# MIND AFTER MATTER: QUASI-EXPERIMENTAL EVIDENCE ON THE CAUSAL EFFECTS OF PHYSICAL HEALTH SHOCKS ON MENTAL HEALTH

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# Introduction

While it is generally acknowledged that physical and mental disorders are intertwined through a mind/body connection, the extent to which a disorder of the body can be *causally* linked to a disorder of the mind, or vice versa, remains difficult to estimate. A large body of literature focusing on co-morbidities has documented the increased risks of developing one kind of disease after having suffered from the other (Prince, Patel et al. 2007). Depression with cardiovascular disease is a common example of such a bi-directional relationship.(Wulsin and Singal 2003; Frasure-Smith and Lesperance 2008)

What is less understood is whether a single, acute, negative health event, or health shock, can have long lasting mental health consequences. For example, while depression rates are higher among those with accidental injuries (Crichlow, Andres et al. 2006), there are no reliable estimates of the level of depression in the population that was caused by such injuries. While Global Burden of Disease studies project the total burden by 2030 caused by depression (5.7% of total burden is due to depression) and by road traffic injuries (4.2% of total burden, ranked 2$^{nd}$ and 4$^{th}$ in the top 10 causes of DALY's respectively) it is difficult to estimate how much, if any, of each burden is caused by the other. (Murray and Lopez 1996; Mathers and Loncar 2006; Prince, Patel et al. 2007)

Understanding how physical and mental illnesses are related to each other is critical to prevention efforts as well as potentially modifying treatment options for improving prognosis of leading causes of disease. On a policy level, there are numerous debates on resource allocation between physical and mental illness. With causal effects of one on the other, the focus would need to shift from this debate to developing solutions that exploit potential complementarities that can improve outcomes for both conditions. For instance, if causal relationships do exist, lower accident rates might also lower population levels of depression. In the presence of causal effects, efforts at preventing one would arguably lead to lower rates of the other.

The biggest limitation in the research on the relationship of mental and physical illnesses is the inability to estimate causal effects in either direction. There are two reasons why this methodological challenge continues to persist in this research. The first is that the causal effects run in both directions, a problem often referred to as endogeneity. With endogeneity, OLS estimations using observational data are invariably biased.

The obvious solution, especially in the medical sciences, is to rely on an experimental study design such as a Randomized Controlled Trial. However, a trial where individuals are randomly 'given' illnesses is beyond the realm of (ethical) possibilities. Researchers in social sciences tend to rely on instrumental variables estimation or try to identify sources of exogenous variation in one of the two variables. However, identifying exogenous variation in health or a good instrumental variable for this problem has been very difficult. This inability to effectively rely on experimental methods or instrumental variables constitutes the second challenge to estimating causal effects in the relationship between physical and mental health. A third approach would be to utilize a quasi-experimental study design: for example combining features of an experiment, such as controlled matching, together with exogenous variation in the exposure of interest. This paper employs the latter, quasi-experimental study design to estimate causal effects of a negative health event on mental health. Specifically, our empirical strategy relies on exogenous exposure to injuries as passengers in bus accidents, with unexposed "controls" drawn from travelers on the same bus routes matched on age, gender, and residential area.

In addition to our estimation of the causal effects of negative health events on mental health, we also explore two pathways which potentially mediate this relationship. The first is household debt, which has been linked positively to mental health problems (Maselko and Patel Forthcoming). With evidence of the causal effect of adverse health events on increases in household debt (Mohanan 2008), we hypothesize that some of the increase in psychological distress is due to increased borrowing. The second potential pathway is disability, which also has been shown to be positively correlated with mental disorders (Kessler, Berglund et al. 2003). We test the hypothesis that some of the effect of adverse health events on mental health is mediated by physical disability.

