DISCUSSION PAPER SERIES

IZA DP No. 9400

Arsenic Contamination of Drinking Water and Mental Health

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October 2015

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Discussion Paper No. 9400
October 2015

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IZA Discussion Paper No. 9400
October 2015

ABSTRACT

Arsenic Contamination of Drinking Water and Mental Health*

This paper investigates the effect of drinking arsenic contaminated water on mental health. Drinking water with an unsafe arsenic level for a prolonged period can lead to arsenicosis, which includes symptoms such as black spots on the skin and subsequent illnesses such as various cancers. We collected household survey data from Bangladesh, a country with wide arsenic contamination of groundwater to construct several measures for arsenic contamination that include the actual arsenic level in the respondent's tubewell (TW) and past institutional arsenic test results, as well as collected household members' arsenicosis symptoms and their physical and mental health. We find that suffering from an arsenicosis symptom is strongly negatively related to mental health, even more so than from other illnesses. Furthermore, individuals drinking from an untested TW have lower mental health and having to walk a longer distance to a TW also decreases mental health. Calculations of the costs of arsenic contamination reveal that the average individual would need to be compensated for suffering from an arsenicosis symptom by an amount as high as the average annual household income.

JEL Classification: Q53, I10, I31

Keywords: arsenic, water pollution, mental health, subjective well-being, environment, Bangladesh

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* We thank conference participants at the 12th IZA Annual Migration Meeting (AM²) in Dakar, the 7th Annual Meeting on the Economics of Risky Behaviors in Izmir and the 3rd IZA Workshop: Labor Market Effects of Environmental Policies in Berlin as well as Victoria Finn for valuable comments and suggestions on earlier versions of this paper.

1 Introduction

The arsenic contamination of groundwater in Bangladesh is regarded as the largest poisoning of a population in history (Smith et al., 2000). It was caused by the reaction to the observation that surface water contaminated with diarrhea-causing bacteria contributed to high infant mortality rates. Therefore, United Nations Children's Fund (UNICEF) initiated the construction of tubewells (TW) in the 1970s to provide safe drinking water. However, the groundwater used for drinking and pumped up via the TW was not tested for arsenic before installation. Frequently drinking water contaminated with an unsafe level of arsenic over a prolonged time period can lead to arsenicosis[1], which includes symptoms such as black spots on the skin and subsequent illnesses such as different cancers.[2] However, arsenic is a naturally occurring phenomenon in Bangladesh's groundwater and contamination may vary within short distances: a high-contaminated TW may be close to a low-contaminated TW (van Geen et al., 2002). Estimations reveal that about 20 million people in Bangladesh are at risk of drinking water that contains a level of arsenic higher than 50 μg/L, the maximum level permitted in Bangladesh; moreover, 45 million people are at risk of drinking water with a level higher than the WHO's maximum contaminant level of 10 μg/L (Flanagan et al., 2012).

This paper aims to analyze whether drinking arsenic contaminated water affects individuals' mental health. Mental health continues to be a largely unrecognized and under-researched topic in developing countries, particularly in Bangladesh, despite a seemingly high prevalence of mental disorders (Hossain et al., 2014). Moreover, this relationship is not yet understood, as there are very few other studies thus far. There is neuroscientific evidence showing that perinatal arsenic exposure may have long-lasting biochemical and behavioral effects on adult mouse offspring and results in depressive-like behavior (Martinez et al., 2008). Epidemiological and toxicological studies show that arsenic is a developmental neurotoxicant that affects intellectual functions such as IQ and memory in both children and adults as well as neural functions in animals (see, e.g., Tolins et al., 2014; Tyler and Allan, 2014). The few studies examining arsenic contamination and self-reported mental health or depression find a negative relationship between the two, but usually entail limited observations and only one measure of arsenic poisoning (see Brinkel et al., 2009 for a review; Keya, 2004 and Syed et al., 2012, for Bangladesh; Fujino et al., 2004, and Dang et al., 2008, for China; Zierold et al., 2004, for the U.S.).[3]

In contrast to the existing literature, we provide new evidence on this question in a quasi-randomized setting where exposure to arsenic contamination was unknown and distributed somewhat randomly (the household's initial choice of water source did not depend on its observed characteristics). This setting

[1] Arsenicosis is the illness related to the effect of consuming arsenic contaminated water or food over a prolonged period.
[2] Other diseases commonly associated with drinking unsafe levels of arsenic contaminated water include internal (bladder, kidney, lung) cancers, neurological effects, hypertension, cardiovascular disease, increases in miscarriages and premature delivery, decreased birth weights, as well as an increase in mortality (Smith et al., 2000; Kapaj et al., 2006; Argos et al., 2010). Moreover, Carson et al. (2011) find household labor supply, Asadullah and Chaudhury (2011) find children's test scores, and Pitt et al (2012) find productivity to be negatively affected by arsenic exposure.
[3] One study using life satisfaction instead of mental health includes Asadullah and Chaudhury (2011), who find that arsenic exposure negatively affects children's life satisfaction.

has been augmented with very rich, relatively large household and community data that include the history of water source and TW usage, objective measures of arsenic exposure, arsenicosis, as well as other demographic, socioeconomic, and health information. Previously such comprehensive information had not been available to study this topic. Our measure of mental health is the GHQ-12 (General Health Questionnaire) score, which is a widely used measure of psychological distress (Argyle, 2001). The GHQ-12's validity to assess psychological well-being has been shown by numerous studies including, e.g., Hardy et al. (1999), Quek et al. (2001), Tait et al. (2003), Navarro et al. (2007) and Sánchez-López and Dresch (2008). Besides wide usage in the psychology and medical literature, it has also been applied by economists (e.g., Clark, 2003; Gardner and Oswald, 2007; Akay et al., 2014). Our study contributes to three types of literature: a) environmental economics (see, e.g., Graff Zivin and Neidell, 2013, for a comprehensive overview), b) "envirodevonomics," which combines environmental and development economics (Greenstone and Jack, 2015), and c) environment and subjective well-being (Frey et al., 2010). This research is part of a substantial effort among economists to make subjective measures part of the economic discipline (Kahneman et al., 1997; Kahneman, and Sugden, 2005).

