highest in the world, surpassing the US and Mexico (WHO, 2016). Obesity can seriously deteriorate children heart, lungs, muscles and bones, kidneys and digestive tract, and hormones that control blood sugar and puberty. It increases the likelihood of adult obesity, and with that increases the risk of cardiovascular diseases and unemployment. This study investigates whether access to drinking water can contribute to the fight against the obesity epidemic in developing countries. Previous studies have shown important benefits associated with access to drinking water, including reduced morbidity and mortality mainly from waterborne diseases (Galiani, Gertler and Schargrodsky, 2005; Gamper-Rabindran, Khan and Timmins, 2010; Duflo, Galiani and Mobarak, 2012), but to the best of my knowledge, no study has investigated whether access to piped water at home reduces body weight and obesity rates.

Conceptually, there are reasons to believe that access to drinking water can have an important effect on obesity prevalence. Households disconnected from water supply networks suffer a higher cost for drinking water, cooking and of washing dishes. This cost typically has two components: the first component is more time and effort to obtain water; instead of simply opening the tap in their houses, they must walk with buckets and spend considerable time fetching water. Access to piped water at home might eliminate this physical activity and in this way could increase weight. However, the burden of collecting water is typically concentrated on adults, not on children, in particular not on young children. On the contrary, access to piped water at home might increase the consumption of water and home-made food at the expense of the consumption of food prepared outside the home including snacks, soft drinks, fast food, and street vendors' food. This substitution in food might lead to a reduction in weight. Elbel et al. (2015), for example, observed that the installation of water jets in New York City public schools was associated with a 3-fold increase in the consumption of water and with some substitution away from milk.

The second component of the cost associated with being disconnected from water supply networks is a higher likelihood of becoming infected with waterborne pathogens; water from public sources are typically less clean than piped water at home. This might generate a substitution in the consumption of fresh veggies, fish and water toward food prepared outside the home, in particular, processed food.

There are important studies that show how contamination induce individuals to engage in “avoidance behavior” including changes in their consumption of food and beverages. For example, Shimshack, Ward and Beatty (2007) found that consumers reduce their fish purchases to avoid mercury exposure; Zivin, Neidell and Schlenker (2011) observed an increase in the consumption of bottled water in areas with water quality violations; Keskin, Shastry and Willis (2017) found that mothers breastfeed their children longer to avoid arsenic contamination in Bangladesh; Onufrak et al. (2014) found an association between perceptions of tap water safety and intake of sugar-sweetened beverages among US adults; and Ritter (2018) found that a sharp decrease in the price of soda in Peru increased the consumption of soda and obesity rates, while reducing diarrhea prevalence among households without access to piped water at home, suggesting that they were substituting contaminated water with soda.

The two implicit conditions for this subsitution in food and increase in weight to happen is, first, that families without piped water at home do have enough money and do have access to snacks, soft drinks, fast food or street-vendors food. This, of course, is not the case in many rural areas and among extremely poor individuals in developing countries. However, lack of access to piped water at home is far from being a problem unique to extremely poor individuals and from rural areas; one in every three urban dwellers in developing countries does not have piped water at home (UnitedNations, 2015). Meanwhile, western food companies are targeting developing countries as the richest nations are shrinking their demand (Jacobs and Richtel, 2017; Euromonitor-International, 2010; Deogun, 1999).

The second condition is that food outside the home has more calories than home-made food or that eating food outside the home leads people to consume more food in total. Typically, food prepared outside the home in most areas of the world has high sugar and fat content, such as widely available deep-fried foods, and sugar and fat are among the highest contributors of calories. Additionally, consuming food prepared outside the home is less time-consuming than preparing and consuming food at home, this lower cost might lead to a larger number of meals per day. Finally, soft drinks and food prepared outside the home might be less satiating than water and home-made food and this characteristic might lead to a larger total quantity of food consumed. For example, there is important evidence that drinking water facilitates weight loss by increasing the sensation of fullness, which in turn leads to a lower meal energy intake (Dennis et al., 2010; Stookey et al., 2008), while liquid carbohydrates show little compensatory dietary response, meaning that individuals who consume more liquid carbohydrates, like soft drinks, do not offset the corresponding increase in calorie intake by reducing their consumption of another caloric food (DiMeglio, Mattes et al., 2000).

In general, previous studies agree that the obesity epidemic has resulted from a change in the type of food consumed rather than solely on an increase in the amount of food consumed. Cutler, Glaeser and Shapiro (2003) argue that the switch from individual to mass preparation lowered the time price of food consumption and have led to increased quantity and variety of the foods consumed. They use the example of the consumption of potatoes, which has increased greatly in the US over the last decades, but almost exclusively in the form of potato chips and french fries, which are typically prepared outside the home and usually not in baked, boiled or mashed form. Other studies have shown how the prices of food typically prepared outside the home like pizza and sodas have fallen over the last decades while the real price of fruits and vegetables has rather increased (Cawley, 2015; Wendt and Todd, 2011).

In principle, then, it seems plausible that if families get access to piped water at home they will reduce their consumption of food outside the home, and this might reduce their obesity rates. However, it is not easy to test this claim empirically. Access to drinking water at home can have two simultaneous effects: it might reduce the consumption of food outside the home, and thereby reduce BMI, but it might also reduce diarrhea prevalence, and a reduction in diarrhea prevalence has the opposite effect on BMI (Kremer et al., 2011). Thus, if we do not disentangle these two effects, it might seem like access to drinking water has no effect on the nutritional status of individuals, as measured by BMI. This conclusion, however, would be misleading; an individual that maintains a normal BMI (greater than 18 and smaller than 25) by offsetting the effect of consuming high-calorie snacks and street food with chronic diarrhea is likely significantly less healthy than an individual that achieve a normal BMI by consuming fewer high-calorie snacks and street food.

This study examines the effect of access to piped water at home on BMI and obesity rates, exploiting both experimental and non-experimental data. The experimental data comes from a social experiment carried out by Devoto et al. (2012) in the city of Tangiers, Morocco. They found that households are willing to pay a substantial amount of money to have a private tap at home. They also find that connection to piped water at home increased time spent in leisure and social activities, improved social integration and reduced conflict. Interestingly, the experiment did not have any effects on diarrhea prevalence, since both treatment and control group had access to a nearby public tap with clean water, and Devoto et al. (2012) did not examine effects on BMI or obesity rates. This context is ideal for the analysis of the present paper because it allows me to estimate the causal effect on BMI through the potential effect on the consumption of food outside the home isolated from the potential offsetting effect of diarrhea on BMI. This estimation is relevant not only as an empirical exercise but also for public policy recommendations; there have been great advances worldwide in improving water quality at the source but access to piped water at home is still very limited (Duflo, Galiani and Mobarak, 2012). Moreover, some studies suggest it is not clear that it is socially profitable (Fewtrell et al., 2005; Devoto et al., 2012; Bennett, 2012); these cost and benefit analyses, however, do not include the potential effect of access to piped water at home on obesity rates.

The non-experimental data comes from the Cebu Longitudinal Health and Nutrition Survey, a cohort of Filipino women and their children from the Metropolitan Cebu area. This data is and ideal complement to the experiment in Morocco because it contains information regarding the children's daily diets, allowing me to investigate potential channels through which access to piped water at home might reduce childhood BMI. Additionally, Cebu is poorer and more rural and has much lower childhood obesity than the city of Tangiers, thus, the exploitation of this data allows me to test the external validity of the experiment in Morocco.