# Methods

## Study Design & Sample

Data for this analysis was collected as part of a quasi-experimental study of the economic consequences of health shocks (Mohanan 2008). The study, conducted during November-December 2006, was located in Karnataka (a large state of 56 million in South India) among passengers on buses run by the state transport corporation

(KSRTC). The quasi-experimental component of the study consists of matching bus passengers who were traveling in a bus that met with an accident (exposed) with passengers traveling on the same bus route but were not in the accident (unexposed). Exposed individuals were identified from KSRTC records as individuals having received compensation as a result of being a passenger in a bus accident of a bus operated by KSRTC one year prior to the study (July 2005-December 2005). All individuals with at least a minor injury were eligible for compensation. For each exposed subject, 4 unexposed individuals were recruited from passengers on the same bus route after matching for age, gender and area of residence. This design and sampling strategy have two main benefits. First, given that everyone in the study sample travels on the same buses, the event of the bus meeting with an accident is plausibly exogenous. It is beyond an individual's control and is not influenced by certain characteristics that might be relevant for the outcome, such as prior levels of distress, propensity to take risks, or any other unobserved characteristics. Second, the matching procedure aimed to ensure that, conditional on matching, the exposure is random. In other words, we expect to see no differences between the exposed and unexposed in any variables related to either the exposure or any other variables of interest. Of the 85 exposed individuals approached to participate in the study, 84 agreed; 336 matched unexposed were recruited, yielding a final sample of 420. For a complete description of the study design and survey see Mohanan (2008).

The bus accidents in this study were all on local (rural) bus routes with low traffic speeds and hence most of the injuries were relatively minor. Of the 84 exposed individuals, 7% (N=6) suffered a fracture, 1 individual lost a limb, and the remaining injuries were minor (cuts, sprains, etc).

## Measures

### Health shock (Independent variable):

A health shock is defined as an acute event associated with a sudden decline in health status. For the purposes of this study, the health shock is the exposure of being a passenger in a bus that met with an accident, which is treated as a binary variable. As a result of the quasi-experimental nature of the study, this variable is plausibly exogenous: conditional on being on the bus, individuals had no influence on whether they would or

would not experience this health shock. As such, we treat it as a random exposure of an adverse health event.

## Magnitude of health shock:

In addition to analyzing the health shock as a binary measure, we also used total hospital expenditures and numbers of days of normal activity affected by the accident to assess the magnitude and severity of the health shock. Total hospital expenditures include amounts spent on hospital admission, consultation charges, surgical fees, investigations and medicines for the hospitalization episode resulting from the accident. This amount was further divided into 5 groups (Rupees[1].100-500; 501-1,000; 1,001-5,000; 10,001-25,000; 25,000+). Unexposed individuals were counted as having zero expenses. Number of days affected was assessed through a question, "How many normal days of activity [of the exposed individual] were affected due to the accident?" Individuals not in the accident were counted as having lost zero days.

## Kessler 10 (Dependent variable):

The Kessler-10 is a measure of global psychological distress and is meant to be a short screening tool for the presence of moderate or severe mental illness, specifically depression or anxiety disorders (Kessler, Andrews et al. 2002). Each of the 10 items inquires about the frequency of specific anxiety and depressive symptoms in the last 4 weeks (for example: "How often did you feel tired for no good reason" and "How often did you feel so nervous that nothing could calm you down"). Responses are rated on a 5-point Likert scale ranging from (1) *none of the time* to (5) *all of the time* and the responses are summed to yield a final score of 10-50. Scores of 25 and above are consistent with a diagnosis of moderate/severe depression and/or anxiety disorder (Furukawa, Kessler et al. 2003; Kessler, Barker et al. 2003). The Kessler-10 has shown to be a valid and reliable measure (Cronbach's alpha: 0.8-0.9) in a wide range of international settings (Furukawa, Kessler et al. 2003; Baggaley, Ganaba et al. 2007).

