The Effect of Physical Activity on Sleep

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Step 0: Specify the Scientific Question

Background

50-70 million Americans have chronic sleep problems and 35.5% of adults report getting less than 7 hours of sleep a day (Disease Control and Prevention 2011). Everyone knows the implications of not getting enough sleep. It has been linked to many health problems such as obesity, mood disorders, and heart disease ("Consequences of Insufficient Sleep" 2017). Getting a good night's sleep gives the body the necessary time to recover and is shown to improve memory ("Sleep, Learning, and Memory" 2017). People across the country test herbal supplements, meditation and prescription drugs to fight insomnia. However, some studies have shown that exercise alone can help improve the quality of sleep (Foundation 2017). We set out to examine this relationship and see if exercise does indeed cause better sleep quality.

The Data

Our data come from the National Health and Nutrition Examination Survey conducted by the US National Center for Health Statistics and can found in the `NHANES` package in R. These data were collected between the years of 2009 and 2012 across the United States. It includes information on a variety of diseases, medical conditions, and health indicators. The original set has 76 variables and 10,000 observations ("About the National Health and Nutrition Examination Survey" 2012).

The `NHANES` includes duplicate rows in order to fix problems associated with oversampling. We decided to remove these duplicates. We also ran a series of stepwise regressions to identify key covariates. After these reductions, we have a final dataset with 10 variables and 4,654 observations. Unfortunately, although this dataset has information on multiple years, the participants all have unique identifiers and thus can not be analyzed in a longitudinal setting. `NA`s were transformed as factor levels labeled as "Undisclosed."

Scientific Question and Target Population

Among American adults aged 20 years or older, how does participating in moderate or vigorous-intensity sports, fitness or recreational activities affect sleep quality?

Step 1: Specify the Causal Model

Option 1

Our endogenous variables are X = {W, A, Y} which are defined as:

W= $\{W_d, W_h, W_l\}$
W_d = {Gender, Age, Race1, Education, MaritalStatus, HHIncomeMid, HomeOwn}
W_h = {HealthGen, DaysPhysHlthBad, DaysMentHlthBad, LittleInterest, Depressed}
W_l = {TVHrsDay, CompHrsDay, AlcoholDay, SmokeNow, RegularMarij, HardDrugs}
A = {PhysActive}
Y = {SleepTrouble}

Our exogenous variables are U = $U_{W_d}, U_{W_h}, U_{W_l}, U_A, U_Y$ P_U. These are the unmeasured factors which influence what values our endogenous variables, X can take.

Our structural causal model is defined as:

$W_d = f_{W_d}(U_{W_d})$
$W_h = f_{W_h}(W_d, U_{W_h})$

$W_l = f_{W_l}(W_d, W_h, U_{W_l})$
$A = f_A(W_d, W_h, W_l, U_A)$
$Y = f_Y(W_d, W_h, W_l, A, U_Y)$

A directed acyclic graph displays this SCM below.

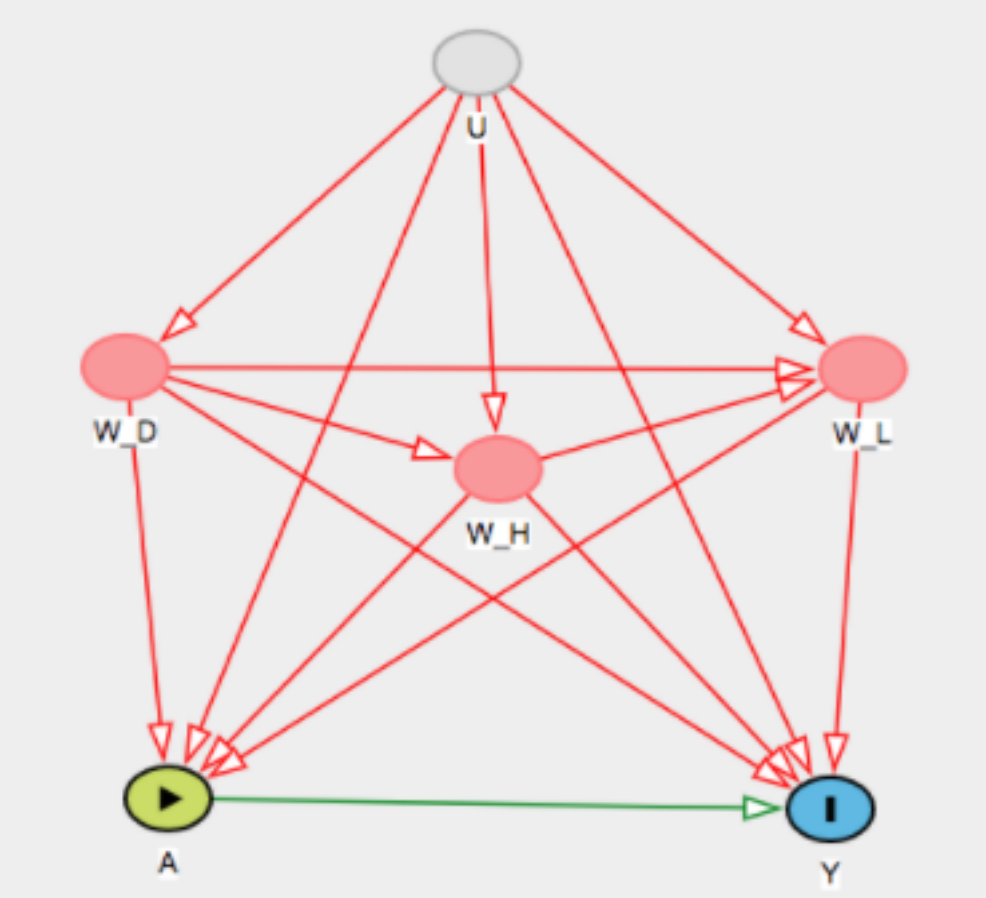

Figure 1: Structural Causal Model Option 1.

