 ENFR were designed to be representative at the national and provincial levels. We aggregated the micro data to the level of the province, creating provincial-level measures of income inequality and self-rated health (age standardised percentage in poor/fair health). This results in an N of 24 ecological units (23 provinces and the Federal District of Buenos Aires). Adjustment by age was done through direct standardisation using the national standard population (year 2000) as a reference. The data were analysed using Pearson correlation coefficients. Scatterplots of all correlations were examined for non-linear associations. Following previous analyses of this type, correlations were weighted by provincial population (Ross *et al.* 2000, De Maio 2008). All analyses were carried out using Stata 11. Stata's survey analysis feature was used to calculate the regional aggregates.

Results

Summary univariate statistics for provincial-level income inequality and self-rated health are presented in Table 1. Among the income inequality indicators, GE(−1) and GE(2) display the most variation, in terms of range and standard deviation.

The relationship between income inequality in 2005, operationalised as the Gini coefficient, and the percentage of adults in a province with poor/fair health in that year is positive ($r = 0.58$, $p < 0.01$; see Figure 1). When income inequality is operationalised with the GE index, a gradient pattern emerges in the coefficients, and the r values increase as the GE index becomes more and more sensitive to inequalities at the top of the income distribution (Table 2). The correlation is strongest with GE(2), with a correlation of 0.75 ($p < 0.01$). However, when the GE index is particularly sensitive to inequalities at the bottom of the income distribution

Table 1. Summaries of provincial-level indicators.

	Mean	Minimum	Maximum	Standard deviation
Income inequality – 2005				
Gini	0.42	0.35	0.47	0.02
GE(−1)	0.46	0.33	0.57	0.04
GE(0)	0.31	0.24	0.39	0.03
GE(1)	0.29	0.20	0.40	0.03
GE(2)	0.37	0.21	0.60	0.06
Unmet basic needs (UBN,%)	17.8	4.8	41.7	7.9
% with poor/fair self-rated health[a]				
2005	20.6	14.0	37.7	5.1
2009	19.7	13.7	29.0	4.5

Note: [a]Age standardised.

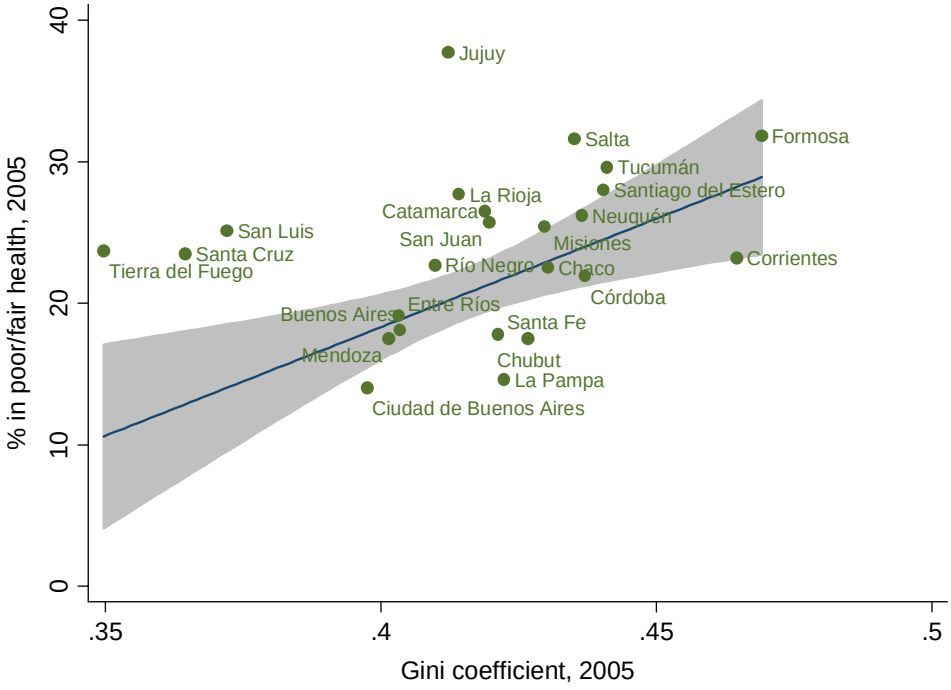

Figure 1. Scatterplot of 2005 income distribution and 2005 self-rated health by province ($r = 0.58$, $p < 0.01$).
Note: Shaded areas in both scatterplots represent 95% confidence intervals.

