The Effect of Piped Water at Home on Childhood Overweight Rate. Experimental

Evidence from Urban Morocco.

Patricia I. Ritter*

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Abstract

Obesity is a global epidemic costing billions of dollars and millions of deaths. The most cost-effective interventions are those that target children, aiming to prevent obesity rather than to reverse it later in life. Roughly 79% of overweight children under five live in middle-income countries, where only about half of the households have access to piped water at home. This study finds evidence that access to piped water at home reduces significantly children's BMI and overweight rates. Back-of-envelope calculations suggest that this benefit alone does not render this type of intervention cost-effective, but adds significantly to other potential benefits.

Keywords: obesity; piped water; childhood; developing countries.

JEL Classification: I12, I18, H41, O12

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*Department of Economics, University of Connecticut. 365 Fairfield Way, Unit 1063. Storrs, CT 06269-1063. E-mail: patricia.ritter@uconn.edu. I am grateful to Jorge Aguero, Talia Bar, Dan Bennett, Dan Black, Kristin Butcher, Kerwin Charles, David Meltzer and Ioana Marinescu, and participants at the at the American Economic Association 2019 Meeting, the International Health Economics Association 2019 Conference and the Northeast Universities Development Consortium 2018 Conference, for their valuable comments and suggestions. I am also greatful to Ricardo Sanchez for his research assistance. Finally, a special thanks to Florencia Devoto, Esther Duflo, Pascaline Dupas, William Parienté, and Vincent Pons for making the experimental data and code publicly available.

1 Introduction

Obesity is a global epidemic that is costing billions of dollars to many countries around the world and leads to approximately four millions deaths per year (Shekar and Popkin, 2020). The most cost-effective interventions are those who target children by preventing preventing obesity among children rather than attempting to reverse it once they become adults (Cawley, 2010). As of 2016, approximately 6% of children under five and 20% of children between ages 5 to 19 worldwide were overweight or obese, respectively. Of these, 79% live in middle-income countries (Shekar and Popkin, 2020). At the same time, while only about 9% of the world population does not have access to improved water sources (Ritchie and Roser, 2020), approximately half of households in middle-income countries do not have access to piped water at home (WHO, 2016*a*). These households spend considerable time fetching water and/or buy it from private sources, sometimes paying up to fifty times as much as as they would for piped utility water (Mitlin et al., 2019; UNESCO, 2019). This study investigates whether access to piped water at home can contribute to the fight against childhood obesity in these countries.

Access to drinking water at home can affect children's BMI and overweight rate through several channels; first, it reduces the cost of drinking water, cooking and washing dishes relative to drinking and eating food prepared outside the home. Food prepared outside the home, including food from street vendors, fast food, sodas and snacks tend to have a higher calorie content than home-made food. Second, the reduction in walking and carrying water generates a reduction in energy expenditure. While young children are not typically in charge of fetching water, older children sometimes are. Third, the reduction in time fetching water frees up time that can be invested in the health of adults and children, for example by cooking more and consuming less food prepared outside the home. Fourth, access to piped water at home typically implies a high initial investment and/or monthly payments, and this decrease in available income can lead to a change in the total consumption of food and/or in the type of food. Fifth, access to drinking water at home can reduce tension and stress by reducing the burden of collecting water , and a reduction in the stress can reduce overeating and fat accumulation (Daubenmier et al., 2011). Finally, access to drinking water at home can affect BMI indirectly through a reduction in diarrheal prevalence since diarrhea reduces calorie absorption (Brown, 2003).

To estimate the causal effect of access to piped water at home on children BMI and overweight rates is not an easy task, for a couple of reasons. First, access to piped water at home is typically not randomly assigned; households with and without access to piped water at home are different in many dimensions that can be correlated with BMI and overweight rates. Second, even if we estimate the causal effect of access to piped water on BMI and overweight rates, we might not be able to disentangle the effect of changes in the calorie intake or energy expenditure on BMI from the effect of changes in diarrheal prevalence on BMI. It is valuable to disentangle these two effects, because they can cancel each other out, making it 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; a child with normal BMI driven by the offsetting effects of a diet high in calories and chronic diarrhea is likely significantly less healthy than a child that achieves a normal BMI through a good balance between calorie intake and physical activity.

This study examines the effect of access to piped water at home on children's BMI and overweight. The data comes from an intervention carried out by Devoto et al. (2012) in the city of Tangiers, Morocco. The intervention consisted of information about, and assistance with, application for a loan used to connect homes to the water supply. Devoto et al. (2012) found that households were willing to pay a substantial amount of money to have a private tap at home, which in turn decreased their available income but provided them with extra free time. They found no effect on labor supply, or on school participation, but they did find that that having a connection to piped water at home increased time spent in leisure and social activities, and reduced stress. 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 overweight rates. This context is ideal for the analysis undertaken in this study because it makes it possible to estimate the direct effect on BMI, isolated from the potential effect of diarrhea on BMI. Additionally, the overweight rate for children under five years of age in Morocco is one of the highest in the world, surpassing the US and Mexico (WHO, 2016*b*).

I find that access to piped water at home decreases BMI-for-age (BMIz) by 0.37 standard deviations and overweight rates by 16 percentage points, among children age five or younger. While the magnitude of the estimates is large, so are the confidence intervals of my estimates. Thus, the precise point estimates are not as informative as the sign of the effects. Additionally, back-of-envelop calculations show my highest point estimate of the increase in BMI requires approximately an increase of only 79 calories per day. The equivalent of half a can of soda or a Chebakia (a Moroccan street cookie). An effect of this magnitude on food consumption seems plausible.

I further find evidence suggesting the effects of access to piped water at home on BMI and overweight rates are mainly driven by a reduction in the variable cost of obtaining water, both in terms of money and time, and by gains in available time at home. On the other hand, gains in available time to carry out activities outside the home and the reduction in stress related to water problems and other potential benefits of obtaining a formal and permanent connection to the water network at home seem to play little role in the effects on children's BMI and overweight rate. Likewise, the reduction in available income due to the installment payments does not seem to be a main driver of the effects on children's BMI and overweight rate. This finding is informative for policy making, since it suggests that we could expect similar results from projects that not only help finance, but also directly subsidize the cost of getting access to piped water at home.

The results of this paper provide causal evidence that access to piped water at home can contribute to the prevention of childhood overweight and obesity in middle-income countries. The provision of piped water at home requires an expensive investment in most settings and my back-of-envelope calculation suggests that the benefit on childhood overweight alone is not enough to make this a cost-effective intervention. However, it adds significantly to other potential benefits of providing piped water at home and policy makers should take this into account.

2 Related Literature

There is an important body of literature related to the potential effect of access to piped water at home on BMI and overweight rates. First of all, there is evidence that drinking water facilitates weight loss by increasing the sensation of fullness, which in turn leads to lower meal energy intake (Dennis et al., 2010; Stookey et al., 2008). On the contrary, liquid carbohydrates, like sodas, show little compensatory dietary response, meaning that individuals who consume them do not offset the corresponding increase in calorie intake by reducing their consumption of other caloric foods (DiMeglio, Mattes et al., 2000). Elbel et al. (2015) and Schwartz et al. (2016) find that the installation of water jets in New York City public elementary and middle schools was associated with a three-fold increase in the consumption of water and with some substitution away from milk, and with a modest but significant decrease in BMI and overweight rate. Importantly, well before the installation of water jets, these schools were part of an initiative to improve children's nutritional environment, offering more fruit and vegetables, removing soda from vending machines, and replacing whole milk with low-fat milk (Elbel et al., 2015). Thus, the alternative to water for this sample of children was not as high in calories and sugar content as the alternative to water that is most often available to children.