Results from the experiment in the city of Tangiers show that access to piped water at home decreases BMI by 0.17 standard deviations (or 0.25 standard deviations of the WHO reference population), although this effect is not statistically significant, and obesity rates by 13.6 percentage points, or 72%, among children age 7 or younger. Results from the longitudinal analysis of Cebu, show that access to piped water at home decreases BMI among children age 10 to 19 by 0.21 standard deviations (or 0.21 standard deviations of the WHO reference population) and obesity rates by 1 percentage point or 100%, while the effect of access to piped water on BMI through diarrhea is positive and large enough to "hide" the effect of access to piped water on BMI through the reduction in consumption. The magnitude of the estimates are large, however, the confidence intervals of my estimates are very large as well. Thus, the precise point estimates are not very informative. Additionally, back-of-envelop calculations show my highest point estimate of the increase in BMI requires approximately an increase of only 56 calories per day. Furthermore, results from the Cebu analysis confirm the hypothesis that access to piped water at home reduces consumption of food prepared outside the home by approximately 40 grams per day or 14%. A Chebakia (a typical street cookie from Morocco), for example, weights approximately 20 grams and has 80 calories and a Ginabot strip (deep-fried swine intestines, common street food in the Philippines)weights approximately 80 grams and has 160 calories.

Obesity, in particular, childhood obesity, is increasing at an alarming pace. Very few interventions have thus far proven to be effective in the fight against this epidemic (Cawley, 2015). This study shows that access to piped water at home has additional social benefits and that it can play an important role in the fight against obesity.

# 2 Experimental Evidence

## 2.1 Setting and Experimental Design

This study exploits an experiment carried out by Devoto et al. (2012) in the city of Tangiers, north urban area of Morocco. The original purpose of the experiment was to estimate the effect of households' connection to the drinking water network on several well-being indicators including water-borne diseases, time use, social integration, and mental well-being. The intervention consisted of information about and assistance with the application for a loan to finance the connection to the water network. The loan was offered by Amendis, the local water provider, as part of a program that sought to increase access to the water and sanitation network. The connection to the water network was at full cost, but the loan was interest-free. The treatment encouraged take-up of the loan by providing information and a marketing campaign, pre-approving the loan and offering the collection of the down-payment at home, saving them the trip to the branch office (Devoto et al., 2012).

Devoto et al. (2012) selected a sample of 845 households from three zones of the city of Tangiers. The households selected had no water connection at home but had a public tap in their neighborhoods. These public taps were connected to the water network of Amedis. The randomization was done at a “cluster” level, where a cluster was defined as two adjacent plots or two plots facing each other on the street or up to one house apart. It was stratified by location, water source, the number of children under five, and the number of households within the cluster. Data were collected before the intervention in August 2007 (hereafter “Baseline”), and 5 months after the water connection (6 months after the intervention), in August 2008 (hereafter “Endline”).

This study works with a subsample of children age 7 or less since they were the only household members from which anthropometric indicators were taken . Additionally, I eliminate from the sample observations with biologically implausible values of anthropometric indicators, following the World Health Organization guidelines (WHO, 2006). The resulting number of observation in the Endline is 332, corresponding to 113 clusters and 133 households in the treatment group and 97 clusters and 107 households in the control group.

## 2.2 Balance Check

Panel A of Table 1 shows the differences between treatment and control group of all children age 7 or less. However, as we will see later, the effects of the treatment are driven by the subsample of children age 7 or less whose houses were not connected to the public tap and therefore had no access to piped water at home before the treatment. Thus, Panel B shows the differences between treatment and control group of this subsample of children. I find only 4 and 3 variables that are statistically significantly different between the treatment and control group in the first and second subsample, respectively. The two differences common across subsamples are in the number of children age 7 or younger and in the distance to the nearest public tap. It is important to mention, however, that the difference in the distance to the nearest public tap appears only after I eliminate the BIV. The same is true with respect to the difference in connection to a public tap. In Table 11 of the appendix, I include the summary statistics and estimations of all my regressions of the sample without eliminating any observation. There is also a difference in the assets index, however, there is no statistically difference in other income or wealth indicator, and the difference in assets is not statistically significant in our second sample. Likewise, there is a difference in the number of children age 8 to 14 in the second sample that is not statistically significant in my first sample. I will control for all these variables in my regressions.

BMI is calculated by the ratio of weight in kilograms divided by the square of height in meters. Weight was measured two times in this sample, therefore, I use the average of these two measurements. Definitions of anthropometric indicators follow the WHO standards (WHO, 2006). BMI-for-age is age- and sex-specific and represents the standardized and adjusted deviation of a child's BMI from the median value of a reference population selected by WHO. Overweight and obese children are defined as those with BMI-for-age greater than one and two standard deviations, respectively. Underweight children are those with BMI-for-age lower than negative two standard deviations. Morocco has one of the highest rates of childhood obesity in the world according to the WHO. This sample is not the exemption: 14% of the children age 0 to 5 were obese in the baseline and almost no child was underweight. Note that in the baseline I do not have anthropometric indicators from children age older than age 5, however, in the Endline they collected the anthropometric indicators of up to age 7. This is the main reason why the number of observations of the anthropometric indicators in the Baseline is less than half of that in the Endline. Nevertheless, the most important outcome variable, obesity rate, seems actually higher for the treatment group than for the control group, and in the robustness section, I work only with those children for which there are anthropometric indicators in the baseline.

Table 1 also shows the summary statistics of important household variables. Note that by sample design, before the treatment all households are located at a walking distance to a public tap with piped water but no household in either group had a formal connection of piped water at home. Nevertheless, some households were to a public tap, through a hose and therefore had already access to the same quality of water at home, since both private taps water and public taps water were provided by the same water company. The average distance to the nearest water source is 142 meters. This distance might not seem too large, in particular when we can see that more than 40% of households get water from neighbors too, but just not having the water in the convenience of home might make a significant difference in the cost of cooking and washing dishes. Finally, Table 1 shows that adults do most of the water fetching, in particular, children age 7 or less do very little of it. Thus, access to water at home should not have an impact on their physical activity.

## 2.3 Empirical Strategy

This section estimates intent-to-treat effects (ITT) and local average treatment effects (LATE). The ITT estimator captures the effect of being selected for treatment (but not necessarily treated). This effect is estimated from the following specification:

$$Y_{i,j} = \beta_o + \beta_1 T_j + \beta_2 X_{i,j} + \varepsilon_{i,j}$$

where $Y_{i,j}$ stands for BMI or for the obesity dummy for child i in cluster j, $T_j$ stands for whether the cluster j was selected to the treatment, $X_{i,j}$ stands for baseline control variables i in cluster j, and $\varepsilon_{i,j}$ stands for the error term. All the regressions have standard errors clustered at the cluster level.

The LATE estimator captures the effects of actually having received the treatment, using the selection to the treatment as an instrumental variable. The first stage estimates the effect of being selected for the treatment on the probability of being connected to the water network from the following specification:

$$C_{i,j} = \beta_2 + \beta_3 T_j + \beta_4 X_{i,j} + \varepsilon_{i,j}$$

where $C_{i,t}$ stands for whether the child lives in a house connected to the water network.

The second stage estimates the effect of being connected to the water network on some outcome from the following specification:

$$Y_{i,j} = \beta_o + \beta_1 \hat{C}_{i,j} + \beta_2 X_{i,j} + \varepsilon_{i,j}$$

where $\hat{C}_{i,j}$ stands for the predicted probability of being connected to the water network estimated in the first stage.

Under the assumption of constant treatment effect, $\beta_1$ could be interpreted as the average treatment effect. In the absence of such assumption, this estimator should be interpreted as the effect of access to the water network on weight outcomes of children of the "complier" households. That is, households that were encouraged by the intervention to connect to the water network but would not have done so in the absence of the intervention. Again, all the regressions have standard errors clustered at the cluster level.