## Disability:

The disability measure consists of the physical disability component of the WHO-DAS (Janca, Kastrup et al. 1996), covering domains of personal care and occupational difficulties. Specific items include difficulty experienced by the individual in the past 30

[1] 1 USD = Approx 40 Indian Rupees in 2006

days in (a) Standing for long periods such as 30 minutes; (b) Taking care of household responsibilities; (c) Walking long distance such as a kilometer; (d) Washing whole body; (e) Getting dressed and (f) Day to day work. Respondents were asked to rate the extent of difficulty in performing each of these activities. Answers were recorded on a 3 point Likert scale with 1 for no disability, 2 for mild/moderate difficulty and 3 for severe / extreme difficulty. The total disability score was a sum of these responses with a potential range of 6-18.

### Demographic and economic variables:

We also collected detailed information on household debt, including the amount of money borrowed by the household during the past year, sources of borrowing and interest rates. The variable “borrow” is a dummy variable that represents whether households borrowed any money during the past year. Current monthly household income is reported as the sum of all sources of income in the household. In instances where income was reported annually, monthly income was imputed by dividing by 12. Gender represents the sex of the exposed / unexposed individual and is included in all models as a dichotomous variable, with male equal to 1 and female equal to 2. The age variable represents the age in years of the exposed / unexposed individual. Educational attainment is dichotomized in terms of literacy (no school / illiterate vs. primary and above). A dummy variable was created equal to 1 for those who were illiterate and 0 for those with positive levels of schooling.

## Analytical Plan

We employ ordinary least squares (OLS) regression modeling as the main method of analysis to examine the effect of the health shock (yes/no) on psychological distress (continuous). Initial models include only the health shock, followed by models adjusting for the demographic variables age, sex and literacy. Next we include disability and borrowing in the past year. In models exploring the relationship between severity of the health shock and distress, we use hospital expenses and days affected instead of the dichotomous shock variable. These models also adjust for physical disability. We use time between the accident and the household survey to examine the potential role of adaptation to the injury on distress. Analogous logit models estimate the increased odds of reporting distress that reaches clinical levels of moderate or severe mental

illness. Given the matched survey design, all standard errors are robust and clustered at the level of the matching household.

## Results

The sample characteristics shown in Table 1 demonstrate that the matching procedure was successful in identifying unexposed individuals who were socio-economically comparable with the exposed. Since the samples were matched on age, gender and geographic area of residence, it is reassuring that the two groups are identical on these measures. Educational attainment in the two groups is similar, both in terms of % illiterate (34.5% among exposed and 33.6% among unexposed) as well as levels of schooling. There are also no significant differences in the average household income in the two groups (Rupees 4482 among exposed vs Rs. 4365 among unexposed).

The health shock is associated with a higher level of distress (13.1 vs. 4.6, $p<0.001$). Figure 1 shows the distribution of distress scores in the two groups. Exposed individuals reported higher physical disability levels (13.3 among the exposed vs. 8.5 among the unexposed, $p<0.001$) and were also more likely to have borrowed money in the past year as compared to their unexposed counterparts (79% vs. 47%, $p<0.001$).

Table 2 presents OLS regression results of the association between the health shock and psychological distress. Exposure to the health shock results in an increase of 8.4 points on the distress scale after controlling for age, gender and literacy (model 2). This is equivalent to an increase in distress of approximately 1.5 SDs of the unexposed group. Given the significantly higher level of physical disability in the exposed group (mean 13.3 among exposed vs. 8.5 unexposed, $p<0.001$), we next investigated whether the effect of the health shock on increased levels of distress is mediated by physical disability. In the multivariate model (model 3), the inclusion of physical disability score reduced the magnitude of the effect of the health shock from $\beta$=8.40 (model 2) to $\beta$=3.07 (model 3), supporting the hypothesis that much of the effect of the health shock is mediated by physical disability. Additionally, every additional point on the physical disability scale was associated with a 1.14 point increase in distress. In analogous logit models predicting the odds of having symptom levels equivalent to a moderate or severe mental illness, the odds of this level of distress among the exposed is 11.45 (95% CI: 5.60 - 23.41), an odds that is reduced to 3.01 (1.26 - 7.19) after adjusting for concurrent physical disability scores.