Access to piped water at home cannot only reduce the monetary and time cost of drinking water but also its health cost; piped water is typically cleaner than water from public sources, so it reduces the likelihood of becoming infected with waterborne pathogens. The reduction in the health cost of drinking water can reduce the consumption of alternatives to water that are typically higher in calories than water. There is important evidence that individuals engage in "avoidance behavior" in relation to contaminated water: Zivin, Neidell and Schlenker (2011) observe an increase in the consumption of bottled water in areas with water quality violations in the US; Keskin, Shastry and Willis (2017) find that mothers breastfeed their children longer to avoid arsenic contamination in Bangladesh; Onufrak et al. (2014) find an association between perceptions of tap water safety and intake of sugar-sweetened beverages among US adults, Ritter (2019*b*) finds evidence suggesting that households without access to piped water at home in Peru substitute contaminated water with soda, reducing diarrhea prevalence but increasing obesity rates and Gutierrez and Rubli (2019) finds evidence suggesting that find evidence that the soda tax in Mexico increased the consumption of contaminated water, increasing diarrhea prevalence.

Access to piped water at home also reduces the monetary and time cost of eating home-made food relative to food prepared outside the home. Individuals, who need to pay elevated sums to obtain water from private sources or spend considerable time fetching water for cooking and washing dishes might find buying food from a street vendor an attractive alternative. In most areas of the world, food prepared outside the home is high in sugar and fats. Deep-fried food, for example, are widely available almost everywhere. Hence, a substitution of consumption of food prepared outside the home for home-made food could reduce BMI. In general, previous studies agree that the obesity epidemic is largely result of a change in the type of food consumed rather than solely 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 cost of food consumption and has led to increases not only in quantity but also to changes in the type of the foods consumed, as in the move from boiled potato to chips and French fries. 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 increased (Cawley, 2015; Wendt and Todd, 2011). There is also evidence of the effect of proximity to, and lower prices of, fast food and super markets on BMI and/or obesity rates Currie et al. (2010); Meltzer and Chen (2011); Courtemanche and Carden (2011), although other studies have found little or no effect Dunn (2010); Anderson and Matsa (2011); Cotti and Tefft (2013).

The extra time made available by the reduction of time spent fetching water can be used to invest in the health of adults and children. Ruhm (2000) find that obesity rates increase when the economy strengthens, while physical activity is reduced and diet becomes less healthy. In a study of women in the US, Anderson, Butcher and Levine (2003) find that maternal employment increases the probability of overweight children. Courtemanche, Tchernis and Zhou (2017) finds that longer parental work hours lead to larger increases in children's BMI z-scores and probabilities of being overweight and obese. About the mechanisms, studies have found that more hours working increase children's weight by reducing supervision and nutrition (Fertig, Glomm and Tchernis, 2009), by spending less time cooking and eating with children, and by purchasing more prepared foods (Cawley and Liu, 2012).

The investment necessary to obtain piped water at home can also decrease available income. In general, it is believed that the relationship between income and BMI follows a U-shape: additional income increases BMI for lower levels of income but reduces BMI for non- poor individuals (Lakdawalla, Philipson and Bhattacharya, 2005). Akee et al. (2013) find that cash transfers increased BMI and obesity rates significantly more for poorer households, while other studies have find no effect (Cawley, Moran and Simon, 2010) or negative effects (Lindahl, 2005).

Access to drinking water at home can reduce tension and stress, by reducing the burden of collecting water (Devoto et al., 2012). A reduction in the stress at home can reduce children's BMI and overweight rates, since stress is associated with overeating, even among young children (Michels et al., 2012). Additionally, elevated cortisol concentrations increases fat accumulation (Daubenmier et al., 2011).

There is also evidence that improvements in water quality increases BMI through its effect on diarrhea prevalence (Kremer et al., 2011; Zhang, 2012).Diarrheal diseases do not affect calorie intake directly but they do reduce calorie absorption (Brown, 2003). Access to drinking water at home also may reduce diarrhea prevalence, since piped water is typically cleaner than water from other sources, and can thus, increase BMI.

Finally, the study closest to this is Ritter (2019*a*); exploiting longitudinal data from the city of Cebu, the Philippine, she finds evidence that access to piped water at home decreases BMI among children ages 10 to 19 by 0.21 standard deviations, and obesity rates by 1 percentage point, but only among children with no history of diarrhea. Among children with a history of diarrhea, the effect of access to piped water on BMI is positive and insignificant, suggesting that among these children the effect of access to piped water on diarrhea, and consequently on BMI, might offset the direct effect on BMI. Another interesting result arising from this paper is that access to piped water at home seems to reduce consumption of food prepared outside the home by approximately 40 grams per day or 14%. The empirical strategy applied in her paper is not robust enough to claim causality but it provides important suggestive evidence about the potential effects of access to piped water at home on BMI.

3 Children BMI and its Connection with Adult Obesity

The most commonly used indicator to screen for weight categories is Body Mass Index (BMI): weight in kilograms by the square of the height in centimeters. BMI is relatively easy to measure, is highly correlated with body fat and extreme values of it are associated with poor health (NHS, 2011). Among adults there are universal criteria for defining overweight and obesity; BMI over 25 and over 30, respectively. Among children there is no fixed threshold, because BMI among children varies by age and gender. The typical way to determine whether a child is maintaining a healthy weight is by comparing his or her BMI with that of children from a reference population of the same age and gender. For the purpose of this study, I follow the World Health Organization (WHO) criteria, since their reference population is the more adequate for my sample; WHO uses a reference population drawn from a sample of children from Brazil, Ghana, India, Norway, Oman and USA. To determine whether a child is overweight, one needs to calculate a BMI Z-score for age and gender (BMIz), which is basically a standardization of BMI using the mean and the variance of the reference population [1]. Children ages 0 to 5 with a BMIz greater than 2 (approximately to the 97th percentile) are classified as overweight,

[1] For the exact formula, please, refer to WHO (2006)

and those with a BMIz greater than 3 (approximately to the 99th percentile) are classified as obese. The criteria change for older children and adolescents. Most studies consider a BMI above the 95 percentile an unhealthy BMI and also highly predictive of adult obesity; approximately, a third of overweight children become obese adults (Serdula et al., 1993).

Finally, another important indicator to asses healthy body weight in children and risk of adult obesity is the age of Adiposity Rebound. BMI typically increases in the first year of life, decreases until age 6 or 7, and "rebounds", that is, starts increasing again. Children, who undergo this rebound by the age of 5 experience an "Early Adiposity Rebound" and are significantly more likely to be obese adults (Rolland-Cachera et al., 1984; Whitaker et al., 1998; Siervogel et al., 1991; Williams and Goulding, 2009). Both overweight and EAR can be influenced by children's net calorie intake (Robertson et al., 1999; Ip et al., 2017).

4 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 5 or less since they were the only household members from which anthropometric indicators were taken. The endline also records anthropometric indicators from children age 6 and 7, but since the randomization was stratified only for number of children 5 or less, and since the criteria for classifying a child as overweight and obese is different for children under and above age five, I work only with children age 5 or less. Additionally, I eliminate from the sample observations with biologically implausible values (BIV) of anthropometric indicators, following the World Health Organization guidelines

(WHO, 2006). [2] Figure A1 and Table A1 of the Appendix show the estimations for eliminating BIV following different criteria. The figures and tables reveal that more lenient criteria leave the distribution with very extreme values in particular for the control group, which affects the estimation of the effect on average BMIz but not on the overweight rate, as we would expect. They also reveal that the results are very robust to more stringent trimming criteria. The resulting number of observation in the Endline is 261, corresponding to 140 children, 113 households and 93 clusters in the treatment group and 121 children, 93 households and 86 clusters in the control group.

Weight was measured two times in this sample, therefore, I use the average of these two measurements or the measurement that is not a BIV. Table A2 of the Appendix, shows the estimations are very similar using the different measurements.