## 2.4 Results - Experimental Evidence

As explained above this intervention relied on an encouragement design as opposed to a direct intervention. Hence, the first question we need to assess is whether the intervention increased water connection significantly. Table 2 shows that, in fact, the intervention successfully encouraged water connections; 81% of the treatment group got connected to the water network, while only 20% of the control group did. Columns 2 show the estimations including control variables. The control variables include all variables that were unbalanced in either of the two samples: number of children age 0 to 7, number of children age 8 to 14, assets index and distance and whether the household was connected to the nearest public tap. Note that the take-up of the loan and the water connection was not significantly lower for households that were connected to a public tap, suggesting that they value having their private and formal connection to the water network at home. It is also important to confirm with our sample the results of Devoto et al. (2012) that there was no effect on diarrhea prevalence. Table 2 shows that in fact, there was no significant effect on diarrhea prevalence. Thus, the estimates on BMI and obesity rates are not going to be affected by changes in diarrhea prevalence.

Table 3 presents the effect of the treatment on BMI-for-age and obesity rates. For an easier interpretation of my results, after calculating overweight, obesity and underweight, I standardized BMI-for-age so that it represents the standardized deviation of a child's BMI from the median value of my sample, rather than from the median value of a reference population. Panel A of the table shows the effect on all children age 7 or less, including those whose houses were connected to the public tap. The first two columns show the Intention-to-Trear (ITT) estimates without and with control variables, respectively. We can see that the treatment reduced BMI-for-age by 0.11 standard deviations and obesity rate by 9 percentage points, although the effect on BMI is not statistically significant. We can see that the inclusion of the control variables mostly increases the statistical power of my estimates. Column 3 and 4 show the Local Average Treatment Effect estimates without and with control variables, respectively. As expected, these estimates are similar but larger in magnitude: access to the piped water at home reduced BMI-for-age by 0.18 standard deviations and obesity rate by 14.5 percentage points, although the effect on BMI is not statistically significant.

These results, however, might be underestimating the effect of having access to running water at home, because as we mentioned before, some of the households in the control and the treatment group were connected to the public tap and therefore had access to running water at home before the treatment. Panel B of Table 3 compares the effects of the program of households that before the program were and were not connected to the public tap. If my results are effectively estimating the effect of access to running water at home, the effect should be driven by the households that before the program were not connected to the public tap. On the contrary, if my results were spuriously generated by the small number of observations and the true effect of the program was zero, it shouldn't be any different for people that before the program were connected to the public tap. Panel B shows that the effects of the program on BMI and obesity rates come mostly from households that before the program were not connected to the public tap. Although the effect on BMI remains statistically insignificant. These results also diminish the probability of an alternative theory about the mechanism; that the effect on BMI and obesity rates could be driven by a reduction of income for the treatment group since they have to repay the loan, while the control group does not. Moreover, the treatment group is paying for water now, while the control group obtains water from the public taps for free. If this alternative story would be true, we should not expect any difference for households that before the treatment were and were not connected to the public tap, since none of these groups were paying for water before the treatment and there was little and no significant difference in the take up of the loan by both groups.

Figure 1 shows the effect of the treatment in the distribution of BMI-for-age for families that did not have access to piped water at home in the baseline. The graph illustrates what we saw in the results: the entire distribution of the treatment group if slightly to the left of the control group, but the most salient difference between the treatment and control group is in the right tail of the distribution, that is fewer obese children (BMI-for-age of 2 or more) in the treatment group than in the control group.

**Magnitude of the Estimates and Back-of-Envelop Calculation**

One concern about my results might be that the point estimates are large in magnitude. However, I would like to emphazise that the confidence intervals of my results are very large as well. Hence, the precise point estimates are not very informative. It is also important to note that many people believe that it requires a significant change in calories to obtain a change in the obesity rate of a society. This belief, however, is incorrect. As Cutler, Glaeser and Shapiro (2003) has illustrated, an increase of only 100 to 150 calories in the daily consumption of food, for example, the calories contributed by three Oreo cookies or one can of Pepsi, is sufficient to explain the 100% increase in obesity rate (10-12 pounds on the average American) in the US between 1965 and 1995. Hall et al. (2011) make a more precise calculation, and arrives at a very similar estimation: it takes approximately 100 calories extra per day to gain 10 pounds. It is also common that obesity rates change proportionally more than the average BMI of the population. Cutler, Glaeser and Shapiro (2003) argue that part of the explanation relies on self-control problems, since people with self-control problems are more likely to be overweight initially and are more responsive to changes in the time costs of food. Finally, another common misbelief is that it takes a long period of time to gain weight. Hall et al. (2011), however, estimate that 50% of the effect on weight of a change in diet happens by 1 year and 95% happens by 3 years. Moreover, if changes in consumption are not permanent, the long-term effects could be smaller in magnitude than the short term effects. Thus, it really takes a few calories and a relatively short period of time to see large effects on BMI and, in particular, on obesity rates.

In this study, the highest point estimate is a decrease of 15.9 percentage points in obesity rate and of 0.28 standard deviations in BMI-for-age, which corresponds to a decrease of 0.41 standard deviations of the BMI-for-age of the reference population used by WHO. The average girl in this sample is 44 months old and 0.41 standard deviations of a 44 months old girl of the reference population correspond to approximately 0.5 BMI units. Given the average height of the girls in our sample, this effect corresponds to a reduction of 1.1 pounds in weight. Applying the rule of thumb established by Hall et al. (2011) and assuming after 5 months 21% of the potential effect has happened, such an increase in weight would require an increase of 55 calories per day for the average girl and about 49 calories for the average boy in this sample, about the calories that a third can of soda or two thirds of a Chebakia (Moroccan street cookie) would provide. An effect of this magnitude on food consumption seems plausible.

Finally, it is important to remember that the LATE estimates capture the effect of access to the water network on the likelihood of being obese of children of the "complier" households. Since the intervention consisted in information and assistance with the loan, but no difference in the loan conditions, those in the pool of households who connected to the network as a consequence of the intervention may not have been very educated but had enough money to repay the loan. This pool of households might have particularly large effects, insofar as low-educated households are less aware of the detrimental consequences of childhood obesity, and households with enough money to repay the loan can also probably afford to buy high-caloric food prepared outside the home. Thus, my estimates might be significantly higher than the average treatment effect.

**Robustness**

A final concern about my results might arise due to the fact that I do not have the anthropometric indicators of all the children in the baseline. The household variables of these two groups are well balanced, but still, it exists the possibility that my results are driven by those children who I do not have in the baseline and that it happens that they were already less obese before the treatment. In order to investigate the validity of this concern, I apply a (DID) Difference-in-Difference with only the sample of children for whom I have anthropometric indicators in the baseline and for those whose houses are not connected to the public tap. Table 4 shows the results of this estimation. Note that I have significantly less variation given that I have fewer observations and that in this specification I exploit only within group variation, hence it is not surprising that I do not obtain statistically significant results. The DID estimate for BMI is positive but very small and not statistically significant. The DID estimate for obesity rate is also statistically insignificant, but very similar to what we obtained with the complete sample: a reduction in obesity rates of 8 percentage points. Thus, the additional observations I have in the Endline mostly increase the power of my estimates.

# 3 Non-Experimental Evidence

## 3.1 Data and Summary Statistics

This section exploits data from the Children of the Cebu Longitudinal Health and Nutrition Survey. This study follows a cohort of Filipino women and their children from the Metropolitan Cebu area who were born between May 1, 1983, and April 30, 1984 . After the baseline, they surveyed children's anthropometric indicators and diet diaries in 1991, 1994, 1998, 2002, 2005. I work with data until 2002, since the WHO standards that are used to calculate the BMI-for-age are comparable only up to age 19 and there are no children age 19 or younger in the year 2005. Additionally, information about whether children had piped water at home, our main explanatory variable, was collected only since 1991, and since I use lagged variables to estimate the effect on BMI, I am not able to estimate the effect on BMI for the year 1991. Finally, the first round of food diaries in 1991 differs from the following diaries, which means I am also not able to use the food diaries from 1991.