We envisage three possible channels through which unsafe arsenic levels in drinking water may affect mental health: physiological, social, and psychological. The physiological channel can occur due to two reasons: first, drinking arsenic contaminated water may affect certain brain functions and in turn directly increase the probability of depression (Martinez et al., 2008). Second, individuals affected by arsenicosis may actually feel sick, which has been shown to be related to lower mental health (Dolan et al., 2008). Arsenic may affect individuals socially if arsenicosis patients suffer from discrimination and social exclusion. There is some evidence showing that arsenicosis is sometimes believed to be contagious and that victims are socially stigmatized (George et al., 2013; Hassan et al., 2005; Brinkel et al., 2009). Suffering from arsenicosis symptoms should therefore lead to a decrease in mental health. A third channel, which is somewhat connected to the other two but refers to a different mechanism, is the psychological channel. Individuals may start worrying about their health, future or family (Schwartz and Melech, 2000) when they or one of their family members have arsenicosis symptoms, or when they drink out of a red or unlabeled TW.[4] Again arsenicosis symptoms would lead to lower mental health. Hence we hypothesize that if arsenic contamination of drinking water is related to mental health, there will be a negative relationship.

This paper is organized as follows: Section 2 describes the data and sample. Section 3 provides the results of the empirical analysis, Section 4 presents the sensitivity analysis, and Section 5 concludes.

[4] The government and select NGOs have tested a number of TWs, which they then labeled green if the water is safe to drink and red if the arsenic level is too high thus making the water unsafe to drink.

2 Data and Sample

The data we use for the empirical analysis comes from the *Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing – a primary data set* that we constructed from four Bangladeshi districts: Chandpur, Gopalgonj, Netrokona, and Sunamgonj. In selecting districts, we considered three sources. The first was a survey of 3,534 boreholes from 61 of the 64 Bangladeshi districts according to the British Geological Survey (BGS). Based on this data, we constructed the proportion of households in the district that had arsenic levels greater than 10 μg/L and 50 μg/L. The next two sources were from the Department of Public Health and Engineering (DPHE) TW census conducted between 1999 and 2002, and the 2009 Multiple Indicator Cluster Survey (MICS) conducted by the Bangladesh Bureau of Statistics and United Nations Children's Fund (UNICEF). We then followed a two-step simple random sampling procedure, where in the first step we randomly selected 150 villages/clusters from four districts. Including a village for random selection was contingent on fulfilling two criteria: first, the DPHE conducted its TW census in that village in 1999–2002, and second, there was at least one (partner) MFI/NGO currently operating in that village/sub-district. In the second step, 30 households were randomly selected from each village.

In total, 30 households in 150 villages were interviewed in 2014, resulting in 4,500 households in the entire dataset. The household survey comprises information on the following: the history of TW use, current and past drinking water sources, information about education, height and weight, chronic and temporary illness, demographic information, migration history, housing conditions, labor supply, and income. Moreover, a TW census was conducted in all 150 villages. For each TW, this census recorded its precise arsenic level, its exact geographical location (latitude and longitude), the establishment date, and whether or not the TW is labeled for arsenic contamination.

We investigate the following measures of arsenic contamination: 1) suffering from an arsenicosis symptom (including darkening of skin on palms, dark spots on the body, keratosis, cardiovascular disorder, and respiratory disorder), 2) the current level of arsenic measured in μ/L in the TWs sourced for drinking water, 3) distance to TW used for drinking water in minutes walking, 4) duration of drinking out of the TW used for drinking water in years, and 5) the TW color. The TW coloring includes a) the result of an awareness scheme implemented by the government (and NGOs in some instances) where contaminated TWs were painted red and safe ones painted green according to their level of arsenic (self-reported by respondents), b) if the individual is currently drinking from a red, green, or unlabeled TW (also self-reported), and c) the interviewer's observation about a red, green, or unlabeled TW. These three information sources about the color can differ due to fading colors over time, for example a once painted red TW may no longer hold the cautionary color today, or because of respondents' differing memories.

The mental health measure we use is the GHQ-12 score (Goldberg and Williams, 1988). It consists of 12 questions related to the respondents' well-being in the past few weeks, such as their ability to concentrate and the occurrence of worry, stress, depression, and self-confidence.[5] The answer possibilities range between 1 and 4, where a higher value refers to a more negative feeling. One person per household, preferably the household head, responded to the survey on this issue. We sum each respondent's answers to an index score ranging from 0 to 36. Importantly and for the ease of interpretation, we reversed the scale in our empirical analysis, so that higher values of the final score indicate better mental health.[6] We also calculate two different versions of the GHQ-12 score for robustness checks. First, we calculate a score ranging from 0 to 12, which is the GHQ caseness score. To calculate this score, we sum the answers to the two low mental health categories. The scale is again reversed so that a higher value reflects better mental health. Second, the GHQ-12 caseness score is transformed into a dummy variable equal to 1 if the 12-scale GHQ score lies between 9 and 12. Individuals are regarded as a 'case' and should receive further attention for psychiatric treatment if the GHQ-12 caseness dummy is equal to 0 (Jackson, 2007).

The final sample for our analysis decreases to 4,099 individuals due to the fact that only one individual per household is asked about his or her mental health and due to missing information in other variables of interest. Table 1 displays summary statistics of the variables used in the analysis. The mental health variable has an overall mean of 24 (on a scale from 0 to 36). The number is a bit lower than the one from Akay et al. (2014), who analyze a sample of rural-to-urban migrants in China. The average of the GHQ-12 score in their study is around 28. Moreover, the average 12-point scale of the GHQ-12 score amounts to 9 in our sample, which is also slightly lower than the average of 10 of the working age population in Britain (see Clark, 2003). 30 percent of our sample can be regarded as mentally unhealthy and would need medical treatment which is again higher than the corresponding number in Clark (2003), namely 19 percent. The prevalence of mental disorders in Bangladesh detected in the literature varies from 6.5 to 31.0 percent among adults (Hossain et al., 2014).

Almost 5 percent of the sample suffers from an arsenicosis symptom themselves and another 7 percent of all households have at least one member other than the respondent with an arsenicosis symptom. Therefore in total about 12 percent of households have at least one member suffering from an arsenicosis symptom. 17 percent of respondents say they drink from a green TW, 11 percent from a red TW and the vast majority of 72 percent drinks from an unlabeled TW. However, about half of the TWs were tested in the past and found that 29 percent were labeled green and 19 percent were red. The interviewers checked the color on all tested TWs and interestingly they observe even fewer colored labels than the respondents: only 5 percent green and 4 percent red. Although the survey question to the respondents about the color on their current TW asks for how the TW *is* labeled, not *was* labeled, the difference in

[5] Six of the questions are negatively phrased and the other six are positively phrased. Hankins (2008) shows that the variances of the responses to the negatively phrased items were significantly higher, which may bias the results; a model with correlated error terms on the negatively phrased items could resolve this bias. In our case, only three out of six negatively phrased items have higher variances, so we assume that the potential bias is rather small and therefore use the regular GHQ-12 measure.

