

Over-Adjustment Bias by Controlling for Overall Health

Shervin Assari^{1,2}

¹Center for Research on Ethnicity, Culture and Health, School of Public Health, University of Michigan, Ann Arbor, United States, ²Department of Health Behavior and Health Education, School of Public Health, University of Michigan, Ann Arbor, United States

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DEAR EDITOR,

Should we control for overall health if we want to know whether higher social capital is associated with more physical activity? Is it reasonable to adjust for overall health if we want to explore the effect of a series of health behaviors on primary health-care use? What if we want to understand how attitude about aging determines the trajectory of functional health over time? What if we want to test if overall health mediates the association between pain and depression? I say No to the first three questions, and I say Yes to the last two questions, but why?

Ueshima *et al.*^[1] conducted a study among 2260 individuals in Japan to test if social capital has any protective effect on physical activity. They, however, controlled for self-rated health in their final model. Could the effect of social capital on physical activity be through an enhancement in overall health? If yes, we do not need to control for overall health. To me, it seems quite reasonable to assume that social capital first improves health perception and then those people who feel healthier would engage or report more physical activity.

Another example is a paper published in 2012 in *Family Practice*. The study tested the effect of various behaviors such as smoking, alcohol abuse, excessive alcohol intake, use of soft drugs, and insufficient physical exercise on primary health-care utilization. This study showed that

Correspondence to:

Dr. Sherwin Assari,
Department of Health Behavior and Health Education, School of Public Health, University of Michigan, Ann Arbor, United State
E-mail: assari@umich.edu

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from the above list of behaviors, only smoking relates to annual contact with general physicians. The results showed that among women but not men, smokers consult their general physician more frequently than non-smokers.^[2] I argue that the negative results of alcohol abuse, excessive alcohol intake, use of soft drugs, overweight and insufficient physical exercise on health-care use might be due to over-adjustment for health. Based on intuition, people feel unhealthy before they seek health-care. Thus, with controlling for health, we will attenuate our association toward the null.

Over-adjustment bias is being introduced to our results when we control for intermediate variables.^[3] This can be avoided by application of Directed Acyclic Graphs (DAGs). DAGs were first introduced by Robins to the epidemiology and can reduce various biases.^[4,5] Shrier and Platt^[6] have simplified the concept and developed a simple 6-step approach for clinicians. Others have also explained applications of such graphs to particular fields of studies.^[7]

It is, however, not a case of over-adjustment when we control for the baseline health status in a longitudinal study. A good example is the work by Levy *et al.* from Department of Epidemiology and Public-Health, Yale University. In this work, authors hypothesized that positive self-perceptions of aging may protect people against functional impairment. They found that those with positive

self-perceptions of aging report a better functional health trajectory.^[8] Although in addition to age, gender, race, and socio-economic status, baseline self-rated health was controlled, this is clearly not a case of over-adjustment. Baseline health is not an intermediate variable for the effect of attitudes on trajectory of functional impairment.

Of course, we can control for overall health if we want to test if it mediates an association of interest. For instance, McIlvane *et al.* from University of South Florida conducted a study to test if functional impairment mediates the pain – depression link among patients with osteoarthritis. They showed that only among middle-age women but not older women, functional impairment mediates the relationship between pain and depressive symptoms.^[9]

Design and analysis of epidemiological studies will definitely benefit from application of DAGs. With a few exceptions, investigators may not control for the effect of overall health in their studies. The first exception is when baseline health is controlled in a longitudinal study, and the second one is when mediation is hypothesized.

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