The acquisition of new debt did not cause increased distress levels and adjusting for this variable did not appreciably alter the magnitude of the effect of the health shock on distress (model 4).

## Physical vs. Psychological aspects of the injury

A critical assumption in our analysis is that the exposure represents a *physical* health shock and mental health effects measured a year later are caused by this *physical* health shock. However, it is possible that the experience of being in a bus accident may have mental health consequences independent of any physical injury. To estimate the differential effects of varying severity of physical injury, we employed two approaches. In the first, we modeled total hospital expenditures resulting from the health shock and for the second, we used the number of days that normal activity was affected after the accident on distress scores (table 4). These models also controlled for physical disability so that the coefficient for very low hospital expenses or a low number of affected days can be interpreted as the effect of the accident on distress through pathways other than physical injury (those not in the accident remain the referent group). Individuals with nominal hospital expenses (Up to Rs.1000 in Panel A) did not significantly differ in distress as compared to those who were not in a bus accident. In contrast, individuals who experienced a severe injury (hospital expenses totaling over 10,000 Rupees) had distress scores that were 8.3 points higher than the unexposed. Using days of normal activity affected (Panel B) yields highly comparable estimates: there were no significant increases in distress among individuals reporting that 2 weeks or less were affected and an 8.6 point increase among those reporting that over sixty days of normal activity were affected. In a separate analysis, we investigated whether being in an accident where someone was killed versus being on one where there were only non fatal casualties would influence levels of distress. After adjusting for the above measures of physical disability, the fatal nature of the accident did not influence levels of distress ($\beta$=0.843, p-value=0.67). These results suggest that, in the absence of major physical injury, there is little evidence that the psychological trauma of being in the accident alone led to increased levels of psychological distress.

### Evidence of Adaptation

The importance of physical disability in the effect of the health shock on distress leads us to examine the potential role of adaptation. The length of time between the accident and the interview ranged from 12-18 months (Mean =15.6, SD = 1.8) and there was no relationship between this variable and distress levels (r=0.07). This finding is not surprising since the variation in the length of time since the accident was fairly narrow and more time might be necessary for adaptation to occur(Bracken and Bernstein 1980).

## Discussion

The evidence presented here points to a large and lasting causal effect of physical health on psychological distress levels. Exposure to the health shock results in an increase of approximately 1.5 standard deviations on the distress scale one year later after controlling for age, gender and literacy. Even after controlling for potential mediators of physical disability and household debt, distress among the exposed was over half a standard deviation higher. This translates into a two times increase in the odds of having levels of distress that are consistent with moderate to severe mental illness.

Another important interpretation of our findings is in terms of mediation of the effects on mental health. Previous studies have found significant associations between mental health and debt burden ((Jenkins, Bhugraa et al. Forthcoming; Maselko and Patel Forthcoming)). One of the hypothesized pathways is that health shocks cause increases in debt burden and this debt, in turn, leads to psychological distress. In our sample, there is overwhelming evidence of the increases in debt as a result of the health shock. Mohanan (2008) reports that the health shock related expenditures were met by borrowing and the odds of exposed households having debt are 5 times higher than the unexposed. Further, the size of the amount of debt among the exposed was almost twice that among the unexposed. In spite of these large differences in household debt, we find no evidence of debt being associated with increases in psychological distress scores.

What emerges as a stable relationship, however, is the association between physical disability levels and psychological distress scores. Up to 65% of the total estimated effect of the health shock on distress scores (8.4 points on the distress score) was

mediated by its effect on disability levels. This study was not designed to attempt to estimate the effect of physical disability on psychological distress. However, our findings suggest that rehabilitative efforts to minimize physical disability could have a spillover effect of reducing mental health consequences of physical illnesses.

Our analysis of the effect of varying degrees of severity using hospital expenditures and the number of days affected suggests that health shocks have differential effects on mental health outcomes depending on the severity of the health event, above and beyond its effects on disability. In the absence of significant injuries, there was no evidence of increased distress levels as result of the exposure to the accident.