[6] Reversing the GHQ scale in the empirical analysis is not uncommon; other studies doing so include Akay et al. (2014) and Clark (2003).

answers could be due to respondents giving information not only about the current state of the TW color, but rather mixing it with what they remember from when the TW still had a color. The average arsenic level in the TWs amounts to 99 µg/L where the highest level observed is 720 µg/L. This is clearly much higher than both the maximum 50 µg/L allowed by the Bangladeshi government and the 10 µg/L maximum that the WHO recommends. However, half of the sample is using TWs that exceed the national threshold of 50 µg/L. It takes about one minute on average to walk to the TW and people have been using theirs for around 10 years. Almost half of the respondents either own a TW or there is a TW on their compound. Basically the entire sample uses TW water for drinking (99.4 percent) and about two thirds also use it for cooking.

Two thirds of the sample are female and accordingly almost 60 percent are spouses whereas one third are household heads. A large majority of 92 percent is married. On average the respondents are 39 years old and there are 2.3 children in a household. About 42 percent of the sample is illiterate, which aligns with the CIA World Factbook's recent literacy estimate of 61.5 percent in 2015.[7] Eight percent of the sample has at least a secondary school certificate (SSC); this is in line with the Bangladesh Household Income and Expenditure Survey's finding of 8.9 percent for rural areas (Bangladesh Bureau of Statistics, 2011). The majority of the sample has worked in the last 7 days and the annual household income amounts to 141,740 Taka (about 1,620 Euro), which is slightly higher than the 2010 rural national average of 115,776 Taka (Bangladesh Bureau of Statistics, 2011). Half of the respondents live in households where at least one member migrated in the past year and on average about 20 relatives live in the same village. The Body Mass Index (BMI) is around 21, which aligns with the results of the Bangladesh Demographic and Health Survey 2011.[8] 36 percent of the respondents were ill in the past month and on average a respondent had about 11 sick days over the past year.

3 Empirical Analysis

We investigate the effect of arsenic contamination of drinking water on mental health by performing stepwise linear probability regressions in the first part of our empirical analysis. We report the results of unconditional and conditional regressions incorporating covariates that are usually included in subjective well-being regressions plus some variables that are specific to the rural setting in Bangladesh. Our estimated equation is as follows:

$$MH_{ij} = \sum Arsenic_{ij} + \sum X_{ij} + \gamma_j + \varepsilon_{ij}, \quad (1)$$

where MH_{ij} is the level of mental health measured by the GHQ-12 score reported by individual i in village j. $Arsenic_{ij}$ is a vector of variables on arsenic contamination. These include suffering from an arsenicosis symptom (the respondent or another household member), drinking from a red or unlabeled

[7] See https://www.cia.gov/library/publications/the-world-factbook/fields/print_2103.html for details.
[8] See http://dhsprogram.com/publications/publication-fr265-dhs-final-reports.cfm for the report.

TW, drinking from a TW that was tested or was not tested, drinking from a TW where the interviewer observes a red or no color, the arsenic level in the TW (in µg/L), the walking distance to the TW in minutes and the duration of TW usage in years. The vector X_{ij} contains personal variables of the respondent as well as some variables on the household level. These variables include gender, relation to household head, marital status, age and age squared, number of children in the household, education, working status, log of annual household income (in Bangladeshi Taka), whether a household member migrated in the past year, the number of relatives in the village, BMI and BMI squared, and information about physical health. γ_j denotes a village fixed effect (FE). However, since we do not wish to rule out the between-village variation from the beginning, we include village fixed effects as a robustness check and in certain regressions where it is reasonable to include them. ε_{ij} denotes the error term. The standard errors in the regressions are clustered at the village level.

Table 2 contains the results of including all measures of arsenic contamination and TW usage in separate unconditional and conditional regressions. Columns (1) to (7) show the unconditional regressions, which suggest a clearly negative relation between having an arsenicosis symptom and mental health. These individuals may feel physically ill, leading to lower mental health, they may worry about their future due to the arsenic poisoning, or they are being discriminated against in their village due to their symptoms. Moreover, drinking out of an untested TW is also associated with lower mental health. This may be due to an uncomfortable feeling of uncertainty about the TW's true arsenic level. A higher level of arsenic slightly lowers mental health, as does a longer distance to the TW. Except for the TW's arsenic level, all results stay robust when introducing control variables (see Columns (8) to (14); for the full list of control variables, please refer to Table A1). We decide to keep the statistically significant variables in further regressions.

In Table 3, we add the information about other household members' arsenicosis symptoms and other illnesses as regressors. The results show first that there is a larger effect of suffering from an arsenicosis symptom than from a different illness. Second, it significantly lowers mental health if household members suffer from an arsenicosis symptom or from other illnesses, but these effects are smaller than the respective ones when the individual him- or herself suffers from the respective illness.[9] Third, it is more detrimental for mental health if a household member has an arsenicosis symptom than another illness. These results show that suffering from an arsenicosis symptom appears to have a more negative relation to mental health than being sick in general.

Table 4 shows the regression results by gender. It shows that men are slightly more affected by having an arsenicosis symptom and by living with an individual who suffers from that kind of symptom. However, men are slightly less affected if another household member suffers from a different illness. Moreover, the negative effect of drinking from an untested TW is only significant for women, which

[9] It would certainly be interesting to investigate whether respondents are even more affected when a child in the household has an arsenicosis symptom rather than another adult member. However, the number of observations in the sample does not allow for a separate analysis.

might be due to the fact that it is mainly women who go get the water and therefore might be more aware of the TW color marks.

The respondents in the sample probably do not only ingest arsenic via drinking water, but also via the food they eat, especially rice (see, e.g., Williams et al., 2006). Unfortunately, we have no detailed information on food intake, but are able to include information about whether they use TW water for drinking or cooking (boiling water does not affect arsenic levels), which gives an approximation of the non-drinking water related intake of arsenic.[10] Table 5 shows the results. First, the dummy variables on the TW water used for drinking and cooking do not change the effects of the arsenic variables already included in the former regressions. Second, using TW water for cooking is significantly positively related to mental health, at least without controlling for village FE. This effect can be due to the easier access to TW water than to other water sources, e.g. surface water, which individuals have to put in extra effort to collect.

So far, the paper has not taken into account the endogeneity issue that threatens properly identifying the effect of arsenic symptoms. Up until 1998 people in Bangladesh were unaware of the arsenic contamination and were therefore most likely obtaining water from the closest TW. Thus, the intake of arsenic was quasi randomly distributed. In 1999 the arsenic issue was publicized and institutional tests of arsenic levels in the then-existent TWs began. When this public campaign ended in 2002, lots of TWs installed thereafter were not tested. Therefore, 1998 is the last time when TW choice was clearly exogenous, or in other words, not dependent on arsenic. Since then drinking from a contaminated TW has not been random but also a choice in the sense that individuals were able to switch to existent or newly installed TWs to avoid high arsenic concentrations. Therefore people who suffer from an arsenicosis symptom might be very different from people who do not suffer from one if they switched TWs due to arsenic contamination. There might be one or several variables affecting the choice to use a contaminated TW (if it is known to be contaminated) and mental health at the same time, in which case our baseline results would display a spurious relationship. By taking the history of TW use into account, one would be able to reduce this endogeneity issue related to potentially switching TWs and the probability of developing symptoms. Moreover, if we can show that switching the TW is related to the distance to the TW rather than to its arsenic level, the probability of developing an arsenicosis symptom would not be related to households' specific switching behavior so that our baseline results would not suffer from a severe bias.