($\alpha = -1$), the association with poor health weakens and becomes non-significant ($r = 0.17$, $p = 0.42$).

The relationship between 2005 income inequality and 2009 health outcomes displays a similar pattern but with generally smaller correlation coefficients. The direction of the correlation between 2005 Gini and 2009 self-rated health remains

Table 2. Pearson correlation coefficients (r values) of provincial-level indicators of income inequality, poverty and self-rated health.

	Gini	GE(−1)	GE(0)	GE(1)	GE(2)	UBN	Poor health (2005)	Poor health (2009)
Gini	1.00							
GE(−1)	0.78***	1.00						
GE(0)	0.98***	0.88***	1.00					
GE(1)	0.98***	0.72***	0.95***	1.00				
GE(2)	0.90***	0.58***	0.85***	0.97***	1.00			
UBN	0.51*	0.28	0.47*	0.63***	0.74***	1.00		
Poor health (2005)	0.58**	0.17	0.48*	0.67***	0.75***	0.66***	1.00	
Poor health (2009)	0.37	0.03	0.29	0.51*	0.65***	0.81***	0.81***	1.00

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$, all two-tailed tests.

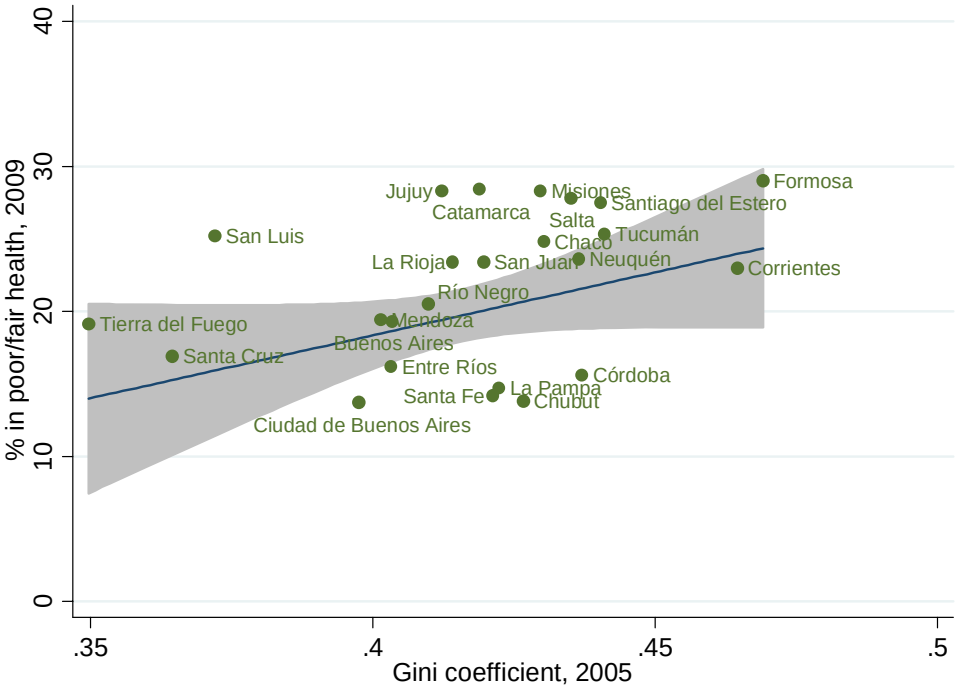

Figure 2. Scatterplot of 2005 income distribution and 2009 self-rated health by province ($r = 0.37$, $p = 0.07$).

positive ($r = 0.37$; see Figure 2), in line with the cross-sectional results, but this association does not attain statistical significance ($p = 0.07$).

Using the GE index, the gradient pattern observed previously remains in place, with the strongest correlation ($r = 0.65$, $p < 0.001$) again being detected using GE(2). The percentage of homes in a province with UBN was significantly associated with provincial Gini coefficients ($r = 0.51$, $p < 0.05$) and likewise displayed a gradient-like relationship with the GE index. The relationship between UBN and 2005/2009 health outcomes strengthens over the study period, with an increase in r from 0.66 to 0.81.