With relatively minor injuries such as the ones experienced by the participants in this study leading to large increases in psychological distress, it is plausible that other major illnesses such as cancers and cardiovascular diseases could have large mental health effects as well. One implication of this inference is the scope to prevent, screen for and, if necessary, treat affective disorders among individuals who suffer from all major non psychiatric illnesses. Additionally, given lower compliance rates of treatment among depressed patients (Gehi, Haas et al. 2005), paying specific attention to mental health sequelae would also impact overall prognosis.

Another implication of this evidence is for the estimation of global mental health burden. Even if one were to restrict attention only to road traffic injuries, with the projected increase in disease burden related to road traffic accidents according to WHO estimates (Mathers and Loncar 2006), there would lead to relatively large increases in psychological distress and related mental health burden. This extrapolation, however, assumes that illnesses that are currently ranked higher than road traffic accidents, such as Diarrhoeal Diseases, which is expected to move from its current position as 5$^{th}$ leading cause of DALYs to 12$^{th}$ by 2030, do not affect mental health as severely. One reason why this might be a plausible reason is that physical injuries are more likely to cause sudden changes in functional ability. As Das et al point out, changes in health and functional ability might have larger effects on mental health than more stable levels of ill health (Das, Do et al. 2007).

## Limitations

The findings presented in this study are subject to several limitations. First, in spite of our efforts to use the matching procedure to address endogeneity, it is possible that there are some residual problems of internal validity resulting from those who were injured in accidents being systematically different from those who were not. For example, depressed individuals might have slower response times and hence be less likely to protect themselves from injury in the event of an accident. Second, although we try to control for travel preferences by matching on bus routes and travel frequency, there could be unobserved heterogeneity between individuals who were on the bus at the time of the accident and the unexposed who were available at home at the time of the survey. This concern was addressed to the extent possible by survey enumerators making repeated visits to the homes of the matched unexposed individuals if they were unavailable at the first visit.

In terms of external validity, our results may not globally generalizable since the study was conducted in mostly rural areas in South India among a low income population that was uninsured. Furthermore, different types of illnesses might potentially have varying effects on psychological distress and the results from injury presented here might not be generalizable to other health conditions.

Yet another potential source of concern is the possibility of respondent bias. Because the survey was conducted in reference to the state bus corporation, a perceived potential to receive more compensation could induce bias. Our findings of null effect on distress levels at low levels of severity of injury address this concern to some extent. However, it is possible that such a bias might be driven by the underlying level of severity; individuals with more severe injury might be more sensitive to the potential to receive further compensation.

This study did not examine mental health effects in terms of Post-traumatic Stress Disorder (PTSD), focusing instead on general levels of psychological distress. While the presence of flashbacks, nightmares, or avoidance behaviors among the injured is important from a clinical perspective, a psychological distress measure is arguably a better metric of the overall mental health burden. Additionally, relying on the distress measure allowed us to directly compare and estimate the causal effects of the injury on mental health.

## Conclusions

While the findings in this paper show evidence of causal effects of a physical health shock on mental health, it also points to large opportunities for future research that can help disentangle the relationship between mental and physical health. It might be possible to exploit similar quasi-experimental methods in the context of exposure to other illnesses. It is not that mental health consequences have not been studied earlier in the context of injuries. However, in prior studies it has been difficult to account for the fact that individuals with mental health problems are often independently at higher risk of being injured (Frank and McGuire 1999; Koivumaa-Honkanen, Honkanen et al. 2002). The contribution of this study has been to demonstrate the potential use of a matching procedure to enable the estimation of *causal* effects.

The evidence also informs the problem faced by policy makers trying to allocate resources to physical and mental health issues. While our analysis provides evidence of large effects of physical health events on mental health, it is likely that there are similar effects in the opposite direction. Improvements in one aspect of health are likely to have spill over effects on the other. Our current inability to incorporate these effects leads to a potential underestimation of the benefits of investing in various areas of health and prevention. Future research efforts targeted at understanding such spillover effects will help recognize the complementarities in investing in health and also inform treatment of patients who, having one condition, could be at risk of developing the other.

