Letters to the Editor

RE: "INVITED COMMENTARY: METHODS FOR ESTIMATING EFFECTS OF MINIMUM WAGES ON HEALTH"

In a recent commentary, Leigh (1) drew on foundational economics research to advise epidemiologists studying the health effects of the minimum wage. We broadly agree with Dr. Leigh that emulating a hypothetical randomized trial is a useful starting point in minimum-wage research (2), serving to clarify the target parameter and specify relevant details of the interventions and populations to which a study is intended to apply. While Leigh never explicitly defines an intervention or target population for this hypothetical trial, his description of the ideal study provides enough detail to impute these points to illustrate where we disagree. To summarize Leigh's advice, the "best" approach is to specify a target population of workers whose wages would actually change after a minimum-wage increase and an intervention reflecting a contrast between their current distribution of wages and universal exposure to a new minimum wage. Leigh's main concern is ostensibly to avoid supposed bias toward the null due to including unaffected workers in the "treatment" condition. We have 2 linked concerns with this otherwise laudable approach: 1) the target parameter does not appear to correspond to a policy-relevant intervention in a target population, and 2) it risks ignoring important spillover effects of economic policy.

To our first point, the target trial implied by Leigh's advice would estimate a parameter that is arguably not of most interest to policy-makers. A randomized trial where the treatment condition involves raising everyone's wages estimates an *exposure effect*, the effect of an intervention that has a 1-to-1 correspondence with the exposure. In contrast, *population intervention effects* capture interventions that shift the distribution of an exposure from its observed (natural) levels and correspond to realistic interventions (3). An example is the population attributable fraction. While exposure effects are invariant to the population distribution of the exposure, population intervention effects are not. Arguably, policy-makers are most interested in population intervention effects that quantify complex changes in wage distributions after perturbations to the minimum wage. A study estimating population intervention effects might have as its target trial a pragmatic trial in the broader population, rather than a more classical randomized controlled trial with strict selection criteria. Inclusion of unaffected individuals does not result in bias toward the null for a population intervention effect, since the ratio of directly affected people to those not directly affected in the population is an important part of the new exposure distribution, and hence part of the target parameter.

Moreover, if investigators are interested in exposure effects, perhaps to try to reveal how the minimum wage affects individuals, it is unclear that exposure effects exist for the minimum wage. Consider that in a hypothetical individ-

ually randomized trial, participants randomized to receive a lower minimum wage might outcompete individuals randomized to a higher minimum wage in the job market. The only conceivable trial of minimum wages would be cluster-randomized with units as counties, states, etc. This highlights the presence of interference when studying the minimum wage, meaning the effect in any individual is undefined without reference to the population exposure distribution (4). Interference manifests in changes to the local labor market (5) and the regional economy, both with probable ramifications for population health. Under interference, exposure effects lose interpretation as constant quantities, but population intervention effects retain conceptual clarity precisely because they define effects as contrasts between potential outcomes under different population exposure distributions.

In the spirit of recent calls for a more consequentialist epidemiology (6), minimum-wage research provides a valuable case study in which the production of policy-relevant effect estimates is clearly achievable. This focus should be a forefront priority as epidemiology increasingly enters the economic policy sphere.

ACKNOWLEDGMENTS

A.R. received financial support from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) through a Biosocial Research Training Grant awarded to the Carolina Population Center (grant T32 HD091058). E.O.C. and E.K.L. were supported by the NICHD through a Population Research Training Grant awarded to the Carolina Population Center (grant T32HD007168). E.K.L. was additionally supported by the National Institute of Environmental Health Sciences through a Biostatistics for Research in Environmental Health Training Grant awarded to the University of North Carolina Department of Epidemiology (grant T32ES007018).

We thank Dr. Daniel Westreich for his feedback and support.

Conflict of interest: none declared.

REFERENCES

1. Leigh JP. Invited commentary: methods for estimating effects of minimum wages on health [published online ahead of print February 10, 2020]. *Am J Epidemiol*. (doi: 10.1093/aje/wkaa019).
2. Hernan MA, Robins JM. Using big data to emulate a target trial when a randomized trial is not available. *Am J Epidemiol*. 2016;183(8):758–764.