5 Balance Check

The first four columns of Table 1 shows the differences between treatment and control group of my sample. I estimate the difference and the t-statistics controlling for baseline stratifying variables and clustering the standard errors. There are no significant difference in the anthropometric indicators, but, unfortunately, there is only anthropometric data of a subsample of the children in the baseline. Neverthe-

[2] A value of height-for-age higher than 6 standard deviations or lower than -6 standard from the reference population is considered and implausible height. Likewise a value of BMI-for-age larger than 5 standard deviations or smaller than -5 standard from the reference population is considered an implausible weight for a given height, age and gender.

less, as we can see in the table, the number of missing observations is not correlated with the treatment and the sample, in general, is very well balanced; there is only one variable, number of children under 15 that is statistically significantly different between the treatment and control group. I will estimate the effect of the treatment controlling for this variable.

The baseline also have anthropometric data for 43 children of whom I do not have data in the Endline, but in this case, this is mostly the result of biological implausible values of BMIz that were eliminated from the sample. Table A3 of the Appendix shows no significant difference in the anthropometric indicators of the "attrition" and the "non-attrition" groups neither in the treatment nor in the control group.

Morocco has one of the highest rates of childhood overweight in the world according to the WHO. This sample is not the exemption: 16% and 6% of the children age 0 to 5 are overweight and obese in the baseline, respectively, and none of the children are underweight. Table 1 also shows the summary statistics of important household variables. By sample design, before the treatment all households are located at a walking distance to a public tap with piped water free of charge but no household in either group had a formal connection of piped water at home. The average distance to the public tap is approximately 130 meters. This distance might not seem too large, but just not having the water in the convenience of the home might make a significant difference. Despite having access to free water at a walking distance, households spend an average of 27 Di per week, or 17 US Dollars per month, buying water from neighbors and water sellers. This is a significant amount of money for households with an average monthly income of 1,504 Di or 210 US Dollars. Table 1 also shows that adults do most of the water fetching, in particular, children age 5 or less seems not to participate in it. Thus, access to water at home should not have an impact on their physical activity.

Some households are located so close to the public tap that they are connected to a public tap, through an informal pipe 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. As we will see later, I also analyze the effect of the treatment on those children whose houses were not connected to the public tap. Thus, Table 2 shows the differences between the treatment and control group of this subsample of children. This subsample is also very well balanced, which is not very surprising given that the randomization was stratified by water source, including whether the household has an informal connection to the public tap. Here again, the only statistically significant difference is in the number of children under 15.

6 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, β_1 could be interpreted as the average treatment effect. In the absence of such an 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.

7 Results - Experimental Evidence

7.1 Main Results

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 the connection to piped water significantly. Table 3 shows the effect of the intervention on the connection to the water network (the first stage), reported access to water, and the number of days in a week with diarrheal episodes. These effects have been previously estimated by Devoto et al. (2012), the purpose here is to confirm the effects for the subsample used in this study. All regressions control for the stratification variables used for the randomization: location, water source, number of households per cluster, number of children 5, for the unbalanced variable: the number of children age 15 or under, and for age, gender and the baseline levels of BMI-for-age. Table A4 of the Appendix shows the estimations without control variables and controlling for different variables for the main results. The control variables used for the randomization and the variable that is unbalanced in the baseline have some effect on my results, as expected. Other control variables merely increase statistical power. Column 1 shows the first stage. We can see that, in fact, the intervention successfully encouraged water connections; 83% of the treatment group established a connection to the water network, while only 22% of the control group did. The F-Statistics associated with the treatment is 88. For the rest of the variables in this table, I first show the Intention-to-Treat (ITT) estimate and then the Second Stage Least Square (2SLS). Columns 2 and 3 show that the treatment also significantly increased the number of households that reported having access to a sufficient supply of water from 88% in the control group to 99% in the treatment group; that is, the intervention successfully eliminated reported water shortages. Finally, columns 4 and 5 show that the intervention had no effect on diarrhea prevalence. Hence, the treatment generated a large increase in the access to piped water at home, without generating any change in the diarrhea prevalence of the individuals. This provides me with an ideal scenario to investigate the effect of access to piped water at home on BMI, while holding constant the potential effect of diarrheal diseases on BMI.

Table 4 reveals the effect of the intervention on the time and monetary costs of obtaining water. Column 1 shows that the intervention essentially eliminated the time households spent fetching water; this effect implies additional 70 minutes every three days. According to the SLS, connection to the water network freed up 116 minutes every three days, that is, approximately 39 minutes per day to spend on other activities. Following Devoto et al. (2012), I also estimate the effect on monthly water expenditure but distinguishing the installment payments from the consumption expenditure. For the purposes of this paper, this distinction is important because as we can see, while the installment payments are greater for the treatment group, as expected, the monthly expenditure of water consumption is lower, although not significantly. Considering that the results showed above suggest that the treatment increased the quantity of water consumed, this result implies that the price per gallon of water decreased. This result is not surprising and coincides with a vast literature suggesting that in urban areas, households without piped water at home pay a much higher price for water from private sources than households that pay for piped utility water.

Table 5 presents the effect of the treatment on BMI-for-age, overweight rate and obesity rate on children age 5 or less. Table A4 of the Appendix shows the estimations controlling for other control variables and without control variables. The first columns show the Intention-to-Treat (ITT) estimates. For an easier interpretation of my results, after calculating the overweight rate, 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. We can see that the treatment reduced BMI-for-age by 0.23 standard deviations. As expected, the 2SLS estimates are similar but larger in magnitude: access to piped water at home reduced BMI-for-age by 0.37 standard deviations. The treatment also reduced the overweight rate by 10 percentage points, while according to the 2SLS, access to the piped water at home reduced the overweight rate by 16 percentage points. Columns 5 and 6 show that there are no significant effects on obesity rates. Figure 1 displays the effect of the effect of treatment on the distribution of BMI-for-age. The graph illustrates what we saw in the results: the distribution of the treatment group is shifted to the left of the control group.

In order to better understand where the effect on BMI comes from, Table 6 shows the effects of the treatment separately on standardized weight-for-age and on standardized height-for-age. Again, for an easier interpretation of my results, I standardized these measures so that they represent the standardized deviation of a child's weight and height from the median value of my sample, rather than from the median value of a reference population. These results are reassuring in several ways; first, they tell us that the effect on BMI comes from a reduction in the weight of children and not from an increase in their height, which is reasonable, given that while the treatment had the potential to affect the weight of all children, height is rarely affected after age two (Ruel and Hoddinott, 2008). This result is also informative, because it tells us that the treatment has decreased, not increased, the net-calorie intake; second, it is reassuring to see that the effect on weight and height are not in opposite directions, since a changes in the calorie intake should affect weight and height (at least up to age two) in the same direction. Finally, it is good news that the increase in calorie intake has reduced BMI and overweight rate but not height-for-age, since height-for-age is a positive indicator of the nutritional status of the children. In the same line, Table 6 also shows that the treatment had no significant impact on underweight rate, which is also good news.

7.2 Heterogeneous Effects and Potential Channels

In this section, I compare the effects of the program on households that were informally connected to the public tap before the program with those that were not. The intervention should have affected these two groups of households differently, in particular, because the intervention should have significantly increased and not reduced the cost of obtaining water for those households that had an informal connection to the public tap that provided water free of charge.

Table 7 shows that there was little difference in the take up of the intervention of the two groups and therefore in the installment payments between the two types of households, but while the monthly water expenditure did not increase for households that were not informally connected to the public tap before the program, it did so, as expected, for households that were informally connected to the public tap before the program. Tables A5 of the Appendix shows the estimations without control variables and controlling for different variables for the main results. Columns 6 and 7 also reveal that the increase in the reported access to water was concentrated only in households that were not informally connected to the public tap before the program. If the treatment increased the quantity of water consumed but not the monthly cost, these results imply that the price per gallon of water decreased for households that were not informally connected to the public tap before the program, and vice-versa for households that were informally connected to the public tap before the program.