Table 5 shows the summary statistics of my sample. Children are 15 years old and weight 40 kilos on average. The obesity and overweight rates are only 1% and 4%, respectively and 14% of children are underweight. This represents a very different context from Tangiers. However, this is unsurprising given that this sample is more rural, poorer, only around half of the households in this sample live within walking distance of a store, only 17% has access to piped water at home and 38% has access to piped water either inside or outside the house. 40% of women fetched water and spent 116 minutes doing so in the week previous to the baseline. Women at that time, however, were pregnant, so these numbers might be underestimating the real percentage and time of women fetching water regularly and unfortunately, there is no information of whether children fetch water regularly in this sample.

Table 5 also shows, as we would expect, that children with piped water at home have higher family incomes, live in more populated areas, eat more food outside the home, drink more sodas and are more likely to be overweight.

## 3.2 Model and Empirical Strategy

This section exploits the longitudinal feature of the data to apply a Fixed Effect Model at the individual level. This simple strategy will provide important complementary evidence to the experiment in Morocco in two main ways: first by investigating the potential channels through which access to piped water at home might reduce childhood obesity, in particular, if it reduces the consumption of food prepared outside the home, and second, by increasing its external validity.

The effect on food consumption is estimated from the following specification:

$$Y_{i,t} = \beta_o + \beta_1 Water_{i,t} + \beta_2 X_{i,t} + \alpha_i + \phi_t + \varepsilon_{i,t}$$

where $Y_{i,t}$ stands for the consumption of food outside the home or other type of consumption of child i in year t, $Water_{i,t}$ stands for whether the child i had piped water at home in year t, $X_{i,t}$ stands for control variables of child i inyear t, $\alpha_i$ and $\phi_t$ stand for child and year fixed effect, respectively, and $\varepsilon_{i,t}$ stands for the error term. All the regressions have standard errors clustered at the household level.

I also present the estimates of the heterogeneous effects by the baseline diarrhea prevalence. Baseline diarrhea prevalence is used here as a proxy for the quality of the water. Families that not only did not have water at home but that the water they had access to was contaminated have a higher cost of drinking and cooking with water and therefore we would expect that access to piped water at home has a higher effect on them than on families. These effects are estimated from the following estimation:

$$Y_{i,t} = \beta_o + \beta_1 Water_{i,t} + \beta_2 Water_{i,t} NoDiarrhea_{i,s} + \beta_2 X_{i,} + \alpha_i + \phi_t + \varepsilon_{i,t}$$

whether $NoDiarrhea_{i,s}$ is a dummy equal to 1 if not the child or the child's mother experienced an episode of diarrhea in the 3 months preceding the baseline, $s$. Coefficient $\beta_1$ therefore captures the effect of access to piped water on children, who were exposed contaminated water, and therefore should be higher than our previous $\beta_1$ estimate, and $\beta_2$ captures the differential effect.

The effect on standardized BMI-for-age and overweight rate is estimated from the following specification:

$$Y_{i,t} = \beta_o + \beta_1 Water_{i,t-1} + \beta_3 X_{i,t-1} + \alpha_i + \phi_t + \varepsilon_{i,t}$$

In this case, I use lagged variables to capture the accumulated effect on BMI.

Rounds in this survey happen every 3-4 years, thus by using lagged explanatory variables, the estimated effect correspond to the long-term effect of access to piped water on BMI, according to Hall et al. (2011). We also know that access to water can reduce diarrhea prevalence and this in turn can increase BMI. Thus, depending on how large is the effect of piped water on diarrhea prevalence and how large is, in turn, the effect of diarrhea prevalence on BMI, $\beta_1$ could be positive or negative.

I cannot estimate the effect of piped water on diarrhea prevalence because we have no data on diarrhea prevalence in all rounds. But I can control for the effect of diarrhea on BMI, at least imperfectly, by including in my specification the interaction of access to piped water at home and whether the child or the child's mother experienced at least one episode of diarrhea in the 3 months preceding the baseline, $s$:

$$Y_{i,t} = \beta_o + \beta_1 Water_{i,t-1} + \beta_2 Water_{i,t-1} Diarrhea_{i,s} + \beta_3 X_{i,t-1} + \alpha_i + \phi_t + \varepsilon_{i,t}$$

Thus, $\beta_1$ now should capture the effect access to piped water on children, who were exposed to none or little contaminated water; that is the effect on BMI due only to a reduction in the consumption of food outside the home and soft drinks. $\beta_2$ should capture the differential effect of access to piped water on children that were exposed to contaminated water; that is, the additional and off-setting effect on BMI through reduction in diarrhea prevalence. However, as we saw before, we would expect that access to piped water at home has a higher effect on food consumption on those families that had access to contaminated water, thus, $\beta_2$ should capture that differential effect as well. Depending on what effect is stronger, $\beta_2$ could be positive or negative.

## 3.3 Results

Table 6 shows the results on food consumption. In addition to the child and year fixed effects, the following control variables were included: income, number of children, the population density of the area and fixed effects of the barangay (neighborhood), where they currently live, since this panel dataset follows individuals even if they move to a different barangay. The following section of the paper will show the sensitivity of the estimates to these and other control variables. Access to piped water at home decreases the consumption of food outside the home on average by approximately 40 grams per day, which represents a decrease of 14%. Part of that increase seems to be driven by a reduction in the consumption of soft drinks, as we can see in column 2, although the effect is not statistically significantly different from zero.

Table 6 also shows a positive but not significant effect on home-made food. This result is reassuring in a couple of ways. First of all, it enables us to discard the alternative hypothesis that access to piped water at home might be correlated with a decrease in income or another omitted variable that decreases all types of consumption. Second, while the effect on the consumption of home-made food, is positive it is not as large in magnitude as the decrease in food outside the home. Thus, there seems to be an effect on total calorie intake resulting from a change in the quality of food, but probably also in the quantity of food, although we find a negative but not significant effect on the total quantity of food consumed.

Panel B of Table 6 explores heterogenous effects. As we would expect, the effect on the consumption of food outside the home is somewhat larger, 42 grams per day (16%), on those children who had access to potentially contaminated water at home in the first round, since access to piped water not only reduced their cost in term of fetching water but also in terms of the likelihood of contracting waterborne diseases. This "avoiding behavior" seems to have a larger effect on the consumption of soft drinks. We can see that for those children access to piped water generates now a statistically significant decrease in soft drinks of approximately 17 milliliters per day, which represents a reduction of 29%.

Table 7 shows the results on standardized BMI-for-age and obesity rate. Results show that if I do not control for the effect of a potential reduction on diarrhea prevalence on BMI or obesity rates, it seems like access to piped water at home had no effect on the nutritional status of children. Panel B shows, however, that access to piped water at home for those children who did not have diarrhea problems in the baseline reduces BMI and obesity rates. Access to piped water at home *reduces* the

BMI-for-age of these children by around 0.21 standard deviations and the obesity rate by 1 percentage points. The effect on children who did have diarrhea problems in the baseline is significantly smaller in absolute terms. I interpret this differential as the net effect of the increase in BMI due to a reduction in diarrhea prevalence and of a reduction in BMI due to a reduction in the avoiding behavior through the consumption of food outside the home.

**Sensitivity Analysis**

The Results Section shows the estimates of my preferred specification. In this section, I show how my estimates change with the inclusion of fixed effects and control variables, and we will see that these changes are very close to what we would expect. Table 8 shows my main results on food consumption. The first column shows the estimate from a simple OLS regression. We can see that piped water at home and the quantity of food eaten outside the house, including soft drinks, are positively correlated. This correlation is probably generated by omitted third factors that are positively correlated with both variables. The first obvious group of variables are those related to time-invariant characteristics of the children, such as wealth, parents' education, and knowledge about nutrition. The second column shows the results from a FE model without any additional control variable. As we can see, controlling for time-invariable characteristics of the children eliminates the apparent positive effect on food eaten outside the house. A second important third factor correlated with both variables is time. In the last decades, there has been an increase in the consumption of food outside the house in many developing countries, in particular in the consumption of snacks and fast food, both for families/individuals with and without piped water at home. Simultaneously, there has been an increase in the number of households with access to piped water at home. In order to control for these simultaneous increases, column 3 includes year fixed effects, and as we would expect, our coefficient of interest grows in absolute terms and becomes statistically significant. This data set follows individuals that move; for this reason, column 4 includes fixed effects of the barangay, where they currently live. Areas with greater access to piped water have typically better access to food outside the home. If individuals move to these areas, we will see an increase in the likelihood of access to both of these things. Again we observe an increase in the magnitude of the estimate. Columns 5 to 7 includes the following control variables ir order: population density, number of children, and family income. We can see that my estimates change little with the inclusion of these variables and if anything they increase. A very similar pattern can be observed in Table 9 for my estimate of the effect of access to piped water on BMI and obesity rates.