3. Westreich D, Edwards JK, Rogawski ET, et al. Causal impact: epidemiological approaches for a public health of consequence. *Am J Public Health*. 2016;106(6):1011–1012.
4. Tchetgen Tchetgen EJ, VanderWeele TJ. On causal inference in the presence of interference. *Stat Methods Med Res*. 2012;21(1):55–75.
5. Cengiz D, Dube A, Lindner A, et al. The effect of minimum wages on low-wage jobs. *Q J Econ*. 2019;134(3):1405–1454.
6. Keyes K, Galea S. What matters most: quantifying an epidemiology of consequence. *Ann Epidemiol*. 2015;25(5):305–311.

Audrey Renson^{1,2}, Esther O. Chung^{1,2}, and
Evans K. Lodge^{1,2,3} (e-mail: arenson@live.unc.edu)

¹ Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC

² Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC

³ School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC

DOI: 10.1093/aje/kwaa117; Advance Access publication: June 23, 2020

© The Author(s) 2020. Published by Oxford University Press on behalf of the Johns Hopkins Bloomberg School of Public Health. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com.

THE AUTHOR REPLIES

I thank Renson et al. (1) for their observations on my invited commentary (2). Epidemiologic analysis of minimum wages can address at least 2 questions. The first pertains to the long-standing issue surrounding the correlation between income and health. We want to know whether income affects health or vice versa. Ideally, we would like to “treat” an experimental group with, say, an increase in income and a control group with no increase; I believe this corresponds to Renson et al.’s exposure effect (1). Such a randomized controlled trial is rare, but a universal basic income experiment is currently being conducted in Stockton, California (3). A minimum-wage increase comes close, however, provided we restrict attention to people in the treatment group who receive the increased wage and people in the control group whose income does not change. Three United Kingdom studies highlighted in a literature review approximate this “comes close” type of trial (4). Importantly, no one in the hypothesized treatment group becomes unemployed, and there are no spillover effects on the control group. If we allowed for unemployment and a subsequent substantial drop in income, or if we allowed workers to forego the new wage, we would be diluting our ability to test whether increases in income lead to better health. This “everyone gets the wage” status in the treatment group and “no spillover” in the control group is the hypothetical trial I suggested in my commentary (2); it estimates the effect of treatment on the treated.

An estimate of the treatment’s effect on the treated could inform at least 4 policy debates. Policy-makers may be interested in the possible health effects of: 1) lowering income taxes on low-income populations; 2) establishing a universal basic income; or 3) expanding the US Earned Income Tax Credit, which, incidentally, requires beneficiaries to maintain employment. In each of these policy interventions, all participants (not necessarily all those eligible) receive the increased income. (Policy-makers may have different policies for increasing participation.) While separate health-effect studies for each intervention would be ideal—and there are some for the Earned Income Tax Credit (5)—policy-makers may want confirming or contradicting

evidence from minimum-wage studies. Fourth, policy-makers may view low wages as occupational health hazards and may desire to reduce those hazards with a “living wage” (6). The 1938 Fair Labor Standards Act, which established the minimum wage, in fact asserts that the reason for the minimum wage is to maintain the “minimum standard of living necessary for health, efficiency, and general well-being of workers” (7, p. 1).

The second question pertains to the health effects on everyone affected—for better or worse—by the minimum wage, not just those who experience the increase. This is the question, I believe, that concerns Renson et al. (1). I agree with them that this is probably the more relevant question for policy-makers (but not the only one). My treatment-effect-on-the-treated trial is not correct for the second question; Renson et al.’s “pragmatic” trial is correct, in my view. I thank Renson et al. for this important insight.

Both my and Renson et al.’s hypothetical trials are theoretical concerns, however. As a practical matter, authors of “minimum wage and health” studies frequently address both questions in their attempts to define the groups “likely to be affected.” Some restrict attention to continuously employed people; others include the unemployed and/or workers earning up to 1.5 times the minimum wage to account for spillovers that would occur in competitive labor markets; and still others include all persons with at most a high school diploma, regardless of their wage (4). I would caution against broadening the definition of affected people to include everyone in society, however, at least when analyzing the modest annual minimum wage increases implemented in the United States and the United Kingdom. Societywide effects, nevertheless, might be observed for decades-long high minimum wages, such as those in Scandinavian countries, or for decades-long low wages, as occur in midwestern and coal states in the United States (leading to “deaths of despair”).

ACKNOWLEDGMENTS

Conflict of interest: none declared.