We approach this issue by first checking whether the household characteristics are in any way related to the level of arsenic in the nearest TW in 1998, when the arsenic contamination issue was still unrevealed. We use geographical information on TW location (latitude and longitude) and calculate the distance between the house and the closest TW in 1998. Moreover, since we only know the current level

[10] Even if we had information about food intake, we would not know the actual level of arsenic ingested unless each food item is tested for it. This is because food is often purchased in the market and is not labelled for arsenic status.

of arsenic in the TWs, we approximate the 1998 level by adjusting the current arsenic level in the respective TWs to the yearly arsenic increase of about two percent (see van Geen et al., 2003). Table 6 shows the results of regressing the level of arsenic in the closest TW in 1998 on basic household characteristics including the household head and spouse's education, the household head's age, the annual household income, the household size, the number of children 16 years and older, and village fixed effects. The results show no significant relationship between household characteristics and the level of arsenic in the TWs in 1998, which can be seen as a confirmation of a quasi-random distribution of arsenic in 1998 across households.

Next, we turn to the reasons for switching TWs. If we can show that switching TWs primarily depends on the distance to the TW rather than on its arsenic level, we can be more confident that our baseline results are not biased in the sense that individuals who switched TWs because of arsenic might have a different probability of developing arsenicosis symptoms and at the same time different mental health levels. In that case the results would rather display a spurious relationship between arsenicosis symptoms and mental health. We investigate the determinants of switching TWs first by looking at self-reports on the reasons for TW switching and second by regressing the probability to have switched TWs on the distance between TWs and their arsenic levels in a three-equation-system. Table 7 shows the distribution of answers to a survey question on why people switched TWs. All respondents who have ever switched a TW were asked and 96 percent claim that they switched because their current TW is closer to their house than the former one. It is important to know that new TWs are being installed over time so that there are more TWs to choose from today than in, e.g., 1998. Only about three percent of the sample say they have switched because the new TW is arsenic free. These numbers support the assumption that it is the distance that matters for TW switching.

Moreover, we estimate a recursive three-equation-system via seemingly unrelated regression (SUR) to account for residual correlation across the equations. The first equation determines the decision to switch TWs after 1998. We again use geographical information of TW location and calculate the difference between the closest TW in 1998 (2003) and the closest TW in 2003 (2014) to get an indicator about how distances change over time. As before, we would like to test whether individuals switch because of distance or arsenic so we also include dummy variables on the level of arsenic in 1998 (2003) above 50 μg/L which is the cutoff for coloring the TW red instead of green. We include information about the time span between 1998–2003 and 2003–2014 to have a more informative picture about the distribution of TWs.[11] In the second equation we check whether the probability of a symptom depends on whether the individual switched their TW and the (exogenous) arsenic level in 1998, also adding a squared and

[11] Only the 1998 variables are really exogenous. When estimating these regressions without the information on 2003–2014 for distance and arsenic level, all the results stay the same. Only the dummy on the arsenic level above 50 μg/L in 1998 is significantly negatively related to switching at the 10 percent level when not including village fixed effects.

cubic term to account for possible non-linearities. The third equation is our main regression with mental health as a dependent variable.[12]

The number of observations in the SUR estimations decreases to 3,756 due to missing observations of distance measures that are related to unmeasured geographic locations of TWs, e.g. those that are now broken but were in use in 1998. Table 8 shows the SUR results without (Column (1)) and with village fixed effects (Column (2)). Indeed, a closer distance to a new TW in 2003 (2014) compared to 1998 (2003) increases the probability to switch TWs, whereas a risky level of arsenic is not related to switching. This confirms the hypothesis that people do not switch TWs because of arsenic and resembles the self-reported reasons for TW switching. Moreover, the results of the second equation with symptom as a dependent variable shows that switching TWs does not significantly affect the probability of developing a symptom, but that the level of arsenic in 1998 does so, in a non-linear way. Column (2) shows that the squared term is significantly negative and the cubic term significantly positive. Presumably rather high levels of arsenic contribute to developing an arsenicosis symptom. The negative effect of symptom on mental health is not altered using this SUR specification, and remains significantly negative.

Since the SUR estimations do take into account the recursive system in which we are interested, but do not use predictions of the prior dependent variables in the subsequent regressions, we also use an instrumental variable approach. We use a cubic specification plus two dummies for high cutoffs of the arsenic level in 1998 to create an exogenous variation for developing a symptom of arsenicosis. Table 9 presents the two stage least squares results. The F statistic of a joint test of the several instruments in the first stage is 9 which suggests that our instruments seem to have reasonable power. Moreover, the effect of the arsenicosis symptom on mental health stays robust using the IV specification.

In order to get a sense of the costs of arsenic contamination, we calculate the financial compensation one would need to pay the average individual to account for the decrease in mental health due to arsenicosis symptoms. The log income needed to compensate the loss caused by symptoms according to column 1 of Table A1 is equal to minus the coefficient of symptom (2.354) divided by the coefficient of log household income (0.231). The ratio of these coefficients gives a value of 10.190 which is about as high as the annual log household income of 10.965 (see Table 1). This means the average individual would need to be compensated for suffering from an arsenicosis symptom by an amount of money as high as the average annual household income to keep his or her mental health constant. Moreover, when only including the effect of other household members' symptoms, the compensation is a bit less than the annual log household income (7.411) and combining these two effects of an own symptom and another household member's symptom gives a value of 17.602, in other words almost twice the annual

[12] Please see Table A2 for descriptive statistics of the newly introduced variables hereafter.

household income. These quick calculations provide a rough indication about the dimension of arsenic poisoning and mental health in Bangladesh.

4 Sensitivity Analysis

In this section we present the results of four types of sensitivity checks: 1) we vary the definition of the GHQ scale, 2) we include village fixed effects, 3) we include the TW's current arsenic level as a control variable, and 4) we take into account potential sorting due to arsenic.

