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The income inequality hypothesis rejected?

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Publishers know academic books are not expected to sell much at all. Last year, however, Thomas Piketty's “Capitalism in the Twenty-First Century” [1] became the exception: by May 2014, this dense 700-page book arguing that inequality is not an accident but a structural feature of capitalism, was number one in the New York Times Bestsellers non-fiction list. While it may be unsurprising to find Dale Carnegie's ‘How to Win Friends and Influence People’ in the list of bestsellers, it is certainly unusual for a tome about income inequality to become such a sensation. And yet, Piketty's book clearly stroked a raw nerve with the public: if inequality continues to rise by the rate observed over recent decades, Piketty argues, we will soon reach higher levels of inequality than those observed in nineteenth century Europe. This is not only a problem in its own right, but such levels of inequality may jeopardize the future of democracy [1, 2].

The idea that income inequality is harmful for health resonates with both academics and the public, and it is with this background that numerous studies over the last three decades have engaged into trying to understand what inequality does to our health. The papers by Clough-Gorr et al. [3], Hu et al. [4], and Regidor et al. [5] in this issue of the Journal are elegant attempts to address what has become an elusive question, using new data or novel statistical techniques. Countries or regions with more income inequality often display poorer health, but establishing whether this statistical association reflects a causal effect of income inequality on health has proved difficult. Each of the papers takes a different approach to shed light into this question, but they all seem to agree on one point: income inequality may well be the Achilles' heel of the next US president, or it may one day undermine Western democracies, but income inequality is unlikely to kill us.

An important—albeit insufficient—step in establish whether income inequality causes poor health involves controlling for compositional differences. The studies by Clough-Gorr et al. [3] and Regidor et al. [5] are welcome additions to the literature trying to examine this compositional explanation. Controlling for differences in the composition of municipalities, Clough-Gorr et al. [3] find that higher income inequality is, in fact, associated with lower

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mortality in Switzerland. Can we conclude from these results that increasing income inequality will save Swiss lives? Let us take a closer look before reaching any conclusion. In their study, they compare the eight-year mortality of Swiss municipalities according to the level of inequality that they had in 2001, controlling for differences in the demographic composition of municipalities that year. Crude rates in Table 1 suggest that, as inequality increases from the first to the forth quintile of income inequality, mortality increases. Exceptionally, however, the mortality of municipalities in the top quintile of inequality is lower than in municipalities in other quintiles. When controlling for compositional differences between municipalities, the relationship turns around: municipalities with higher income inequality have now lower mortality than municipalities with lower income inequality (Table 2).

The most interesting insight from Clough-Gorr et al. [3] is not that more inequality lowers mortality in Switzerland, as the authors might argue, but the fact that after controlling for a few compositional differences in demographics (gender, marital status, nationality, urbanisation and language), the relationship between income inequality and mortality changes dramatically. In their study, the relationship went from being positive -or null- to becoming negative. Clough et al. [3]'s ability to control for some compositional differences illustrates both the strength as well as the caveat in their approach: municipalities with different levels of inequality are unlikely to be exchangeable (we shall return to this point later).

Likewise, Regidor et al. [5] examine the relationship between income inequality and mortality at the province level in Spain. Again, their study compares seven-year mortality between provinces with different levels of inequality in 2001. Their approach is very similar to that taken by Clough-Gorr et al. [3] and it reinforces the importance of compositional differences: although their results in the first column of Table 3 suggest that higher income inequality is associated with higher mortality at ages 25–64, the relationship becomes negative—just like in Switzerland—after controlling for a few sociodemographic variables. Eventually, the relationship becomes null again after controlling for per-capital income in their final model. The study itself does not include descriptives of compositional differences between provinces with different levels of income inequality. Yet, the mechanisms at play are most likely similar to those in Clough-Gorr et al. [3] and suggest that provinces with different levels of income inequality are unlikely to be exchangeable.

Lack of exchangeability arises when distributions of risk factors for a given outcome differ between treated and control [6]. To illustrate, consider the distribution of measured variables in Clough-Gorr et al. [3]. Table 1 shows that municipalities in the lowest quintile of income inequality were 3 % urban, compared to 62 % in municipalities in the fourth quintile, or 37 % of municipalities in the top quintile. Differences in other demographics were just as large and raise the likely prospect that there are as yet many other compositional differences that will remain unaccounted for in these studies. Although in epidemiology we often hope to collect sufficient data to achieve exchangeability by conditioning on measured covariates, unfortunately we can never be certain to have succeeded [6], and prospects are high that we will most often measure only a small fraction of all covariates that differ between treated and control. This immediately casts doubts on the notion that the mortality of municipalities

in the top quintile of income inequality is a good *counterfactual* for the mortality that we would have observed in municipalities in the bottom quintile of income inequality, had the latter actually experienced the inequality of municipalities that ended up in the top quintile. The potential for unobserved heterogeneity—unmeasured confounding—is just too large for us to conclude from these results that an intervention or policy that would increase income inequality, ceteris paribus, would cause mortality to drop.