Table 8 shows that the reduction in the time fetching water was also larger for households that were not informally connected to the public tap before the program, but the difference is not statistically significant and the effect is not purely concentrated among these households. Households that were informally connected to the public tap before the program did also benefit from additional time because the connection was not permanent. So many households still needed to walk to the public tap to connect the pipe and then fill containers of water at home. Naturally, their walking distance was shorter and they did not have to transport the containers from the public tap to the house. Moreover, since they could fill the containers at home, they could also do other household chores, such as cooking, while doing this. Table 8 reveals, in fact, that only households that were not informally connected to the public tap before the program reported gains in time for housework and for activities at home, in general, while the difference in time gained for activities outside the home is positive and not statistically significant, as we can see in Table 9. There may have been other benefits for households informally connected to the public tap before the program as well; for example, since the informal pipes were likely illegal, they might have worried about fines or problems with the authorities. Columns 3 and 4 show that the effect of obtaining a private, formal, and permanent connection to the water network reduced the percentage of houses declaring water to be a problem for the household, and the effect is not statistically different between both types of households. Columns 5 and 6 also show similar increases for both types of households in terms of life satisfaction.

Finally, Table 10 shows that the effects on BMI and overweight rate are concentrated among children of households that were not informally connected to the public tap. Figure 2 shows the effect of the treatment on the distribution of the BMIz of children who did not have access to piped water at home in the baseline. Again we can see that the distribution of the treatment group is shifted to the left of the control group. This evidence suggests that the effects on BMI and overweight rates are mainly driven by a reduction in the variable cost per gallon of water, both in terms of money and time, and by gains in available time at home, in particular for household chores. On the other hand, gains in available time to carry out activities outside the home and the reduction in stress related to water problems and other potential benefits of obtaining a *formal* connection to water do not seem to play an important role in the effects on children BMI and overweight rate. Likewise, the reduction in available income due to the installment payments does not seem to be a main driver of the effects on BMI and overweight rate. This finding is informative for policy making, since it suggests that we could expect similar results from projects that not only finance, but also subsidize the cost of getting access to piped water at home.

7.3 Magnitude of the Estimate and Back-of-Envelope Calculation

One possible concern about my results is that the point estimates are large in magnitude. Aside from the facts that first, the confidence intervals are large as well, and so, the point estimates might not be as informative as the sign of the effects, and second, that this is a particular sample with very large prevalence of childhood overweight rate, there is one important reason why large effects could be expected in this context. As explained above, increases in the energy intake of children of this age may not only increase BMI-for-age, but also increase the probability of an "Early Adiposity Rebound" (Robertson et al., 1999; Ip et al., 2017). Early Adiposity Rebound happens when children's BMI start to increase before age 5, while a Normal Adiposity Rebound typically occurs around age 6 or 7. Hence, the intervention might have prevented EAR among the children in the treatment group. This would mean that the difference in BMIz and overweight rate will shrink as those children in the treatment group experience their AR later on and its BMI starts to increase. The difference, however, would not disappear completely, since there is significant evidence that EAR is predictive of adult obesity (Rolland-Cachera et al., 1984; Whitaker et al., 1998; Siervogel et al., 1991; Williams and Goulding, 2009). Unfortunately, the intervention did not collect several waves of data so that I could directly test whether the treatment delayed AR.

Even without considering the potential effect on EAR, our estimated effects are plausible, as we will see with a back-of-envelope calculation. This is so because, contrary to popular belief, it requires only a small increase in the consumption of calories to bring about large changes in overweight rates. As Cutler, Glaeser and Shapiro (2003) illustrate, 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 in the US between 1965 and 1995 (an increase of 10-12 pounds on the average American). 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 for obesity and overweight rates to 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 of a change in diet on body weight happens during the first year and 95% happens within three 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 takes only a few calories and a relatively short period of time to see large effects on BMI and, in particular, on overweight rates.

In this study, I obtain the highest point estimate for households that are not connected to the public tap; access to piped water at home decreases overweight rate by 20 percentage points and BMI-for-age by 0.48 standard deviations, which corresponds to a decrease of 1.6 pounds[3]. Applying the rule of thumb established by Hall et al. (2011)[4] and assuming that after five months, 21% of the potential effect has occurred, such an increase in weight would require an increase of 79 calories per day. The equivalent of half a can of soda or a Chebakia (a Moroccan street cookie). An effect of this magnitude on food consumption seems plausible.

8 Cost-Effectiveness

A final and important question is whether the benefits associated with reducing childhood overweight rates are large enough to render this type of investment cost-effective. To answer this question, I make another back-of-envelope calculation to estimate a Cost-effectiveness ratio (CER): $(C-A)/Q$, where C stands for the cost of the program, A stands for the averted health care costs of adult obesity and Q stands for the quality- adjusted life years (QALYs) saved. The costs averted and

[3] The estimation on weight is obtained by running the same regression as for BMI-for-age but including also age and height as control variables.

[4] This rule of thumb is based on an estimation made for adults, but to the best of my knowledge, there is no similar estimation made for children.

QALYs saved were calculated over a period of 25 years, from 40 to 65 years of age, and were discounted at an annual rate of 3%, following Wang et al. (2003); Brown et al. (2007). The cost of the intervention was between US $540 and US $1,340 per household; hence, I assume a cost of US $940. For the benefit, I consider only the averted health care costs for adult obesity. Approximately, 30% of overweight children (under the definition I am using) under the age of 5 become obese adults (Serdula et al., 1993). The estimated effect of access to piped water at home is a reduction of 18 percentage points in the likelihood of overweight among children under the age of 5, and there are 1.5 children under age 5 per household, on average. The estimations for the annual health care cost of an obese adult range from US $ 2,741 for the USA to US $173 for Brazil (Shekar and Popkin, 2020). The largest, but most reliable estimate is from Cawley and Meyerhoefer (2012), so I use this estimate, weighted for the GDP ratio of the two countries, which leads to US $141 annual health care cost per obese adult. I use the estimated QALY from Brown et al. (2007). Given the estimated effect of the program on overweight rate of the children I obtain a CER of circa US $18,000 per QALY.

We can compare this CER with that of other cost-effective programs (for US standards) designed to reduce childhood overweight: Planet Health and the Coordinated Approach to Child Health (CATCH) intervention, both US programs. These are school-based programs that include special interdisciplinary curricula. CATCH also includes house visits and changes to the school food service. Controlled trials were used to estimate the effect of the programs: Planet Health reduced obesity rates by 5.5 percentage points among middle-school age girls, while CATCH reduced overweight rates by 11 percentage points among girls and 9 percentage points among boys age 8-11. The effects of these programs in terms of overweight are smaller than the effect estimated in this study, however, the CER of these programs are US $4,300 (Wang et al., 2003) and US$ 900 (Brown et al., 2007) per QALY, respectively. The lower CER is driven by a lower cost of the interventions and by a larger health care cost associated with adult obesity in the US.

In general, a program with a CER of US $18,000 per QALY is not considered cost-effective for low and middle-income countries (Woods 2016). If we also consider the savings in monthly water expenditure that represent about US $30 per year, for a total of 25 years, the CER decreases to US$ 7,000 per QALY. This CER still does not represent a cost-effective investment for low and middle-income countries. It is important to consider, however, that the government must have saved some money with the reduction in amount of water consumed from the public taps, a cost saving that we are not including in this calculation, and that access to piped water at home could also reduce overweight rate of older children and adults, for whom I do not have anthropometric data. Hence, while the benefit on childhood overweight alone does not seem to render a cost-effective intervention, they should be added to other benefits to estimate a more comprehensive cost-effectiveness ratio.