Table 10 shows the results of the first three robustness checks. First, with respect to the dependent variable's definition, we apply a 12-point instead of the 36-point scale definition of the GHQ score, which is known as the GHQ-12 'caseness' definition. Moreover, we create a dummy of this 12-point scale variable. Individuals are regarded as a 'case' and need to receive further attention for psychiatric treatment if the GHQ-12 Caseness Dummy is equal to 0 (Jackson, 2007).[13] Column (1) and (2) show the results, which are robust to these other scaling methods of the dependent variable; only the negative result of an untested TW is not statistically significant anymore. Furthermore, we include village fixed effects as control variables to check whether results are driven only by between-village variation. Column (3) shows that this is not the case—the results remain virtually the same. Moreover, we include the TW's current arsenic level into the regression, which we had not done before because it was not significant and likely to be endogenous. However, we would like to check whether it influences the main results, which as we can see from Column (4) it does not.

Finally, in Table 11 we present the results on comparing households that never moved with those that have. With this robustness check we would like to see whether sorting, potentially due to arsenic, might change the results. Only about one eighth of the sample has ever moved. We see that the effect of an arsenicosis symptom is even stronger for people who have moved (see Columns (3) and (4)). If individuals were moving away from arsenic we should find the opposite result. We therefore conclude that sorting does not present a problem to our results.

5 Conclusions

This paper aims to investigate the effect of drinking arsenic contaminated water on mental health. We use household survey data from Bangladesh, where there is widespread arsenic contamination of groundwater. Drinking contaminated water for a prolonged period can lead to severe health problems, including different forms of cancer and an increased mortality rate. We construct several measures for arsenic contamination that include the respondent's physical health as well as the actual arsenic level in their tubewell (TW) and the color of the TW they are using. The Bangladeshi government and NGOs

[13] We also estimate separate regressions for the negatively and positively phrased items as well as for each of the twelve questions. Tables A3 and A4 present the results, which stay rather robust.

tested a number of TWs and marked them green if they were safe for drinking water and red if they were unsafe. We use the GHQ-12 score as a measure for mental health. Using extensive information about the respondents' physical condition and TW usage, we are able to provide a more thorough picture of the relationship between drinking arsenic contaminated water and mental health than what the literature on this topic currently offers. Mental health in general, but especially regarding drinking contaminated water, is a widely under-researched area, particularly in developing countries. In addition, the expenditure on mental health and proper mental health legislation to legally reinforce policy goals is much lower in low income countries than in high income countries (WHO, 2011). Public awareness of this issue in developing countries, particularly Bangladesh, therefore needs to be increased.

We find that suffering from an arsenicosis symptom, even more so than other illnesses, is strongly negatively related to mental health. Living with an individual who suffers from arsenicosis also lowers mental health, more so than living with an individual suffering from a different illness. These results point to either a social/stigma channel or a psychological/worry channel through which the effect on mental well-being might work. On the one hand, in rural communities in Bangladesh arsenicosis is often believed to be contagious and affected individuals may suffer social exclusion (see, e.g., Brinkel et al., 2009). On the other hand, arsenicosis symptoms may make the individual start worrying about becoming more seriously ill and about how this might affect him or her, as well as his or her family. Future research should more thoroughly investigate these potential channels. Regression results also show that individuals drinking from an untested TW have lower mental health than those drinking from tested TWs. Having to walk a longer distance to the TW also decreases mental health.

This paper's findings show that arsenic contamination of drinking water is negatively related to mental health. Calculations of the costs of arsenic contamination reveal that the average individual would need to be compensated for suffering from an arsenicosis symptom by an amount as high as the average annual household income. Implications of these findings include on the one hand actions to reduce the risks of contamination through providing information both about safe TWs that are relatively close and about ways to filter water for safe drinking usage. On the other hand if a stigma channel drives the effect, such that individuals with arsenicosis symptoms suffer from social exclusion, information campaigns clarifying facts about arsenicosis, such as not being contagious, could increase awareness and empathy and thus reduce psychological suffering of arsenicosis patients.

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Table 1: Descriptive Statistics of Main Variables

Variable	Mean	Std. Dev.	Min.	Max.
GHQ-12 scale (0 to 36)	24.342	5.203	0	36
GHQ-12 scale (0 to 12)	9.421	3.002	0	12
GHQ-12 Caseness Dummy	0.698	0.459	0	1
Arsen. symptom	0.046	0.209	0	1
Other HH member with arsen. symptom	0.070	0.255	0	1
Drinking from green TW	0.168	0.374	0	1
Drinking from red TW	0.112	0.315	0	1
Drinking from unlabeled TW	0.720	0.449	0	1
TW tested: Green	0.288	0.453	0	1
TW tested: Red	0.186	0.389	0	1
TW not tested	0.526	0.499	0	1
TW color observed: Green	0.053	0.223	0	1
TW color observed: Red	0.042	0.201	0	1
TW no color observed	0.379	0.485	0	1
Level of arsenic in TW (µg/L)	98.897	106.019	0	720
More than 50 µg/L in TW	0.525	0.499	0	1
Distance to TW (minutes)	1.167	2.050	0	20
Duration of TW usage (years)	9.607	9.431	0	90
TW water used for drinking	0.994	0.079	0	1
TW water used for cooking	0.594	0.491	0	1
HH owns TW/ TW on compound	0.467	0.499	0	1
Female	0.664	0.472	0	1
Household Head	0.328	0.469	0	1
Spouse	0.591	0.492	0	1
Other HH member	0.081	0.273	0	1
Married	0.916	0.278	0	1
Widowed	0.045	0.207	0	1
Unmarried/divorced	0.039	0.194	0	1
Age	38.765	13.000	16	90
Number of children in HH	2.277	1.349	0	9
Illiterate	0.417	0.493	0	1
Education: None	0.414	0.493	0	1
Education: Lower than SSC	0.503	0.500	0	1
Education: SSC or higher	0.083	0.276	0	1
Worked in the last 7 days	0.847	0.360	0	1
Annual HH income (Taka)	141,740.823	188,625.584	1	2,529,350
Log. of annual HH income (Taka)	10.965	1.967	0	14.743
Anyone in HH migrated in last year	0.504	0.500	0	1
Nb. of relatives in village	19.867	16.622	0	210
BMI	20.941	3.418	14	39.256
Illness in last 30 days	0.364	0.481	0	1
Other HH member with illness	0.399	0.490	0	1
Nb. of sick days (last year)	11.168	14.490	0	250
N		4,099		

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Note: There are only 4,098 and 4,097 observations for the variables 'TW water used for drinking' and 'TW water used for cooking', respectively.