Discussion

These ecological analyses suggest that income inequality is associated with poor self-rated health in Argentina and that the strength of this association generally increases as the income inequality indicator becomes more and more sensitive to inequalities at the upper end of the distribution. This suggests that it is income gaps at the top of the income spectrum (i.e., among the rich) that may be ecologically associated with poorer levels of health. This pattern was observed in our cross-sectional analysis of 2005 data as well as in analyses that used health outcomes from 2009. This finding may be consistent with both the neo-material and psychosocial pathways (Kawachi *et al.* 1999, De Maio 2010). Increased income gaps at the top of the income distribution may signal a qualitatively different kind of inequality (Wen *et al.* 2003), a marked polarisation between the rich and the middle/poor classes. Fitting the rationale of the neo-material explanation, this polarisation may be associated with

the deterioration of public infrastructure and the growth of gated communities and private community amenities. Qualitative research may be particularly useful in exploring this possibility. At the same time, increased income gaps at the top of the distribution may also be consistent with the psychosocial pathway, if the social comparisons that are critical to stress pathways are made between the poor/middle class and the rich (Buunk *et al.* 1997, Hagerty 2000, Pham-Kanter 2009).

When the 4-year time lag was introduced, the association between inequality and health generally weakened but the pattern remained consistent. The analysis therefore extends a relatively simple ecological analysis in two ways and finds that the extension by income inequality indicator generated new insight on a gradient-like effect with the income inequality indicator. The findings from the lagged analyses suggest that the health effects of income inequality may be more temporally limited than previously theorised, with stronger correlations in cross-sectional analysis than in lagged analysis. Future studies should examine this effect using a longer follow-up period.

When the income inequality indicator was sensitive to inequalities at the bottom of the distribution (GE(−1)), the association between inequality and poor health failed to reach statistical significance and the value of the correlation coefficient approached 0 (decreasing from $r = 0.17$ in 2005 to $r = 0.03$ in 2009). This suggests that theories of the health effects of income inequality need to be attuned to qualitative differences in inequalities; inequalities at the bottom of the income spectrum – despite mathematically contributing to a Gini coefficient – can actually signal pro-poor economic effects that improve the living conditions of the poor (Wen *et al.* 2003) or at the very least attenuate underlying health effects of income inequality. In other words, because Lorenz curves can intersect and qualitatively different distributions may therefore yield similar Gini coefficients, it is important to operationalise income inequality with a range of indicators – the Gini coefficient is known to be sensitive to inequalities in the middle of the spectrum and the GE index offers a sensitivity parameter that allows researchers to examine gradient effects.

Until now, the conventional practice in this area of research has been to treat the choice of income inequality indicator as a methodological nuisance – alternative measures are generally used only to support the choice of the Gini coefficient, and little, if any, attention has been given to the interpretation of how alternative measures may be correlated with health outcomes. However, instead of being a methodological nuisance, the use of a range of inequality indicators, such as those offered by the GE index, in studies such as these may be the source of new insight on how income distribution functions as a social determinant of health. These results indicate that it is increasing income gaps at the top end of the distribution that is particularly associated with poor population health.

There are three important limitations to this analysis. The first is the reliance on self-rated health and income data. A large segment of the income inequality – health literature has relied on self-rated health status (Lynch *et al.* 2004, Wilkinson and Pickett 2006, 2007), as it has been found to be highly predictive of actual health status, including subsequent morbidity (Kennedy *et al.* 1998) and mortality (Idler and Benyamini 1997, Blakely *et al.* 2002). At the same time, some studies have raised questions regarding the validity (Sen 2002, De Maio 2007a) and reliability (Crossley and Kennedy 2002) of self-rated health questions; however, self-rated health remains an accepted and widely used measure in the income inequality literature and in the

Southern Cone countries of Latin America. Future analysis should examine the robustness of these conclusions by using other indicators of provincial-level health status, including cause-specific mortality data as well as risk factor data that the ENFR was specifically designed to collect. In the absence of tax-based register data, we have relied on ENFR questions of self-reported income. As is the case with self-reported health, self-reported income is liable to measurement error. In particular, we may expect an under-reporting of income among higher income groups. Previous research from Argentina suggests that this may be a problem (Javier *et al.* 1995, Gasparini and Escudero 2001), and this could result in artificially low indicators of inequality. At the same time, error can also be expected in the income reporting of individuals involved in the informal economy. This may lead to an underestimate of the income of the poor and lower middle class. Future analyses could build on this work by considering measures of wealth inequality, along with measures of income inequality.