**Robustness Check**

The estimations with this dataset by itself do not provide enough robust evidence that access to piped water at home has a causal effect BMI, given that this empirical strategy does not control for potential omitted variables that change within child over time. It would be particularly troublesome for our estimates if the omited variables are positively correlated with access to piped water and negatively correlated with the consumption of food outside the home and BMI, or vice versa. For example, it is possible that families that are becoming more concerned about their health, decide to decrease their consumption of food outside the home and to invest in piped water. In order to test the validity of this concern, at least to some degree, in this section, I run a placebo test: whether there is an impact of access to piped water at home on past levels of food consumption, BMI and obesity rates. Naturally, access to piped water in one period can not have an effect on food consumption or BMI leves in the past, so if we find similar results as the one we obtained with our main specification it is most likely that there are omited variables that are biasing my results. Fortunately, Table 10 show that in general the results of these estimates look very different from my main results. The only coefficient that is significantly different from zero is the differential effect on the consumption of food outside the home. But note that in this case, children from households without diarrhea prevalence are eating more food outside the home before they get access to piped water at home as opposed to eating less food outside the home but not as much as the children from households with diarrhea prevalence.

# 4 Conclusions

This study investigates whether expanded access to piped water at home can contribute to the fight against obesity in developing countries. It exploits experimental data from the city of Tangiers, Morocco and longitudinal data from the city of Cebu, the Philippines. Results from the experiment in the city of Tangiers show that access to piped water at home decreased obesity rates among children age 7 or younger. Results from the longitudinal analysis in Cebu, a very different context with very little childhood obesity, also provides evidence that access to piped water at home decreased BMI and obesity prevalence among children age 10 to 19. Furthermore, results from this analysis confirm the hypothesis that access to piped water at home reduces the consumption of food outside the home, and that the effect of access to piped water on BMI through diarrhea is positive and large enough to "hide" the effect of access to piped water on BMI through the reduction in consumption.

This study suggests that access to piped water at home might play an important role in the fight against obesity in developing countries. It also provides evidence that programs that facilitate water access at home can have important health benefits, even in areas with access to clean water. This result is especially relevant given that, while there have been great advances in improved water sources worldwide, access to piped water at home is still very limited. Finally, this paper contributes to a better understanding of the demand and willingness to pay for piped water at home; Devoto et al. (2012) found that households are willing to pay a substantial amount of money to have a private tap at home, which was somewhat puzzling, since they did not find any effects on productive or monetary benefits. Nevertheless, this paper finds that access to piped water reduces the consumption of food prepared outside the house, and this might generate some monetary savings, in addition to the health benefits of reducing childhood obesity.

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Figure 1: Effect of the Treatment on BMI-for-Age Children Age 0-7 Not Connected to a Public Tap