Table 2: Mental Health Regressions I: Arsenic Information

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Arsen. symptom	-3.502							-2.228						
	(0.509)***							(0.475)***						
Drinking from red TW		-0.116							-0.029					
		(0.305)							(0.298)					
Drinking from		-0.310							-0.289					
unlabeled TW		(0.234)							(0.226)					
TW tested: Red			-0.241							-0.175				
			(0.262)							(0.237)				
TW not tested			-0.526	-0.862						-0.467	-0.695			
			(0.182)***	(0.399)**						(0.175)***	(0.411)*			
TW color observed:				-0.133							-0.195			
Red				(0.601)							(0.583)			
TW no color observed				-0.524							-0.351			
				(0.411)							(0.424)			
Level of arsenic in TW					-0.003							-0.001		
(µg/L)					(0.001)***							(0.001)		
Distance to TW						-0.227							-0.249	
(minutes)						(0.038)***							(0.037)***	
Duration of TW usage							-0.018							-0.014
(years)							(0.012)							(0.012)
Control Variables	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.11	0.10	0.11	0.11	0.10	0.11	0.10
N	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable: GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB.
For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 3: Mental Health Regressions II: Other Household Members

	(1)	(2)	(3)
Arsen. symptom	-2.365	-2.226	-2.354
	(0.478)***	(0.464)***	(0.474)***
Illness in last 30 days	-1.277	-1.833	-1.815
	(0.184)***	(0.228)***	(0.227)***
Other HH member with arsen. symptom	-1.772		-1.712
	(0.387)***		(0.383)***
Other HH member with illness		-0.917	-0.865
		(0.182)***	(0.183)***
TW tested: Red	-0.221	-0.283	-0.228
	(0.235)	(0.237)	(0.235)
TW not tested	-0.492	-0.505	-0.494
	(0.172)***	(0.172)***	(0.171)***
Distance to TW (minutes)	-0.244	-0.254	-0.246
	(0.038)***	(0.037)***	(0.037)***
Control Variables	Yes	Yes	Yes
R^2	0.13	0.13	0.13
N	4,099	4,099	4,099

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable: GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 4: Mental Health Regressions III: Female vs. Male

	(1)	(2)
	Female Subsample	Male Subsample
Arsen. symptom	-1.848	-2.725
	(0.642)***	(0.644)***
Illness in last 30 days	-1.753	-1.851
	(0.294)***	(0.307)***
Other HH member with arsen. symptom	-1.441	-2.110
	(0.436)***	(0.567)***
Other HH member with illness	-0.967	-0.729
	(0.249)***	(0.286)**
TW tested: Red	-0.540	0.479
	(0.281)*	(0.366)
TW not tested	-0.547	-0.285
	(0.216)**	(0.286)
Distance to TW (minutes)	-0.216	-0.288
	(0.057)***	(0.057)***
Control Variables	Yes	Yes
R^2	0.12	0.18
N	2,721	1,378

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable: GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 5: Mental Health Regressions IV: TW Water Usage

	(1)	(2)
Arsen. symptom	-2.356	-2.368
	(0.464)***	(0.465)***
Illness in last 30 days	-1.721	-1.663
	(0.228)***	(0.231)***
Other HH member with arsen. symptom	-1.724	-1.693
	(0.374)***	(0.378)***
Other HH member with illness	-0.820	-0.774
	(0.185)***	(0.198)***
TW tested: Red	-0.025	-0.166
	(0.240)	(0.257)
TW not tested	-0.431	-0.404
	(0.173)**	(0.178)**
Distance to TW (minutes)	-0.251	-0.156
	(0.038)***	(0.045)***
TW water used for drinking	-0.047	-0.137
	(1.059)	(1.081)
TW water used for cooking	0.903	0.480
	(0.202)***	(0.291)
Control Variables	Yes	Yes
Village Fixed Effects	No	Yes
R^2	0.14	0.20
N	4,097	4,097

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable: GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 6: Quasi Random Distribution of Arsenic in 1998

Dep. Var.: Arsenic level in closest TW in 1998	(1)
Education: Lower than SSC (Household head)	0.011
	(0.012)
Education: SSC or higher (Household head)	0.005
	(0.022)
Education: Lower than SSC (Spouse)	0.008
	(0.011)
Education: SSC or higher (Spouse)	0.005
	(0.026)
Age (Household head)	0.000
	(0.000)
Log. of annual HH income (Taka)	0.003
	(0.002)
Household Size	0.004
	(0.004)
Children 16 years or older	-0.005
	(0.008)
Village Fixed Effects	Yes
R^2	0.67
N	3,756

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 7: Reasons for TW Switching (Survey Question)

	Percent
It is nearer	96.21
It is arsenic free	2.71
It is nearer & arsenic free	0.58
Was not using TW before	0.03
High rate of iron	0.48
N	3,769

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: Only respondents who have ever switched TWs were asked this question.

Table 8: Endogeneity I (SUR)

Dep. Var.	Indep. Var.	(1)	(2)
Switched after 1998	Difference betw. distance of closest	0.032	0.157
	TW in 1998 and 2003	(0.012)***	(0.040)***
	Difference betw. distance of closest	-0.000	0.220
	TW in 2003 and 2014	(0.002)	(0.053)***
	Arsenic level in closest 1998 TW	-0.031	-0.014
	above 50 µg/L	(0.024)	(0.028)
	Arsenic level in closest 2003 TW	0.007	0.021
	above 50 µg/L	(0.024)	(0.027)
	Control Variables	No	No
	Village fixed effects	No	Yes
Arsen. symptom	Switched after 1998	-0.0001	-0.0059
		(0.0085)	(0.0088)
	Arsenic level in closest 1998 TW	3.0978	34.0391
		(16.0109)	(24.2256)
	Arsenic level in closest 1998 TW	-0.1435	-0.2894
	Squared	(0.0910)	(0.1216)**
	Arsenic level in closest 1998 TW	0.0004	0.0006
	Cubic	(0.0001)***	(0.0002)***
	Control Variables	Yes	Yes
	Village fixed effects	No	Yes
GHQ-12 scale (0 to 36)	Arsen. symptom	-2.479	-2.552
		(0.389)***	(0.384)***
	Control Variables	Yes	Yes
	Village fixed effects	No	Yes
N		3,756	3,756

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: SUR (seemingly unrelated regression) results. “Switched after 1998” is equal to 1 if the household switched TWs after 1998. “GHQ-12 scale (0 to 36)” is defined from 0 to 36, higher values indicate higher SWB. Higher values of “Difference betw. distance of closest TW in 1998/2003 and 2003/2014” indicate that the closest TW in 2003/2014 is closer than the closest TW in 1998/2003. “Arsenic level in closest 1998 TW (Squared/Cubic)” is scaled by a factor of 100,000. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 9: Endogeneity II (IV)