Nevertheless, prospects are slim that we will ever be able to carry out an experiment whereby we randomly assign municipalities to different levels of income inequality and follow them up for a few years. The question arises, then, whether observational data can be used to gauge at the causal effect of income inequality on health. The paper by Hu et al. [4] is a step in this direction. Following the approach by several others studies in the last couple of years [7–11], Hu et al. [4] use fixed effect models that exploit variations over time (1987–2008) in income inequality in 43 European countries. Mimicking what epidemiologists traditionally know as a cross-over design, fixed effect estimators control for all stable characteristics [12–15] by exploiting variations over time in exposure within units of analysis. In their paper, Hu et al. [4] identify the effect of income inequality on mortality by using each country as its own control. The approach compares a country's mortality when it is exposed to high levels of income inequality to the mortality in that same country when it is exposed to lower levels of income inequality. Assuming that changes in income inequality within countries are uncorrelated with changes in other unmeasured time-varying covariates, differences in mortality across periods of different income inequality within countries yield an unbiased estimate of the effect of income inequality on mortality. Averaging these differences across all countries yields an estimate of the average ‘treatment effect’, which controls for all stable characteristics of the country [16].

Using this more sophisticated approach, Hu et al. [4] are able to ensure that treated and control are exchangeable, at least in terms of historical antecedents, permanent behavioural differences or other time-invariant confounders. With the possible exception of external causes of death and particularly male homicide, they find little evidence that income inequality does much to the mortality of European populations. Yet, two considerations are important. As Fig. 1 highlights, many European countries have experienced relatively little change in their levels of income inequality, which by most international standards remain low. Although the Russian Federation and countries in the former Soviet Union did experience large increases in inequality immediately after the collapse of the Soviet Union, these political changes are being controlled for in the analyses, and they would offer a poor identification strategy as so many other things changed around that period. Thus, in most countries, estimation relies on a comparison of mortality across a relatively narrow range of income inequality variation. It is possible that more dramatic decreases in income inequality in regions that are already highly unequal might yield different results. For example, a recent study [10] exploited the declines in inequality in Brazil from 2000 to 2009, a period of effective social policy reforms that saw declining levels of income inequality in many parts of one of the most unequal nations in the world. Using state fixed effects models, the authors found that declines in state income inequality were associated with increases in life expectancy [10].

A second consideration refers to the potential biases that arise when the etiologic period, or the time interval required for inequality to influence mortality, is misspecified in fixed effect or first difference models [17]. Mis-specifying the lag period may not only attenuate the estimated effects, but in some cases it may even induce a sign-reversing bias, if the lag period used is out of phase with the true etiologic period [17]. Although Hu et al. [4] experimented with up to 10-year lags, their study may not include a sufficiently long time series to assess this problem in detail. How sensitive the findings for the relationship between income inequality and health are to alternative specifications regarding lag times is illustrated by a study by Zheng [18]. Using data for the US for years 1986–2006, the study found that income inequality does not have an instantaneous effect on mortality. However, a significantly negative effect of inequality on individuals' mortality risk emerges after 5 years, peaking at 7 years and declining after 12 years, raising important questions about the latency period between exposure to inequality and onset of disease.

Nevertheless, the fact remains that, using different methods, the three studies above cast major doubts about the income inequality hypothesis. In a BMJ Editorial 13 years ago, Mackenbach concluded that most evidence supporting the income inequality hypothesis had by then disappeared [19]. Some read this as a premature obituary of the income inequality hypothesis [20]. Today, despite renewed public interest for the increasing income inequality trend in our societies, and the collective view that high income inequality is undesirable from a moral or societal point of view, there still exists no strong evidence-base to argue that tackling income inequality would be an effective strategy to improve population health.

Why do we observe, then, a correlation between income inequality and health at the aggregate level? This may be a hint to the fact that income inequality is correlated, but not causally associated, with other determinants of health that may well be of interest to public health. For example, it is likely that countries with low levels of income inequality, such as the Scandinavian nations, also happen to have in place a wide range of social policies that may bring benefits to health. These countries have an extensive history of generous maternity leave benefits, unemployment insurance, income maintenance programmes and national health care insurance, among other programmes. While these policies bear undoubtedly some relationship to the fact that these countries have high taxes, this needs not implying that income inequality *per se* affects population health. Whether and how specific social policies bring population health benefits would need to be addressed by formally evaluating the causal impact of these policies on health. Only then will we be able to identify more concrete ways through which we can use social and economic policy to improve population health.

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