9 Conclusions

This study investigates whether expanded access to piped water at home can contribute to the fight against obesity in middle-income countries, exploiting experimental data from the city of Tangiers, Morocco. Results show that access to piped water at home decreased BMI and overweight rates among children age 5 or younger. I further find evidence suggesting the effects of access to piped water at home on BMI and overweight rates are mainly driven by a reduction in the variable cost of obtaining water, both in terms of money and time, and by gains in available time at home, in particular for household chores. Gains in available time to carry out activities outside the home and the reduction in stress related to water problems and other potential benefits of obtaining a formal connection to the water network at home seem to play little role in the effects on children's BMI and overweight rate. Likewise, the reduction in available income due to the installment payments, does not seem to be a main driver of the effects on BMI and overweight rate. This finding is informative for policy making, since it suggests that we could expect similar results from projects that not only finance, but also subsidize the cost of getting access to piped water at home.

This study suggests that access to piped water at home can contribute to the fight against overweight and obesity in middle-income 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. Back-of-envelope calculations suggest, however, that the effect on early childhood overweight alone is not enough to make this type of intervention cost-effective but it adds significantly to other potential benefits and should be considered in future calculations.

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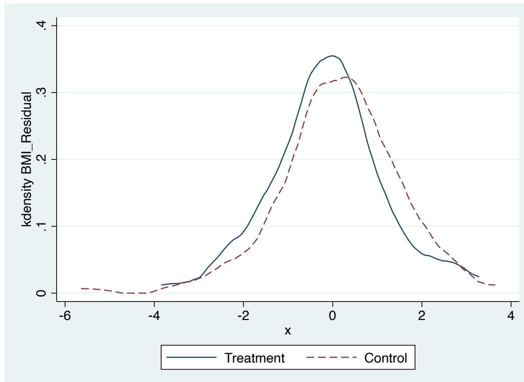
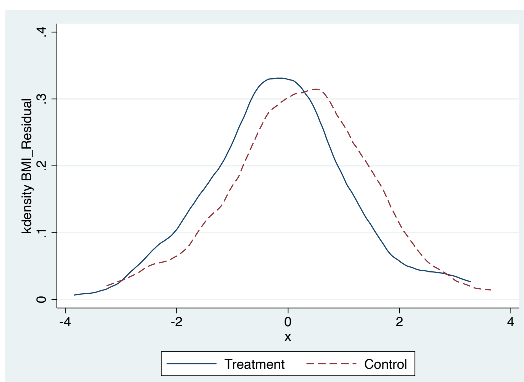
Figure 1: The Effect of the Treatment on BMI-for-Age



Note: Residuals are calculating after regressing BMI-for-Age on location, water source, the number of households, number of children under 5, the number of children under 15, baseline BMI-for-age and a dummy variable for missing observations on baseline std. BMI-for-age. Standard errors are clustered at the cluster level.

Figure 2: The Effect of the Treatment on BMI-for-Age for those Children not Informally Connected to the Public Tap



Note: Residuals are calculating after regressing BMI-for-Age on location, water source, the number of households, number of children under 5, the number of children under 15, baseline BMI-for-age and a dummy variable for missing observations on baseline std. BMI-for-age. Standard errors are clustered at the cluster level.

Table 1: Balance Check

	Obs	Mean Cont.	SD Cont.	Diff	Pval
Age	222	2.45	1.54	-0.22	0.26
Age (Endline)	261	3.02	1.56	-0.07	0.70
Female (%)	222	0.52	0.50	0.00	0.99
Female (%)(Endline)	261	0.51	0.50	-0.01	0.83
Height	114	93.52	11.48	-1.85	0.51
Height (Endline)	261	93.86	14.92	0.18	0.92
Weight	114	14.53	2.52	-0.65	0.33
BMI	114	16.78	2.48	-0.42	0.44
BMI-for-age	114	0.77	1.39	-0.22	0.49
Underweight (%)	114	0.00	0.00	0.00	.
Overweight (%)	114	0.14	0.35	0.04	0.69
Obesity (%)	114	0.07	0.26	-0.05	0.40
Missing BMI (%)	261	0.53	0.50	0.01	0.83
Num. adults	261	2.88	1.45	0.26	0.26
Num. children Age 0-14	261	2.93	1.82	-0.58	0.00
Head male (%)	260	0.90	0.30	0.02	0.69
Head age	252	42.69	10.80	-0.96	0.56
Head married (%)	260	0.95	0.22	-0.03	0.42
Head no education (%)	251	0.36	0.48	-0.05	0.51
Head's education att.	215	3.42	3.44	0.29	0.63
Head's income (dirhams)	234	1358.10	1023.08	-76.00	0.66
Family income (dirhams)	261	1503.95	1366.20	31.68	0.88
Working for pay (%)	261	0.20	0.14	0.00	0.86
Adults working for pay (%)	261	0.40	0.24	-0.03	0.46
Assets score	261	0.36	1.66	-0.15	0.52
Num. rooms	260	3.13	1.30	0.30	0.13
Permanent house (%)	261	0.85	0.36	0.01	0.74
Toilet (%)	261	1.00	0.00	0.00	.
Chlorine in water (%)	74	0.56	0.50	0.05	0.71
Clear water (%)	261	0.99	0.09	-0.01	0.70
Treat water (%)	223	0.09	0.29	0.05	0.37
Distance to public tap (mts)	261	130.28	103.45	0.63	0.97
Storage water (%)	258	0.86	0.35	0.04	0.39
N. fetch water per week -Adult	261	1.19	1.69	-0.09	0.71
-Male adult	256	1.18	2.41	0.19	0.68
-Female adult	258	1.18	2.53	-0.36	0.37
-Children age 6-14	153	0.77	1.59	-0.32	0.25
-Children age 0-5	238	0.00	0.00	0.00	.
Minutes feching water last 7 days	259	248.04	452.08	-86.38	0.16
Water Storaged last 7 days (liters)	248	0.48	0.76	-0.02	0.90
Water Payment last 7 days (Dirhams)	255	27.43	61.79	8.07	0.45
Report enough water	261	0.74	0.44	-0.03	0.60
Report water problem	257	0.32	0.47	-0.05	0.39

Note: Columns (1) display the number of observations, columns (2) and (3) display the average and standard deviation of the control group, respectively. Columns (4) show the estimated difference in pre-treatment means between treatment and control groups, which is obtained from regressing the variable of interest on the treatment dummy, controlling for the stratification variables: location, water source, the number of households and number of children under 5. Standard errors are clustered at the cluster level and p- values are reported in Columns (5).