	(1) OLS	(2) IV First Stage (Dep. Var.: Arsen. Symptom)	(3) IV
Arsenic level in closest 1998 TW		22.2218	
		(25.7366)	
Arsenic level in closest 1998 TW Squared		-0.4480***	
		(0.1318)	
Arsenic level in closest 1998 TW Cubic		0.0009***	
		(0.0002)	
Ars. level in closest 1998 TW above 100 μg/L		0.0395**	
		(0.0194)	
Ars. level in closest 1998 TW above 200 μg/L		0.0598**	
		(0.0236)	
Arsen. symptom	-2.367		-6.606***
	(0.467)***		(2.5172)
F Test		8.99	
Control Variables	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes
R^2	0.20	0.11	0.17
N	4,099	3,756	3,756

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: Standard errors clustered at the village level in parentheses. "Arsenic level in closest 1998 TW (Squared & Cubic)" is scaled by a factor of 100,000. Dep. Var. in (1) and (3): GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 10: Robustness Analysis I

	(1) GHQ (0-12)	(2) GHQ Dummy	(3) GHQ (0-36)	(4) GHQ (0-36)
Arsen. symptom	-1.440	-0.149	-2.367	-2.369
	(0.278)***	(0.036)***	(0.467)***	(0.468)***
Illness in last 30 days	-1.100	-0.148	-1.669	-1.669
	(0.129)***	(0.020)***	(0.230)***	(0.230)***
Other HH member with arsen. symptom	-0.937	-0.103	-1.691	-1.693
	(0.222)***	(0.030)***	(0.380)***	(0.379)***
Other HH member with illness	-0.558	-0.068	-0.773	-0.771
	(0.107)***	(0.016)***	(0.198)***	(0.198)***
TW tested: Red	-0.186	-0.017	-0.211	-0.262
	(0.131)	(0.022)	(0.254)	(0.264)
TW not tested	-0.127	-0.014	-0.422	-0.449
	(0.100)	(0.016)	(0.176)**	(0.181)**
Distance to TW (minutes)	-0.124	-0.020	-0.159	-0.157
	(0.023)***	(0.004)***	(0.045)***	(0.045)***
Level of arsenic in TW (μg/L)				0.001
				(0.001)
Control Variables	Yes	Yes	Yes	Yes
Village Fixed Effects	No	No	Yes	No
R^2	0.11	0.08	0.20	0.20
N	4,099	4,099	4,099	4,099

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dep. Var. in (1): *GHQ-12 scale (0-12)*, defined from 0 to 12, higher values equal higher SWB. Dep. Var. in (2): *GHQ-12 Caseness Dummy* is equal to 1 if *GHQ-12 scale (0-12)* is higher than 8. Individuals are regarded as a 'case' and receive further attention for psychiatric treatment if *GHQ-12 Caseness Dummy* is equal to 0 (Jackson, 2007). For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 11: Robustness Analysis II (Stayers vs. Movers)

	Stayers		Movers	
	(1)	(2)	(3)	(4)
Arsen. symptom	-2.191	-2.241	-3.009	-3.327
	(0.511)***	(0.486)***	(1.240)**	(1.632)**
Illness in last 30 days	-1.843	-1.643	-1.600	-1.554
	(0.233)***	(0.236)***	(0.558)***	(0.828)*
Other HH member with arsen. symptom	-1.669	-1.744	-2.281	-0.967
	(0.399)***	(0.401)***	(1.094)**	(1.223)
Other HH member with illness	-0.972	-0.853	-0.276	-0.568
	(0.192)***	(0.213)***	(0.596)	(0.966)
TW tested: Red	-0.294	-0.126	0.187	0.585
	(0.245)	(0.261)	(0.725)	(1.248)
TW not tested	-0.564	-0.465	0.017	0.406
	(0.167)***	(0.184)**	(0.552)	(0.717)
Distance to TW (minutes)	-0.244	-0.198	-0.234	-0.264
	(0.041)***	(0.054)***	(0.090)**	(0.124)**
Control Variables	Yes	Yes	Yes	Yes
Village Fixed Effects	No	Yes	No	Yes
R^2	0.13	0.21	0.17	0.43
N	3,580	3,578	519	519

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable: GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB. For the list of control variables, see Table A1. Movers are defined as individuals who currently live more than 0km away from the house/village in which they were born. Only male household heads were taken into account in this definition since females often move due to marriage, which we do not want to capture in this definition.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table A1: Mental Health Regressions: Control Variables

	(1) All	(2) Female Subsample	(3) Male Subsample
Arsen. symptom	-2.354	-1.848	-2.725
	(0.474)***	(0.642)***	(0.644)***
Illness in last 30 days	-1.815	-1.753	-1.851
	(0.227)***	(0.294)***	(0.307)***
Other HH member with arsen. symptom	-1.712	-1.441	-2.110
	(0.383)***	(0.436)***	(0.567)***
Other HH member with illness	-0.865	-0.967	-0.729
	(0.183)***	(0.249)***	(0.286)**
TW tested: Red	-0.228	-0.540	0.479
	(0.235)	(0.281)*	(0.366)
TW not tested	-0.494	-0.547	-0.285
	(0.171)***	(0.216)**	(0.286)
Distance to TW (minutes)	-0.246	-0.216	-0.288
	(0.037)***	(0.057)***	(0.057)***
HH owns TW/ TW on compound	-0.174	-0.271	0.046
	(0.175)	(0.228)	(0.291)
Female	-2.106		
	(0.602)***		
Spouse	1.285	1.551	
	(0.623)**	(1.157)	
Other HH member	0.635	0.694	0.284
	(0.398)	(0.885)	(0.487)
Married	0.930	1.048	0.420
	(0.435)**	(0.958)	(0.572)
Widowed	-0.732	-0.522	-2.304
	(0.847)	(1.090)	(1.519)
Age	-0.094	-0.153	-0.081
	(0.043)**	(0.069)**	(0.076)
Age squared	0.001	0.002	0.001
	(0.000)	(0.001)*	(0.001)
Number of children in HH	-0.104	-0.173	0.035
	(0.071)	(0.089)*	(0.099)
Education: Lower than SSC	-0.180	-0.004	-0.434
	(0.180)	(0.219)	(0.262)
Education: SSC or higher	0.385	0.738	0.075
	(0.293)	(0.440)*	(0.411)
Worked in the last 7 days	0.287	0.084	1.230
	(0.224)	(0.259)	(0.434)***
Log. of annual HH income (Taka)	0.231	0.228	0.253
	(0.047)***	(0.057)***	(0.077)***
Anyone in HH migrated in last year	-0.260	-0.323	-0.082
	(0.164)	(0.209)	(0.233)
Nb. of relatives in village	-0.024	-0.040	-0.003
	(0.007)***	(0.011)***	(0.007)
BMI	0.336	0.225	0.650
	(0.218)	(0.268)	(0.335)*
BMI Squared	-0.006	-0.004	-0.012
	(0.005)	(0.006)	(0.007)
Nb. of sick days (last year)	-0.049	-0.053	-0.043
	(0.007)***	(0.009)***	(0.011)***
R2	0.13	0.12	0.18
N	4,099	2,721	1,378