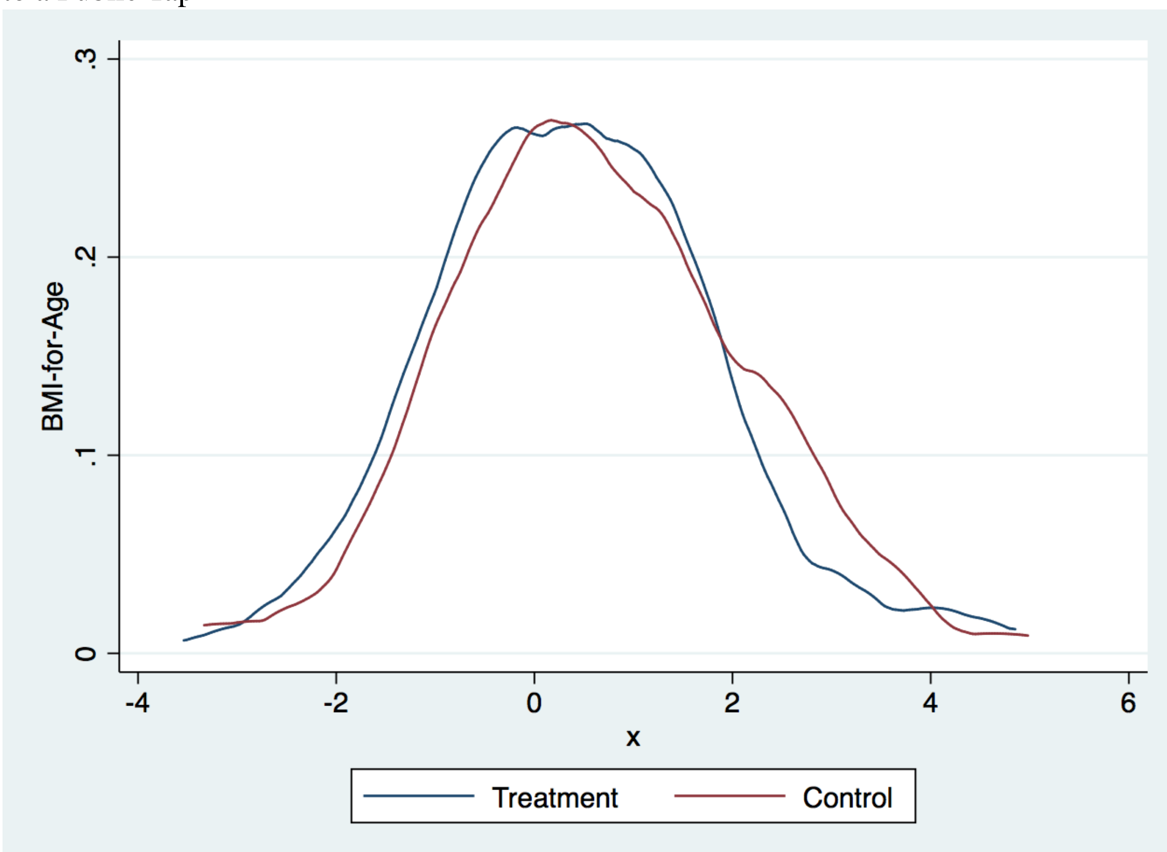

Table 1: Balance Check - Experimental

| | Children Age 0-7 | | | | Children Age 0-7 Not Connected to Public Tap | | | |
|---|---|---|---|---|---|---|---|---|
| | **Obs.** | **Control Group** | **Treat. Group** | **P-Val** | **Obs.** | **Control Group** | **Treat. Group** | **P-Val** |
| Age | 135 | 3.13 | 3.05 | 0.74 | 109 | 3.00 | 3.05 | 0.85 |
| Age (Endline) | 332 | 3.53 | 3.58 | 0.78 | 280 | 3.61 | 3.53 | 0.72 |
| Female (%) | 135 | 0.60 | 0.49 | 0.23 | 109 | 0.64 | 0.50 | 0.15 |
| Female (%) (Endline) | 332 | 0.19 | 0.21 | 0.74 | 280 | 0.20 | 0.22 | 0.80 |
| Height | 135 | 94.40 | 93.76 | 0.78 | 109 | 92.93 | 93.53 | 0.82 |
| Weight | 135 | 14.70 | 14.40 | 0.59 | 109 | 14.36 | 14.31 | 0.95 |
| BMI | 135 | 16.65 | 16.28 | 0.36 | 109 | 16.73 | 16.25 | 0.26 |
| BMI-for-age | 135 | 0.70 | 0.45 | 0.27 | 109 | 0.76 | 0.42 | 0.19 |
| Underweight (%) | 135 | 0.00 | 0.01 | 0.36 | 109 | 0.00 | 0.02 | 0.39 |
| Overweight (%) | 135 | 0.35 | 0.27 | 0.32 | 109 | 0.36 | 0.29 | 0.43 |
| Obesity (%) | 135 | 0.13 | 0.15 | 0.72 | 109 | 0.13 | 0.15 | 0.80 |
| Extreme Obesity (%) | 135 | 0.06 | 0.04 | 0.54 | 109 | 0.06 | 0.03 | 0.44 |
| Num. adults | 332 | 2.99 | 3.22 | 0.20 | 280 | 2.98 | 3.09 | 0.56 |
| Num. children 8-14 | 332 | 1.02 | 0.84 | 0.14 | 280 | 1.19 | 0.81 | 0.00 |
| Num. children <=7 | 332 | 1.95 | 1.58 | 0.00 | 280 | 2.06 | 1.61 | 0.00 |
| Num. children <=7 (EL) | 332 | 1.98 | 1.84 | 0.16 | 280 | 2.02 | 1.89 | 0.27 |
| Head male (%) | 332 | 0.88 | 0.92 | 0.21 | 280 | 0.88 | 0.91 | 0.38 |
| Head age | 318 | 43.50 | 42.14 | 0.25 | 268 | 43.72 | 41.73 | 0.12 |
| Head married (%) | 332 | 0.93 | 0.89 | 0.30 | 280 | 0.92 | 0.88 | 0.20 |
| Head no education (%) | 332 | 0.35 | 0.31 | 0.45 | 280 | 0.37 | 0.28 | 0.12 |
| Head's education att. | 282 | 3.02 | 3.30 | 0.52 | 236 | 2.68 | 3.37 | 0.13 |
| Head's income (dirhams) | 332 | 1162 | 1189 | 0.82 | 280 | 1168 | 1154 | 0.91 |
| Family income (dirhams) | 332 | 1532 | 1595 | 0.67 | 280 | 1548 | 1555 | 0.96 |
| Working for pay (%) | 332 | 0.20 | 0.21 | 0.74 | 280 | 0.19 | 0.21 | 0.21 |
| Adults working for pay (%) | 332 | 0.39 | 0.37 | 0.45 | 280 | 0.38 | 0.38 | 0.83 |
| Assets score | 332 | 0.38 | 0.00 | 0.05 | 280 | 0.15 | -0.07 | 0.31 |
| Num. rooms | 330 | 3.14 | 3.33 | 0.19 | 278 | 3.19 | 3.31 | 0.44 |
| Permanent house (%) | 332 | 0.86 | 0.89 | 0.34 | 280 | 0.84 | 0.89 | 0.22 |

| | Children Age 0-7 | | | | Children Age 0-7 Not Connected to Public Tap | | | |
|---|---|---|---|---|---|---|---|---|
| | **Obs.** | **Control Group** | **Treat. Group** | **P-Val** | **Obs.** | **Control Group** | **Treat. Group** | **P-Val** |
| Toilet (%) | 332 | 1.00 | 1.00 | . | 280 | 1.00 | 1.00 | . |
| Chlorine in water (%) | 98 | 0.60 | 0.70 | 0.30 | 84 | 0.61 | 0.73 | 0.26 |
| Clear water (%) | 332 | 0.99 | 0.99 | 0.70 | 280 | 0.99 | 0.99 | 0.76 |
| Treat water (%) | 281 | 0.10 | 0.11 | 0.78 | 230 | 0.08 | 0.10 | 0.62 |
| Distance to public tap (mts) | 332 | 130 | 157 | 0.05 | 280 | 149 | 175 | 0.09 |
| Main source of water (%): | | | | | | | | |
| Connected to p. tap (hose) | 332 | 0.20 | 0.12 | 0.07 | 280 | 0.00 | 0.00 | . |
| Public tap (containers) | 332 | 0.37 | 0.39 | 0.78 | 280 | 0.47 | 0.44 | 0.72 |
| Neighbor | 332 | 0.40 | 0.45 | 0.34 | 280 | 0.50 | 0.52 | 0.76 |
| Other | 332 | 0.03 | 0.03 | 0.78 | 280 | 0.03 | 0.04 | 0.89 |
| Storage water (%) | 329 | 0.85 | 0.85 | 0.97 | 277 | 0.81 | 0.83 | 0.70 |
| N. times fetch water in 7 days: | | | | | | | | |
| Adults | 332 | 3.63 | 3.71 | 0.89 | 280 | 4.26 | 3.88 | 0.58 |
| Male adults | 332 | 2.46 | 2.40 | 0.90 | 280 | 2.86 | 2.49 | 0.49 |
| Female adults | 332 | 2.24 | 2.01 | 0.62 | 280 | 2.68 | 2.14 | 0.34 |
| Children 8-14 | 332 | 1.01 | 0.66 | 0.22 | 280 | 1.19 | 0.72 | 0.15 |
| Children <=7 | 332 | 0.01 | 0.03 | 0.46 | 280 | 0.02 | 0.03 | 0.74 |
| Water use in the last 7 days: | | | | | | | | |
| Volume (liters) | 316 | 0.44 | 0.47 | 0.79 | 265 | 0.42 | 0.37 | 0.54 |
| Payment (dirhams) | 325 | 25.40 | 31.45 | 0.42 | 274 | 31.20 | 35.82 | 0.60 |
| Report enough water | 332 | 0.73 | 0.65 | 0.15 | 280 | 0.72 | 0.66 | 0.29 |
| Report water problem | 326 | 0.31 | 0.36 | 0.36 | 274 | 0.28 | 0.35 | 0.21 |

Table 2: First Stage and Diarrhea Results - Experimental Data

| | Piped Water at Home (1st Stage) | | Diarrhea Rate | |
|---|---|---|---|---|
| | (1) | (2) | (1) | (2) |
| ***Panel A. Total Effect*** | | | | |
| Treatment | 0.614*** | 0.608*** | 0.068 | 0.046 |
| | (0.059) | (0.067) | (0.125) | (0.115) |
| Mean Control Group | 0.197 | | 0.229 | |
| Number of observations | 332 | 332 | 296 | 296 |
| R2 | 0.374 | 0.375 | 0.001 | 0.039 |
| ***Panel B. Effect by Connection to the Public Tap*** | | | | |
| treatment Assigned to Treatment Group | 0.608*** | 0.614*** | 0.128 | 0.126 |
| | (0.067) | (0.062) | (0.135) | (0.125) |
| treatmentpublictap | 0.055 | 0.047 | -0.421 | -0.486 |
| | (0.137) | (0.137) | (0.304) | (0.300) |
| _cons | 0.195 | | 0.213 | |
| Number of observations | 332 | 332 | 296 | 296 |
| R2 | 0.375 | 0.387 | 0.011 | 0.048 |

Note: Control variables include assets index, number of kids age 7 or younger, number of kids age 8 to 14, distance and whether the household was connected to the nearest public tap. Standard errors are clustered at cluster level.
Note: *** p<0.01, ** p<0.05, * p<0.1