Table 2: Balance Check

	Obs	Mean Cont.	SD Cont.	Diff	Pval
Age	185	2.37	1.50	-0.18	0.39
Age (Endline)	217	3.01	1.50	-0.10	0.61
Female (%)	185	0.50	0.50	0.02	0.75
Female (%)(Endline)	217	0.49	0.50	0.02	0.80
Height	91	91.97	11.50	-1.31	0.67
Height (Endline)	217	93.86	13.81	-0.02	0.99
Weight	91	14.15	2.60	-0.49	0.52
BMI	91	16.86	2.34	-0.40	0.46
BMI-for-age	91	0.82	1.31	-0.24	0.46
Underweight (%)	91	0.00	0.00	0.00	.
Overweight (%)	91	0.14	0.35	0.03	0.77
Obesity (%)	91	0.07	0.26	-0.05	0.45
Missing BMI (%)	217	0.54	0.50	0.02	0.73
Num. adults	217	2.89	1.44	0.06	0.82
Num. children Age 0-14	217	3.28	1.83	-0.75	0.00
Head male (%)	216	0.90	0.30	0.03	0.38
Head age	210	42.97	10.81	-2.63	0.12
Head married (%)	216	0.95	0.23	-0.02	0.68
Head no education (%)	209	0.39	0.49	-0.11	0.16
Head's education att.	179	2.89	3.19	0.83	0.17
Head's income (dirhams)	196	1320.48	923.38	16.24	0.92
Family income (dirhams)	217	1498.71	1308.73	14.46	0.95
Working for pay (%)	217	0.19	0.13	0.02	0.34
Adults working for pay (%)	217	0.39	0.23	-0.00	0.90
Assets score	217	0.04	1.59	-0.04	0.87
Num. rooms	216	3.19	1.37	0.14	0.48
Permanent house (%)	217	0.83	0.38	0.00	0.92
Toilet (%)	217	1.00	0.00	0.00	.
Chlorine in water (%)	63	0.57	0.50	0.07	0.64
Clear water (%)	217	0.99	0.10	-0.01	0.71
Treat water (%)	180	0.07	0.25	0.08	0.22
Distance to public tap (mts)	217	153.40	106.00	1.60	0.93
Storage water (%)	214	0.81	0.39	0.04	0.38
N. fetch water per week -Adult	217	1.44	1.86	-0.08	0.78
-Male adults	213	1.37	2.71	0.18	0.74
-Female adults	214	1.50	2.81	-0.34	0.46
-Children age 6-14	134	0.77	1.49	-0.26	0.42
-Children age 0-5	199	0.00	0.00	0.00	.
Minutes feching water last 7 days	215	273.68	484.60	-98.33	0.15
Water Storaged last 7 days (liters)	204	0.45	0.77	-0.11	0.34
Water Payment last 7 days (Dirhams)	211	35.17	68.68	10.51	0.39
Report enough water	217	0.73	0.45	-0.01	0.87
Report water problem	213	0.27	0.45	-0.05	0.45

Note: Columns (1) display the number of observations, columns (2) and (3) display the average and standard deviation-of the control group, respectively. Columns (4) show the estimated difference in pre-treatment means between treatment and control groups, which is obtained from regressing the variable of interest on the treatment dummy, controlling for the stratification variables: location, water source, the number of households and number of children under 5. Standard errors are clustered at the cluster level and p- values are reported in Columns (5).

Table 3: Effects on Water Access and Diarrhea Prevalence

	(1) Connected to Water Network 1st. Stage	(2) HH reports Enough Water ITT	(3) HH reports Enough Water 2SLS	(4) Days with Diarrhea per week ITT	(5) Days with Diarrhea per week 2SLS
Treatment	0.61***	0.11**		-0.00	
	(0.06)	(0.05)		(0.14)	
Connected to Water Ntwk			0.18**		-0.01
			(0.09)		(0.23)
R^2	0.386	0.175	0.247	0.094	0.094
Observations	261	261	261	234	234

	(1) Connected to Water Network 1st. Stage	(2) HH reports Enough Water ITT	(3) HH reports Enough Water 2SLS	(4) Days with Diarrhea per week ITT	(5) Days with Diarrhea per week 2SLS
Mean Value Control Group	0.22	0.88	0.86	0.27	0.24

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 4: Effects on Time and Monetary Costs of Obtaining Water

	(1) Minutes fetching water past 3 days ITT	(2) Minutes fetching water past 3 days 2SLS	(3) Installment (in Dirhams) ITT	(4) Installment (in Dirhams) 2SLS	(5) Water Expenditure (in Dirhams) ITT	(6) Water Expenditure (in Dirhams) 2SLS
Treatment	-70.27***		51.36***		-11.61	
	(16.81)		(8.15)		(23.83)	
Connected to Water Ntwk		-115.88***		84.70***		-19.14
		(27.45)		(11.82)		(39.59)
R^2	0.267	0.301	0.248	0.385	0.208	0.204
Observations	261	261	261	261	261	261

	(1) Minutes fetching water past 3 days ITT	(2) Minutes fetching water past 3 days 2SLS	(3) Installment (in Dirhams) ITT	(4) Installment (in Dirhams) 2SLS	(5) Water Expenditure (in Dirhams) ITT	(6) Water Expenditure (in Dirhams) 2SLS
Mean Value Control Group	72.69	96.02	15.92	-3.38	104.52	111.25

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 5: Effects on Anthropometric Indicators

	(1) BMI-for-Age (St. Dev) ITT	(2) BMI-for-Age (St. Dev) 2SLS	(3) Overweight Child ITT	(4) Overweight Child 2SLS	(5) Obese Child ITT	(6) Obese Child 2SLS
Treatment	-0.23*		-0.10**		-0.03	
	(0.13)		(0.05)		(0.03)	
Connected to Water Ntwk		-0.37*		-0.16**		-0.04
		(0.22)		(0.08)		(0.06)
R^2	0.202	0.168	0.162	0.091	0.112	0.101
Observations	261	261	261	261	261	261

	(1) BMI-for-Age (St. Dev) ITT	(2) BMI-for-Age (St. Dev) 2SLS	(3) Overweight Child ITT	(4) Overweight Child 2SLS	(5) Obese Child ITT	(6) Obese Child 2SLS
Mean Value Control Group	0.09	0.16	0.19	0.22	0.08	0.09

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 6: Effects on Other Anthropometric Indicators

	(1) Weight for-Age (St. Dev) ITT	(2) Weight for-Age (St. Dev) 2SLS	(3) Height for-Age (St. Dev) ITT	(4) Height for-Age (St. Dev) 2SLS	(5) Underweight Child ITT	(6) Underweight Child 2SLS
Treatment	-0.18*		-0.00		0.01	
	(0.11)		(0.13)		(0.02)	
Connected to Water Ntwk		-0.30*		-0.00		0.02
		(0.18)		(0.21)		(0.04)
R^2	0.208	0.201	0.216	0.216	0.080	0.074
Observations	261	261	261	261	261	261

	(1) Weight for-Age (St. Dev) ITT	(2) Weight for-Age (St. Dev) 2SLS	(3) Height for-Age (St. Dev) ITT	(4) Height for-Age (St. Dev) 2SLS	(5) Underweight Child ITT	(6) Underweight Child 2SLS
Mean Value Control Group	0.09	0.16	-0.02	-0.03	0.02	0.02

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 7: Heterogeneous Effect on Water Access

	(1) Connected to Water Network 1st. Stage	(2) Installment (in Dirhams) ITT	(3) Installment (in Dirhams) 2SLS	(4) Water Expenditure (in Dirhams) ITT	(5) Water Expenditure (in Dirhams) 2SLS	(6) HH reports Enough Water ITT	(7) HH reports Enough Water 2SLS
Treatment	0.59***	52.17***		-22.90		0.13**	
	(0.07)	(8.61)		(26.81)		(0.06)	
Treatment x Public Tap	0.10	-4.97		69.58*		-0.15	
	(0.15)	(22.22)		(40.02)		(0.10)	
Public Tap	0.07	13.43	-4.84	-18.37	-156.19	0.25***	0.20
	(0.13)	(12.72)	(27.86)	(24.84)	(108.72)	(0.07)	(0.13)
Connected to Water Ntwk			88.11***		-37.32		0.22**
			(13.04)		(45.37)		(0.09)
Connected x Public Tap			-19.85		105.85*		-0.25*
			(31.16)		(62.25)		(0.15)
R^2	0.387	0.249	0.386	0.212	0.207	0.182	0.242
Observations	261	261	261	261	261	261	261

	(1) Connected to Water Network 1st. Stage	(2) Installment (in Dirhams) ITT	(3) Installment (in Dirhams) 2SLS	(4) Water Expenditure (in Dirhams) ITT	(5) Water Expenditure (in Dirhams) 2SLS	(6) HH reports Enough Water ITT	(7) HH reports Enough Water 2SLS
Mean Value Control Group	0.23	17.27	-1.87	132.11	151.02	0.85	0.82

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 8: Heterogeneous Effect on Time