A second limitation is the reliance on aggregate-level analysis. Limitations of this type of analysis, including problems of ecological fallacy (Robinson 1950, Schwartz 1994, Pearce 2000) and the associated inability to distinguish contextual from compositional effects (Diez-Roux 2002), are well known, and the conclusions we can draw from these analyses are as a consequence limited. In addition, correlation analyses offer a very limited capacity for establishing cause–effect relationships, particularly if it is not possible to adjust for potential co-founders due to a relatively low number of ecological units, as is the case with Argentine provinces. Exploratory analyses utilising ordinary least squares (OLS) regression suggest that the Gini coefficient's effect may not be robust to the inclusion of UBN as an additional covariate, whereas the GE(2) unadjusted result is indeed stable and remains significant with the inclusion of provincial UBN (regression coefficients of 0.58, $p < 0.001$ in the unadjusted model and 0.44, $p < 0.05$ in the adjusted model; in both cases, GE(2) was centred around its mean). However, as we have only 24 ecological units, the validity of analysing these data with multiple regressions is questionable.

Given the existing theoretical work on pathways linking income inequality to health, the strength of these analyses does not rest on an ability to test specific causal pathways but for exploring the robustness of the hypothesis to changes in methodology. Indeed, our correlations may be confounded by region-specific fixed effects that are not accounted for in these exploratory analyses. Despite this limitation, ecological correlations remain a key building block in empirical research on the health effects of income inequality. Furthermore, given on-going debates in the literature over the appropriateness of multi-level strategies that control for individual-level income (Wilkinson and Pickett 2009a, Bernburg 2010), aggregate-level studies remain an important branch of the field.

Another limitation is rooted in the availability of data sources; as of now, only two waves of the ENFR have been carried out and this restricted our analysis to a 4-year lag. Our results may therefore be specific to Argentina's experiences in the period 2005–2009; a period of economic recovery from the devastating crisis of 2001–2003 (Rock 2002, Lloyd-Sherlock 2005). If more waves of the ENFR are implemented, longer lag effects can be tested. Given existing work that suggests that lags of 10–15 years are appropriate (Blakely *et al.* 2000, Leigh and Jencks 2007), this is a particularly important issue for future studies to investigate. Longer follow-up periods may be associated with increased variation of both income inequality and

health, thereby increasing the statistical power of the analysis (Blakely 2000). This will be of help to better map out the dynamics of the health effects of income inequality. Longer periods of study are also needed for the 'historically deep' analysis that is required to fully test the complex theoretical ideas underlying the income inequality model; this calls for a truly interdisciplinary lens, blending social epidemiology, sociology and political economy (Coburn 2000, 2004).

Future studies should seek to identify potential heterogeneity in the estimated relationship between inequality and health. For example, a gender-based analysis could seek to map out differential effects of income inequality on men and women. Studies are also needed to situate the health effects of income inequality in Argentina in a regional context, perhaps through cross-national comparisons with the neighbouring Southern Cone countries. Such work may identify 'natural experiments', which may add particular insight to our understanding of how social and political processes related to inequality influence population health. Cross-national analysis also offers greater potential for multilevel techniques, as the number of ecological would increase.

Despite a large and growing scholarly literature, a consensus on the income inequality–population health hypothesis has not been reached. The policy implications of this body of work are contested (Starfield and Birn 2007). Much remains to be done on methodological and theoretical levels, yet the results of this study point towards the need for more consideration on how the choice of income inequality indicator may influence results. A renewed appreciation of the sensitivity of the hypothesis to the choice of the inequality indicator as well as an awareness of the temporal dynamics of the effect may yield valuable insight and, in the process, contribute to new understanding of how income redistribution may be means by which to improve population health.

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