Table 3: Results on BMI-for-Age and Obesity Rates - Experimental Data

| | Standardized BMI-for-Age | | | | Obesity Rate | | | |
|---|---|---|---|---|---|---|---|---|
| | **ITT** | | **2SLQ** | | **ITT** | | **2SLQ** | |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(1)** | **(2)** | **(3)** | **(4)** |
| ***Panel A. Total Effect*** | | | | | | | | |
| Treatment | -0.080 | -0.108 | -0.131 | -0.173 | -0.074* | -0.085** | -0.121* | -0.136** |
| | (0.128) | (0.126) | (0.208) | (0.203) | (0.039) | (0.042) | (0.065) | (0.068) |
| Mean Control Group | 0.045 | | 0.071 | | 0.177 | | 0.201 | |
| Controls | | X | | X | | X | | X |
| Observations | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 |
| R2 | 0.002 | 0.015 | 0.004 | 0.015 | 0.012 | 0.025 | . | . |
| ***Panel B. Effect by Connection to the Public Tap*** | | | | | | | | |
| Treatment x Not Connected to Public Tap | -0.139 | -0.176 | -0.229 | -0.280 | -0.088** | -0.098** | -0.144** | -0.159** |
| | (0.142) | (0.141) | (0.234) | (0.231) | (0.043) | (0.045) | (0.072) | (0.075) |
| Difference in | 0.332 | 0.394 | 0.520 | 0.603 | 0.080 | 0.086 | 0.133 | 0.139 |
| | (0.318) | (0.318) | (0.492) | (0.485) | (0.111) | (0.111) | (0.171) | (0.168) |
| Mean Control Group Not Connected to Public Tap | 0.092 | | 0.137 | | 0.186 | | 0.215 | |
| Controls | | X | | X | | X | | X |
| Observations | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 |
| R2 | 0.006 | 0.020 | 0.008 | 0.017 | 0.014 | 0.035 | . | . |

Note: Control variables include assets index, number of kids age 7 or younger, number of kids age 8 to 14, distance and whether the household was connected to the nearest public tap. Standard errors are clustered at cluster level.

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 4: Difference in Difference - With Data from Baseline

| | **Standardized BMI-for-Age** | | **Obesity Rate** |
|---|---|---|---|
| | **DiD** | | **DiD** |
| | **coef/se** | | **coef/se** |
| Treatment | 0.045 | Treatment | -0.081 |
| | (0.210) | | (0.074) |
| After | -0.191 | After | -0.000 |
| | (0.182) | | (0.053) |
| Treatment Group | -0.247 | Treatment Group | 0.018 |
| | (0.190) | | (0.062) |
| Mean Control Group Baseline | 0.260* | Mean Control Group Baseline | 0.128*** |
| | (0.138) | | (0.046) |
| Number of observations | 218 | Number of observations | 218 |
| R2 | 0.020 | R2 | 0.010 |

note: *** p<0.01, ** p<0.05, * p<0.1

note: *** p<0.01, ** p<0.05, * p<0.1

Table 5: Summary Statistics - Longitudinal Data

| | Total | | Piped Water at Home | |
|---|---|---|---|---|
| | | | With | Without |
| | Obs. | Mean | Mean | Mean |
| Age (in years) | 5,496 | 15.02 | 15.47 | 14.94 |
| | | (2.99) | (3.02) | (2.98) |
| Male (%) | 5,496 | 52% | 56% | 52% |
| | | (0.50) | (0.50) | (0.50) |
| Height (in cm) | 5,496 | 147.54 | 151.68 | 146.84 |
| | | (13.04) | (12.18) | (13.05) |
| Weight (in kg) | 5,496 | 40.21 | 44.12 | 39.55 |
| | | (11.81) | (12.81) | (11.50) |
| Body Mass Index (BMI) | 5,496 | 18.05 | 18.81 | 17.92 |
| | | (3.02) | (3.54) | (2.91) |
| BMI-for-age | 5,496 | -0.89 | -0.68 | -0.92 |
| | | (1.06) | (1.21) | (1.03) |
| Overweight (%) | 5,496 | 5% | 8% | 4% |
| | | (0.21) | (0.28) | (0.19) |
| Obesity (%) | 5,496 | 1% | 3% | 1% |
| | | (0.09) | (0.16) | (0.08) |
| Underweight (%) | 5,496 | 14% | 12% | 14% |
| | | (0.34) | (0.32) | (0.35) |
| Diarrhea (%) | 5,496 | 86% | 86% | 86% |
| | | (0.35) | (0.35) | (0.35) |
| Urban (%) | 5,497 | 72% | 96% | 67% |
| | | (0.45) | (0.19) | (0.47) |
| Piped water at home (%) | 5,497 | 17% | 100% | 0% |
| | | (0.38) | (0.00) | (0.00) |
| Piped water anywhere (%) | 5,497 | 38% | 100% | 25% |
| | | (0.49) | (0.00) | (0.43) |
| Mother fetched water 1st. Round (%) | 5,497 | 40% | 29% | 42% |
| | | (0.49) | (0.45) | (0.49) |
| Min. p/week m. fetched water 1st. Round | 3,521 | 116.25 | 101.58 | 118.72 |
| | | (106.30) | (85.04) | (109.30) |
| No store at a walking distance (%) | 5,497 | 61% | 49% | 64% |
| | | (0.49) | (0.50) | (0.48) |
| Standardized family income | 5,497 | 0.26 | 0.87 | 0.13 |
| | | (1.09) | (1.38) | (0.97) |
| Food outside the home (grs/day) | 5,497 | 282.48 | 366.27 | 265.02 |
| | | (262.04) | (289.06) | (252.61) |
| Home-made food (grs/day) | 5,495 | 642.95 | 650.33 | 641.40 |
| | | (335.83) | (345.02) | (333.89) |
| Soft drinks (mls/day) | 5,497 | 64.46 | 92.20 | 58.67 |
| | | (122.58) | (143.00) | (117.06) |

Table 6: Results on Consumption (1) - Longitudinal Data

| | **Food outside the home (grs/day)** | **Soft drinks (mls/day)** | **Home-made food (grs/day)** | **Total Food food (grs/day)** |
|---|---|---|---|---|
| ***Panel A. Total Effect*** | | | | |
| Piped water inside home or yard | -40.092** | -11.800 | 12.077 | -28.606 |
| | (18.376) | (9.192) | (20.459) | (26.531) |
| Number of observations | 5,497 | 5,497 | 5,495 | 5,442 |
| R2 | 0.117 | 0.161 | 0.159 | 0.233 |
| ***Panel B. Effect by Diarrhea Prevalence in the Baseline*** | | | | |
| HH has piped water inside home or yard | -42.372** | -17.158* | 4.508 | -41.725 |
| | (19.625) | (9.688) | (22.821) | (29.151) |
| Piped water inside home or yard x no diarrhea | 15.376 | 36.500 | 51.596 | 89.202 |
| | (54.198) | (27.803) | (47.747) | (68.523) |
| Number of observations | 5,497 | 5,497 | 5,495 | 5,442 |
| R2 | 0.117 | 0.161 | 0.159 | 0.234 |

Note: regressions include individual FE, year FE, Barangay FE and controls for population density, family income and number of children.
Note: *** p<0.01, ** p<0.05, * p<0.1

Table 7: Results on Body Mass Index and Overweight Rate- Longitudinal Data

| | **Std BMI-for-age** | **Obesity Rate** |
|---|---|---|
| ***Panel A. Total Effect*** | | |
| Piped water inside home or yard (lag) | 0.007 | 0.001 |
| | (0.050) | (0.003) |
| Number of observations | 5,496 | 5,496 |
| R2 | 0.141 | 0.032 |
| ***Panel B. Effect by Diarrhea Prevalence in the Baseline*** | | |
| Piped water inside home or yard (lag) | -0.206** | -0.011* |
| | (0.102) | (0.006) |
| Piped water inside home or yard x diarrhea (lag) | 0.247** | 0.013* |
| | (0.117) | (0.007) |
| Number of observations | 5,496 | 5,496 |
| R2 | 0.142 | 0.032 |

Note: regressions include individual FE, year FE, Barangay FE and controls for population density, family income and number of children.
Note: *** p<0.01, ** p<0.05, * p<0.1