	(1) Minutes fetching water past 3 days ITT	(2) Minutes fetching water past 3 days 2SLS	(3) HH reports More Time for Housework ITT	(4) HH reports More Time for Housework 2SLS	(5) HH reports More Time Activities at Home ITT	(6) HH reports More Time Activities at Home 2SLS
Treatment	-73.29***		0.22***		0.25***	
	(18.01)		(0.07)		(0.06)	
Treatment x Public Tap	18.62		-0.44**		-0.26	
	(25.33)		(0.20)		(0.18)	
Public Tap	-56.23**	-41.79	0.29**	0.26	0.24**	0.47**
	(25.35)	(32.48)	(0.14)	(0.23)	(0.10)	(0.22)
Connected to Water Ntwk		-123.55***		0.37***		0.42***
		(30.07)		(0.12)		(0.11)
Connected x Public Tap		44.65		-0.67**		-0.44
		(35.95)		(0.30)		(0.27)
R^2	0.268	0.301	0.196	0.201	0.183	0.103
Observations	261	261	255	255	261	261

	(1) Minutes fetching water past 3 days ITT	(2) Minutes fetching water past 3 days 2SLS	(3) HH reports More Time for Housework ITT	(4) HH reports More Time for Housework 2SLS	(5) HH reports More Time Activities at Home ITT	(6) HH reports More Time Activities at Home 2SLS
Mean Value Control Group	81.26	108.69	0.26	0.19	0.14	0.07

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 9: Heterogeneous Effect on Time for Activities Outside the House and Well-being

	(1) HH reports More Time Activities Outside ITT	(2) HH reports More Time Activities Outside 2SLS	(3) HH reports Water Main Problem ITT	(4) HH reports Water Main Problem 2SLS	(5) Life Satisfaction Scale (0-10) ITT	(6) Life Satisfaction Scale (0-10) 2SLS
Treatment	0.22***		-0.29***		0.54*	
	(0.07)		(0.08)		(0.29)	
Treatment x Public Tap	0.05		-0.18		0.03	
	(0.16)		(0.19)		(0.69)	
Public Tap	-0.06	0.09	-0.05	0.18	0.71	1.34
	(0.10)	(0.30)	(0.13)	(0.16)	(0.52)	(0.89)
Connected to Water Ntwk		0.37***		-0.49***		0.91*
		(0.11)		(0.12)		(0.49)
Connected x Public Tap		0.02		-0.19		-0.08
		(0.23)		(0.26)		(0.99)
R^2	0.270	0.248	0.202	0.419	0.267	0.284
Observations	261	261	261	261	261	261

	(1) HH reports More Time Activities Outside ITT	(2) HH reports More Time Activities Outside 2SLS	(3) HH reports Water Main Problem ITT	(4) HH reports Water Main Problem 2SLS	(5) Life Satisfaction Scale (0-10) ITT	(6) Life Satisfaction Scale (0-10) 2SLS
Mean Value Control Group	0.11	0.07	0.39	0.29	6.83	6.06

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table 10: Heterogeneous Effect on Anthropometric Indicators

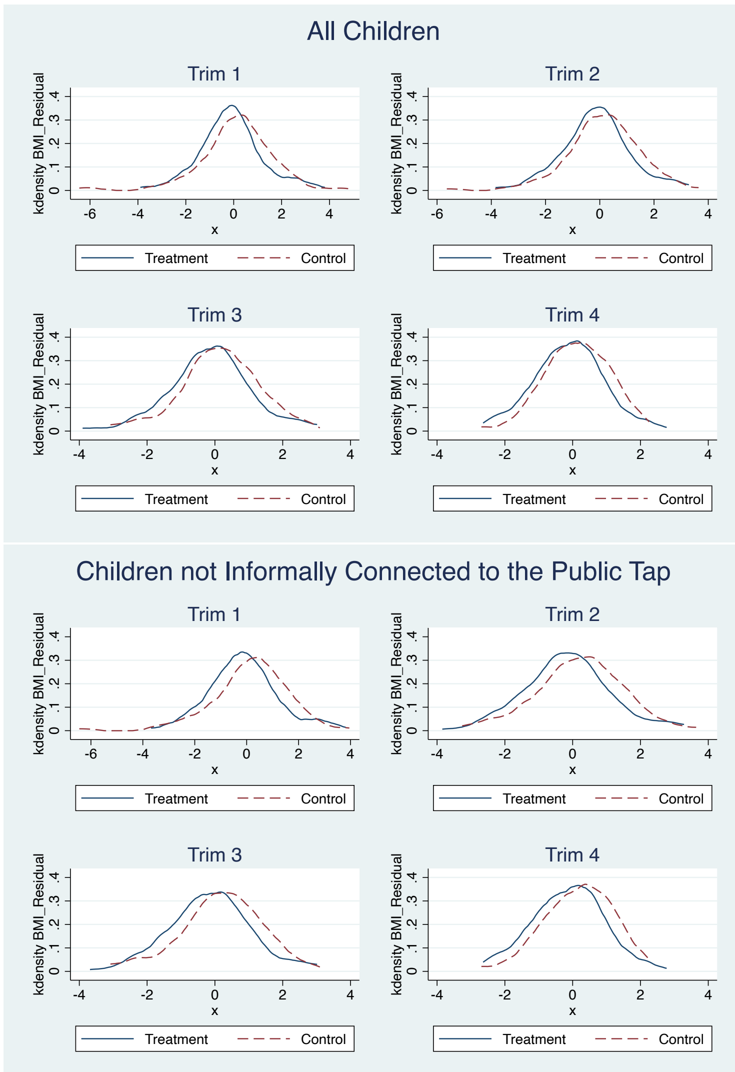
	(1) BMI-for-Age (St. Dev) ITT	(2) BMI-for-Age (St. Dev) 2SLS	(3) Overweight Child ITT	(4) Overweight Child 2SLS	(5) Obese Child ITT	(6) Obese Child 2SLS
Treatment	-0.28**		-0.12**		-0.03	
	(0.14)		(0.05)		(0.04)	
Treatment x Public Tap	0.36		0.11		-0.01	
	(0.35)		(0.13)		(0.09)	
Public Tap	-0.39*	-0.49	-0.12	-0.24	0.02	-0.04
	(0.23)	(0.53)	(0.08)	(0.17)	(0.07)	(0.15)
Connected to Water Ntwk		-0.47*		-0.19**		-0.04
		(0.25)		(0.09)		(0.06)
Connected x Public Tap		0.59		0.19		-0.01
		(0.53)		(0.20)		(0.14)
R^2	0.205	0.165	0.165	0.085	0.112	0.101
Observations	261	261	261	261	261	261

	(1) BMI-for-Age (St. Dev) ITT	(2) BMI-for-Age (St. Dev) 2SLS	(3) Overweight Child ITT	(4) Overweight Child 2SLS	(5) Obese Child ITT	(6) Obese Child 2SLS
Mean Value Control Group	0.42	0.50	0.47	0.59	0.18	0.25

Note: control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

A Appendix

Figure A1: Sensitivity to Different Trims of BMI



Note: Trim 1: height-for-age higher than 7 or lower than -7 standard deviations, BMI-for-age larger than 6 or smaller than -6 standard deviations. Trim 2: height-for-age higher than 6 or lower than -6 standard deviations, BMI-for-age larger than 5 or smaller than -5 standard deviations (WHO standards). Trim 3: height-for-age higher than 5 or lower than -5 standard deviations, BMI-for-age larger than 4 or smaller than -4 standard deviations (WHO standards). Trim 4: height-for-age higher than 4 or lower than -4 standard deviations, BMI-for-age larger than 3 or smaller than -3 standard deviations (WHO standards). Residuals are calculating after regressing BMI-for-Age on control variables. Standard errors are clustered at the cluster level.