Option 2

Our endogenous variables X = {W, A, Z, Y} which are defined as:

W = $\{W_d, W_h, W_l\}$
W_d = {Gender, Age, Race1, Education, MaritalStatus, HHIncomeMid, HomeOwn}
W_h = {HealthGen, DaysPhysHlthBad, DaysMentHlthBad, LittleInterest}
W_l = {TVHrsDay, CompHrsDay, AlcoholDay, SmokeNow, RegularMarij, HardDrugs}
A = {PhysActive}
Z = {Depressed}
Y = {SleepTrouble}

Our exogenous variables are U = $\{U_{W_d}, U_{W_h}, U_{W_l}, U_A, U_Z U_Y\} \sim P_U$. These are the unmeasured factors which influence what values our endogenous variables, X can take.

Our structural causal model is defined as:

$W_d = f_{W_d}(U_{W_d})$
$W_h = f_{W_h}(W_d, U_{W_h})$
$W_l = f_{W_l}(W_d, W_h, U_{W_l})$
$A = f_A(W_d, W_h, W_l, U_A)$
$Z = f_Z(W_d, W_h, W_l, A, U_Z)$
$Y = f_Y(W_d, W_h, W_l, A, Z, U_Y)$

A directed acyclic graph displays this SCM below.

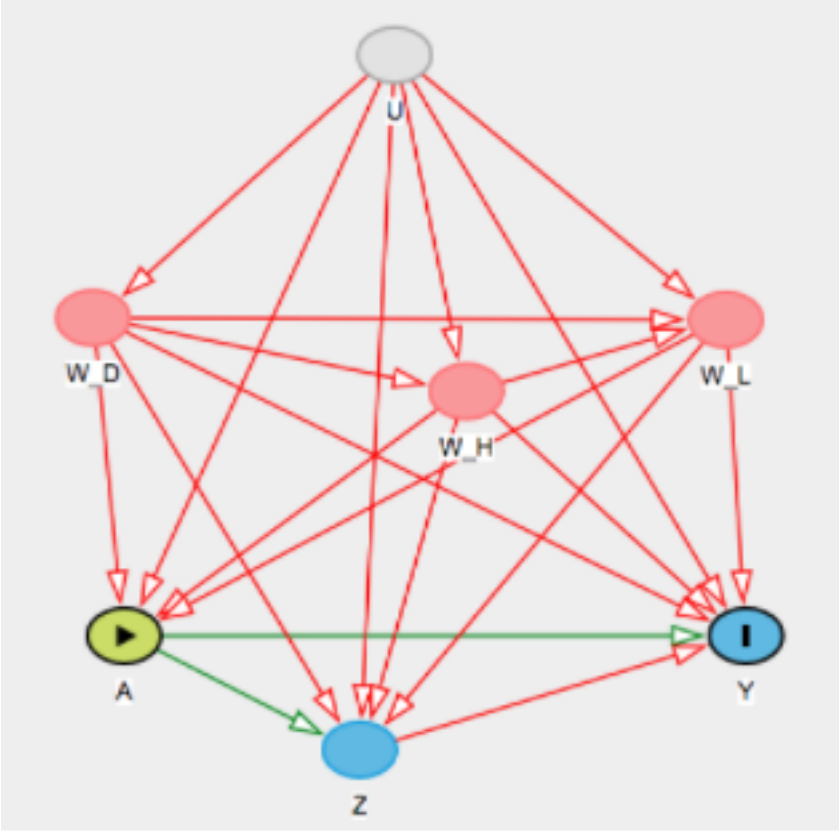

Figure 2: Structural Causal Model Option 2.

This alternative model defines Depressed as an intermediary between the exposure and outcome. Both models are valid, however we will proceed with the first model in the following analyses.

Step 2: Translation in the Target Causal Parameter Using Counterfactuals

Step 3: Specify the Observed Data and its Link

Step 4: Indentifiability

Step 5: The Statistical Model and Estimand

Step 6: Estimation

Step 7: Interpretation

References

"About the National Health and Nutrition Examination Survey." 2012. *National Center for Health Statistics*, september. doi:https://www.cdc.gov/nchs/nhanes/about_nhanes.htm.

"Consequences of Insufficient Sleep." 2017. *WGBH Educational FoundationDivision of Sleep Medicine at Harvard Medical School*. doi:http://healthysleep.med.harvard.edu/healthy/matters/benefits-of-sleep/sleep-and-disease-risk.

Disease Control, Centers for, and Prevention. 2011. "Unhealthy Sleep-Related Behaviors." *MMWR* 60: 233–34.

Foundation, National Sleep. 2017. "Study: Physical Activity Impacts Overall Quality of Sleep." doi:sleepfoundation.org/sleep-news/study-physical-activity-impacts-overall-quality-sleep.

"Sleep, Learning, and Memory." 2017. *WGBH Educational Foundation Division of Sleep Medicine at Harvard Medical School*. doi:http://healthysleep.med.harvard.edu/healthy/matters/benefits-of-sleep/learning-memory.