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Table 1: Sample Characteristics

| Variables | Exposed Mean [SD] | Unexposed Mean [SD] | p-value* |
|---|---|---|---|
| N | 84 | 336 | |
| % female | 29% | 29% | |
| Age | 38.9 [12.2] | 38.0 [11.6] | 0.54 |
| Rural Residence | 83% | 82% | 0.89 |
| Education (%) | | | |
| No School / Illiterate | 34.52% | 33.63% | 0.88 |
| Primary | 19.05% | 21.43% | 0.63 |
| Middle School | 20.24% | 22.92% | 0.6 |
| High School | 7.14% | 8.63% | 0.66 |
| College + | 19.05% | 13.39% | 0.19 |
| Avg hh income per month | 4482 [3167] | 4365 [3076] | 0.76 |
| Avg Psych distress score (10-50) | 23.1 [8.2] | 14.6 [5.0] | <0.001 |
| Mod / Severe Mental Illness (%) (Score > 24) | 41.60% | 6.50% | <0.001 |
| Avg Disability Score (6-18) | 13.3 [3.4] | 8.5 [2.9] | <0.001 |
| Borrowed in past year | 78.60% | 47% | <0.001 |

* p-values are from t-tests and chi2 tests comparing exposed and unexposed

Standard Deviations in [ ]

## Table 2: OLS Regression of Physical Health Shock on Psychological Distress Scores

OLS Regression of random health shock on psychological distress scores

| | Model 1<br>Coeff (SE) | Model 2<br>Coeff (SE) | Model 3<br>Coeff (SE) | Model 4<br>Coeff (SE) |
|---|---|---|---|---|
| Exposed | 8.48 (.91)*** | 8.40 (.89)*** | 3.07 (.91)*** | 3.01 (.81)*** |
| Female | | 2.15 (1.12) | 1.74 (.88)* | 1.75 (.89)* |
| Age | | 0.09 (.03)** | 0.01 (.03) | 0.02 (.03) |
| Literate | | 0.01 (.79) | -0.53 (.60) | -.54 (.60) |
| Physical Disability Score | | | 1.14 (.10)*** | 1.12 (.10)*** |
| Borrowed in past year | | | | 0.34 (.47) |

* p-value less than <0.05; ** p-value less than <0.01; *** p-value less than <0.001

All standard errors are robust and clustered at the level of matching household

Table 3: OLS Regression of Severity of Injury on Psychological Distress Score

| | Coeff. (Rob SE) | P-value | N (% of Exposed) |
|---|---|---|---|
| Panel A: Severity (Hospital Expenses) | | | |
| Rs. 0-500 | -0.02 (1.10) | 0.998 | 11 (13.10) |
| Rs. 501-1000 | 0.61 (1.49) | 0.686 | 14 (16.67) |
| Rs. 1001-5000 | 3.53 (1.17) | 0.003 | 37 (44.05) |
| Rs. 5001-10000 | 3.88 (1.65) | 0.022 | 11 (13.10) |
| Rs. 10001-25000 | 8.29 (1.90) | <0.001 | 11 (13.10) |
| | | | |
| Panel B: Severity (Days of Normal Activity Affected) | | | |
| 1-7 days | -0.49 (1.09) | 0.656 | 15 (17.86) |
| 8-15 days | 1.21 (1.71) | 0.482 | 12 (14.29) |
| 16-30 days | 3.56 (1.24) | 0.005 | 31 (36.90) |
| 31-60 days | 4.53 (1.42) | 0.002 | 15 (17.86) |
| > 60 days | 8.64 (2.14) | <0.001 | 11 (13.10) |

* Standard Errors are clustered at level of household

** All Models control for age of injured, sex, literacy, disability score and household borrowing

Figure 1: Distribution of Psychological Distress Scores, by Exposure to Health Shock