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable: GHQ-12 scale (0 to 36) defined from 0 to 36, higher values indicate higher SWB.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table A2: Descriptive Statistics of TW History

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Arsenic level of the nearest TW in 1998	0.001	0.001	0	0
Switched after 1998	0.777	0.416	0	1
Difference betw. distance of closest TW in 1998 and 2003	0.109	0.581	0	6
Difference betw. distance of closest TW in 2003 and 2014	0.363	3.436	0	43
Arsenic level in closest 1998 TW above 50 µg/L	0.584	0.493	0	1
Arsenic level in closest 2003 TW above 50 µg/L	0.609	0.488	0	1
Arsenic level in closest 1998 TW above 100 µg/L	0.352	0.478	0	1
Arsenic level in closest 1998 TW above 200 µg/L	0.228	0.420	0	1
N		3,756		

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: The minimum values for the variables 'Difference betw. distance of closest TW in 1998 (2003) and 2003 (2014)' are marginally below zero.

Table A3: Negative vs. Positive Phrasing in GHQ-12 Questions

	Negative Phrased Items		Positive Phrased Items	
	(1)	(2)	(3)	(4)
Arsen. symptom	-1.262	-1.278	-0.915	-0.817
	(0.279)***	(0.286)***	(0.207)***	(0.197)***
Illness in last 30 days	-0.963	-0.964	-0.668	-0.606
	(0.156)***	(0.154)***	(0.087)***	(0.088)***
Other HH member with arsen. symptom	-0.626	-0.599	-0.695	-0.636
	(0.216)***	(0.213)***	(0.165)***	(0.160)***
Other HH member with illness	-0.557	-0.557	-0.262	-0.243
	(0.119)***	(0.128)***	(0.072)***	(0.075)***
TW tested: Red	-0.198	-0.237	-0.123	-0.062
	(0.156)	(0.164)	(0.087)	(0.093)
TW not tested	-0.307	-0.319	-0.110	-0.082
	(0.114)***	(0.113)***	(0.068)	(0.070)
Distance to TW (minutes)	-0.170	-0.093	-0.067	-0.055
	(0.025)***	(0.028)***	(0.018)***	(0.020)***
Control Variables	Yes	Yes	Yes	Yes
Village Fixed Effects	No	Yes	No	Yes
R^2	0.10	0.17	0.11	0.19
N	4,099	4,099	4,099	4,099

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable in (1) and (2): negatively phrased GHQ-12 items, defined from 0 to 18, higher values indicate higher SWB. Negatively phrased items include: Lost much sleep over worry, constantly under strain, couldn't overcome difficulties, feeling unhappy/depressed, losing confidence in yourself, thinking of yourself as a worthless person. Dependent variable in (3) and (4): positively phrased GHQ-12 items, defined from 0 to 18, higher values indicate higher SWB. Positively phrased items include: Able to concentrate, felt that you are playing a useful part in things, capable of making decisions, enjoy day-to-day activities, able to face up to your problems, and feeling happy, all things considered. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.

Table A4: Separate Regression for each GHQ-12 Question

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Arsen.	-0.290	-0.276	-0.166	-0.124	-0.290	-0.055	-0.211	-0.154	-0.235	-0.207	-0.197	-0.147
symptom	(0.056)***	(0.068)***	(0.047)***	(0.048)**	(0.075)***	(0.061)	(0.070)***	(0.060)**	(0.071)***	(0.067)***	(0.060)***	(0.063)**
Illness in	-0.163	-0.180	-0.087	-0.112	-0.242	-0.120	-0.209	-0.176	-0.227	-0.158	-0.035	-0.105
last 30 days	(0.027)***	(0.034)***	(0.027)***	(0.026)***	(0.040)***	(0.033)***	(0.030)***	(0.027)***	(0.039)***	(0.037)***	(0.033)	(0.031)***
Other HH	-0.210	-0.119	-0.178	-0.141	-0.117	0.059	-0.151	-0.153	-0.175	-0.138	-0.136	-0.254
member with arsen. symptom	(0.038)***	(0.049)**	(0.046)***	(0.045)***	(0.061)*	(0.046)	(0.042)***	(0.043)***	(0.056)***	(0.049)***	(0.047)***	(0.045)***
Other HH	-0.044	-0.142	-0.024	-0.063	-0.117	-0.052	-0.078	-0.062	-0.131	-0.095	-0.019	-0.038
member with illness	(0.026)*	(0.029)***	(0.025)	(0.025)**	(0.035)***	(0.027)*	(0.030)***	(0.025)**	(0.034)***	(0.029)***	(0.025)	(0.030)
TW	-0.027	-0.085	0.002	0.025	-0.036	-0.006	-0.001	0.010	-0.043	-0.012	-0.016	-0.038
tested: Red	(0.029)	(0.035)**	(0.032)	(0.033)	(0.046)	(0.036)	(0.036)	(0.034)	(0.044)	(0.041)	(0.032)	(0.035)
TW not	-0.028	-0.025	-0.034	-0.048	-0.058	-0.024	-0.003	-0.021	-0.109	-0.062	-0.029	-0.053
tested	(0.022)	(0.025)	(0.025)	(0.025)*	(0.031)*	(0.026)	(0.023)	(0.025)	(0.034)***	(0.032)*	(0.024)	(0.027)**
Distance	-0.016	-0.024	-0.016	-0.017	-0.027	-0.017	-0.011	-0.002	-0.031	-0.037	-0.035	-0.014
to TW (minutes)	(0.006)***	(0.007)***	(0.005)***	(0.007)***	(0.006)***	(0.006)***	(0.007)*	(0.005)	(0.008)***	(0.007)***	(0.007)***	(0.006)**
Control V.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.08	0.04	0.06	0.05	0.06	0.03	0.08	0.04	0.08	0.07	0.07	0.07
N	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099	4,099

Source: Dataset on Arsenic Contamination, Labor Supply, Health and Wellbeing, own calculations.
Notes: OLS regressions. Standard errors clustered at the village level in parentheses. Dependent variable (defined between 1 and 4, where higher values refer to higher mental health) in (1): Been able to concentrate on whatever you are doing, (2): Lost much sleep over worry, (3): Felt that you are playing a useful part in things, (4): Felt capable of making decisions about things, (5): Felt constantly under strain, (6): Felt you couldn't overcome your difficulties, (7): Been able to enjoy your normal day to day activities, (8): Been able to face up to your problems, (9): Been feeling unhappy and depressed, (10): Been losing confidence in yourself, (11): Been thinking of yourself as a worthless person, (12): Been feeling reasonably happy, all things considered. For the list of control variables, see Table A1.
*** significant at 1%; ** significant at 5%; * significant at 10%.