Table 8: Sensitivity Analysis -Results on Food Consumption - Longitudinal Data

| | Food outside the home (grs/day) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| HH has piped water inside home or yard | 99.187*** | 0.628 | -32.571* | -40.143** | -40.035** | -41.164** | -42.372** |
| | (11.075) | (17.990) | (18.565) | (19.668) | (19.681) | (19.664) | (19.625) |
| Piped water inside home or yard x no diarrhea | 14.543 | 33.938 | 31.043 | 12.841 | 12.829 | 16.192 | 15.376 |
| | (30.520) | (49.439) | (50.911) | (53.788) | (53.822) | (54.027) | (54.198) |
| Individual FE | | X | X | X | X | X | X |
| Year FE | | | X | X | X | X | X |
| Barangay FE | | | | X | X | X | X |
| Controls | | | | | X | X | X |
| Number of observations | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 |
| R2 | 0.021 | 0.000 | 0.077 | 0.115 | 0.115 | 0.116 | 0.117 |

| | Soft drinks (mls/day) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| HH has piped water inside home or yard | 30.451*** | 9.908 | -12.616 | -16.541* | -16.791* | -16.652* | -17.158* |
| | (5.149) | (9.386) | (9.314) | (9.666) | (9.679) | (9.707) | (9.688) |
| Piped water inside home or yard x no diarrhea | 22.147 | 23.808 | 23.648 | 36.308 | 36.512 | 36.985 | 36.500 |
| | (14.260) | (29.250) | (27.509) | (27.692) | (27.637) | (27.653) | (27.803) |
| Individual FE | | X | X | X | X | X | X |
| Year FE | | | X | X | X | X | X |
| Barangay FE | | | | X | X | X | X |
| Controls | | | | | X | X | X |
| Number of observations | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 |
| R2 | 0.011 | 0.001 | 0.132 | 0.159 | 0.160 | 0.161 | 0.161 |

Note: Control variables population density, family income and number of children are added one by one in regressions 5 to 7.
Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 9: Sensitivity Analysis -Results on Obesity Rates - Longitudinal Data

| | Std BMI-for-age | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| Piped water inside home or yard (lag) | -0.010 | -0.058 | -0.150 | -0.198* | -0.197* | -0.210** | -0.206** |
| | (0.160) | (0.100) | (0.103) | (0.105) | (0.105) | (0.103) | (0.102) |
| Piped water inside home or yard x diarrhea (lag) | 0.283 | 0.196* | 0.188 | 0.225* | 0.225* | 0.246** | 0.247** |
| | (0.172) | (0.113) | (0.115) | (0.119) | (0.119) | (0.117) | (0.117) |
| Individual FE | | X | X | X | X | X | X |
| Year FE | | | X | X | X | X | X |
| Barangay FE | | | | X | X | X | X |
| Controls | | | | | X | X | X |
| Number of observations | 5,496 | 5,496 | 5,496 | 5,496 | 5,496 | 5,496 | 5,496 |
| R2 | 0.007 | 0.003 | 0.099 | 0.135 | 0.135 | 0.142 | 0.142 |

note: *** p<0.01, ** p<0.05, * p<0.1

| | Obesity Rate | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| Piped water inside home or yard (lag) | 0.021 | -0.026 | -0.026 | -0.011* | -0.011* | -0.011* | -0.011* |
| | (0.015) | (0.018) | (0.018) | (0.006) | (0.006) | (0.006) | (0.006) |
| Piped water inside home or yard x diarrhea (lag) | -0.002 | 0.026 | 0.027 | 0.013* | 0.013* | 0.013* | 0.013* |
| | (0.017) | (0.018) | (0.018) | (0.007) | (0.007) | (0.007) | (0.007) |
| Individual FE | | X | X | X | X | X | X |
| Year FE | | | X | X | X | X | X |
| Barangay FE | | | | X | X | X | X |
| Controls | | | | | X | X | X |
| Number of observations | 5,496 | 5,496 | 5,496 | 5,496 | 5,496 | 5,496 | 5,496 |
| R2 | 0.005 | 0.001 | 0.003 | 0.030 | 0.031 | 0.032 | 0.032 |

Note: Control variables population density, family income and number of children are added one by one in regressions 5 to 7.
Note: *** p<0.01, ** p<0.05, * p<0.1

## Table 10: Placebo Regressions- Longitudinal Data

| | Lag Food outside the home (grs/day) | Lag Soft drinks (mls/day) | | Lag Std BMI-for-age | Lag Obesity Rate |
|---|---|---|---|---|---|
| ***Panel A. Total Effect*** | | | | | |
| HH has piped water inside home or yard | 33.651 | -15.036 | HH has piped water inside home or yard | 0.006 | 0.000 |
| | (27.377) | (11.680) | | (0.046) | (0.001) |
| Number of observations | 3,420 | 3,423 | Number of observations | 5,397 | 5,398 |
| R2 | 0.133 | 0.248 | R2 | 0.097 | 0.059 |
| ***Panel B. Effect by Diarrhea Prevalence in the Baseline*** | | | | | |
| HH has piped water inside home or yard | 20.015 | -11.053 | HH has piped water inside home or yard | -0.005 | -0.000 |
| | (29.657) | (12.628) | | (0.088) | (0.001) |
| Piped water inside home or yard x no diarrhea | 120.646* | -37.101 | Piped water inside home or yard x diarrhea | 0.013 | 0.000 |
| | (66.772) | (27.976) | | (0.101) | (0.001) |
| Number of observations | 3,420 | 3,423 | Number of observations | 5,397 | 5,398 |
| R2 | 0.134 | 0.249 | R2 | 0.097 | 0.059 |

Note: regressions include individual FE, year FE, Barangay FE and controls for population density, family income and number of children.
Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

# ONLINE APPENDIX

Table 11: Balance Check - Experimental

**Children Age 0-7**
**(Without eliminating BIV)**

| | Obs. | Control Group | Treat. Group | P-Val |
|---|---|---|---|---|
| Age | 151 | 2.97 | 3.03 | 0.81 |
| Age (Endline) | 377 | 3.33 | 3.43 | 0.58 |
| Female (%) | 151 | 0.58 | 0.48 | 0.21 |
| Female (%) (Endline) | 375 | 0.17 | 0.19 | 0.58 |
| Height | 151 | 92.70 | 93.15 | 0.84 |
| Weight | 151 | 14.40 | 14.34 | 0.91 |
| BMI | 151 | 16.93 | 16.45 | 0.21 |
| BMI-for-age | 151 | 0.85 | 0.54 | 0.17 |
| Underweight (%) | 151 | 0.00 | 0.01 | 0.35 |
| Overweight (%) | 151 | 0.41 | 0.31 | 0.22 |
| Obesity (%) | 151 | 0.15 | 0.18 | 0.74 |
| Extreme Obesity (%) | 151 | 0.07 | 0.04 | 0.37 |
| Num. adults | 377 | 2.98 | 3.28 | 0.08 |
| Num. children 8-14 | 375 | 0.98 | 0.85 | 0.25 |
| Num. children <=7 | 377 | 1.88 | 1.57 | 0.00 |
| Num. children <=7 (EL) | 377 | 1.96 | 1.83 | 0.15 |
| Head male (%) | 377 | 0.88 | 0.92 | 0.25 |
| Head age | 360 | 42.62 | 42.33 | 0.79 |
| Head married (%) | 377 | 0.92 | 0.90 | 0.53 |
| Head no education (%) | 377 | 0.31 | 0.30 | 0.89 |
| Head's education att. | 320 | 3.20 | 3.47 | 0.52 |
| Head's income (dirhams) | 377 | 1178 | 1201 | 0.83 |
| Family income (dirhams) | 377 | 1542 | 1630 | 0.52 |
| Working for pay (%) | 377 | 0.20 | 0.21 | 0.88 |
| Adults working for pay (%) | 375 | 0.39 | 0.37 | 0.39 |
| Assets score | 375 | 0.41 | 0.01 | 0.03 |
| Num. rooms | 373 | 3.17 | 3.35 | 0.21 |
| Permanent house (%) | 375 | 0.86 | 0.89 | 0.47 |