Table A1: Sensitivity to Different Trims of BMI

Main Effects

	(1) BMI-for-Age (St. Dev) Trim 1	(2) BMI-for-Age (St. Dev) Trim 2	(3) BMI-for-Age (St. Dev) Trim 3	(4) BMI-for-Age (St. Dev) Trim 4	(5) Overweight Child Trim 1	(6) Overweight Child Trim 2	(7) Overweight Child Trim 3	(8) Overweight Child Trim 4
Treatment	-0.17	-0.23*	-0.24*	-0.27*	-0.10**	-0.10**	-0.09*	-0.08*
	(0.12)	(0.13)	(0.14)	(0.15)	(0.05)	(0.05)	(0.05)	(0.04)
R^2	0.197	0.202	0.221	0.219	0.179	0.162	0.151	0.117
Observations	270	261	250	232	270	261	250	232

Heterogeneous Effects

	(1) BMI-for-Age (St. Dev) Trim 1	(2) BMI-for-Age (St. Dev) Trim 2	(3) BMI-for-Age (St. Dev) Trim 3	(4) BMI-for-Age (St. Dev) Trim 4	(5) Overweight Child Trim 1	(6) Overweight Child Trim 2	(7) Overweight Child Trim 3	(8) Overweight Child Trim 4
Treatment	-0.18	-0.28**	-0.27*	-0.34**	-0.11**	-0.12**	-0.10**	-0.09**
	(0.14)	(0.14)	(0.15)	(0.16)	(0.05)	(0.05)	(0.05)	(0.05)
Treatment x Public Tap	0.06	0.36	0.14	0.46	0.06	0.11	0.08	0.11
	(0.36)	(0.35)	(0.34)	(0.35)	(0.12)	(0.13)	(0.13)	(0.12)
Public Tap	-0.09	-0.39*	-0.19	-0.30	-0.08	-0.12	-0.09	-0.11
	(0.28)	(0.23)	(0.20)	(0.23)	(0.08)	(0.08)	(0.08)	(0.07)
R^2	0.197	0.205	0.221	0.224	0.180	0.165	0.152	0.120
Observations	270	261	250	232	270	261	250	232

Note: Trim 1: height-for-age higher than 7 or lower than -7 standard deviations, BMI-for-age larger than 6 or smaller than -6 standard deviations. Trim 2: height-for-age higher than 6 or lower than -6 standard deviations, BMI-for-age larger than 5 or smaller than -5 standard deviations (WHO standards). Trim 3: height-for-age higher than 5 or lower than -5 standard deviations, BMI-for-age larger than 4 or smaller than -4 standard deviations (WHO standards). Trim 4: height-for-age higher than 4 or lower than -4 standard deviations, BMI-for-age larger than 3 or smaller than -3 standard deviations (WHO standards). Control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table A2: Sensitivity to Different Measurements of BMI

Main Effects

	(1) BMI-for-Age (St. Dev) Measure 1	(2) BMI-for-Age (St. Dev) Measure 2	(3) BMI-for-Age (St. Dev) Average	(4) Overweight Child Measure 1	(5) Overweight Child Measure 2	(6) Overweight Child Average
Treatment	-0.26**	-0.21	-0.23*	-0.08*	-0.10**	-0.10**
	(0.13)	(0.13)	(0.13)	(0.05)	(0.05)	(0.05)
R^2	0.200	0.175	0.202	0.160	0.157	0.162
Observations	260	258	261	260	258	261

Heterogeneous Effects

	(1) BMI-for-Age (St. Dev) Measure 1	(2) BMI-for-Age (St. Dev) Measure 2	(3) BMI-for-Age (St. Dev) Average	(4) Overweight Child Measure 1	(5) Overweight Child Measure 2	(6) Overweight Child Average
Treatment	-0.32**	-0.28*	-0.28**	-0.09*	-0.12**	-0.12**
	(0.14)	(0.15)	(0.14)	(0.05)	(0.05)	(0.05)
Treatment x Public Tap	0.36	0.42	0.36	0.05	0.12	0.11
	(0.36)	(0.36)	(0.35)	(0.13)	(0.12)	(0.13)
Public Tap	-0.38	-0.44*	-0.39*	-0.04	-0.12	-0.12
	(0.23)	(0.23)	(0.23)	(0.08)	(0.08)	(0.08)
R^2	0.203	0.181	0.205	0.160	0.160	0.165
Observations	260	258	261	260	258	261

Note: Columns (3) and (6) show the average of the two measurements or the measurement that is not a biological implausible value. Control variables include stratification variables used for the randomization (location, water source, number of households per cluster, number of children 5), number of children under 15, baseline BMIz, age and gender. Standard errors are clustered at the cluster level.

Table A3: Difference between "Non-Attrition" and "Attrition" Samples

Treatment Group

	Obs	Mean Non Attrition	SD Non Attrition.	Diff.	Pval
BMI	83	16.38	2.30	-0.08	0.87
BMI-for-age	83	0.49	1.39	0.03	0.94
Underweight (%)	83	0.00	0.00	0.06	0.26
Overweight (%)	83	0.18	0.38	-0.08	0.40
Obesity (%)	83	0.05	0.23	-0.03	0.64

Control Group

	Obs	Mean Non Attrition	SD Non Attrition.	Diff.	Pval
BMI	74	16.78	2.48	0.16	0.85
BMI-for-age	74	0.77	1.39	0.06	0.89
Underweight (%)	74	0.00	0.00	0.00	.
Overweight (%)	74	0.14	0.35	0.03	0.76
Obesity (%)	74	0.07	0.26	0.03	0.62

Note: Columns (1) display the number of observations, columns (2) and (3) display the average and standard deviation of the "non-attrition" group, respectively. Columns (4) show the estimated difference in pre-treatment means between children in the "non-attrition" group and in the "attrition" group, which is obtained from regressing the variable of interest on the attrition dummy, controlling for the stratification variables: location, water source, the number of households and number of children under 5. Standard errors are clustered at the cluster level and p- values are reported in Columns (5).

Table A4: Sensitivity to Different Control Variables

Connected to water network (First Stage)

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	0.58***	0.60***	0.61***	0.61***	0.61***
	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Observations	261	261	261	261	261

Households reports enough water - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	0.05	0.09*	0.11*	0.11**	0.11**
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
Observations	261	261	261	261	261

Monthly Water Expenditure - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-17.40	-22.90	-10.57	-11.61	-8.83
	(25.78)	(24.47)	(23.90)	(23.83)	(22.57)
Observations	261	261	261	261	261

Minutes spent fetching water past 3 days - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-60***	-77***	-70***	-70***	-70***
	(16.14)	(21.46)	(17.05)	(16.81)	(16.33)
Observations	261	261	261	261	261

BMI Z-Score

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-0.17	-0.20	-0.23*	-0.23*	-0.23*
	(0.13)	(0.13)	(0.14)	(0.13)	(0.14)
Observations	261	261	261	261	261

Overweight

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-0.08*	-0.09*	-0.10*	-0.10**	-0.10**
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
Observations	261	261	261	261	261

(1) No control variables. (2) Controls for stratification variables used for the randomization. (3) Controls for (2) and for the unbalanced variable, the number of children under 15. (4) Controls for (3), baseline BMIz, age and gender (controls used in the original regressions). (5) Controls for (2), and control variables used by Devoto et al. (2012): number of children under 15, quintile in asset distribution, quantity of water storaged the week before baseline, and distance to the public tap. Standard errors are clustered at the cluster level.

Table A5: Sensitivity to Different Control Variables- Heterogeneous Effect

Connected to water network (First Stage)

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	0.56***	0.59***	0.59***	0.59***	0.59***
	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Treatment x Public Tap	0.17	0.10	0.09	0.10	0.12
	(0.14)	(0.16)	(0.15)	(0.15)	(0.16)
Observations	261	261	261	261	261

Households reports enough water - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	0.08	0.11**	0.13**	0.13**	0.13**
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Treatment x Public Tap	-0.10	-0.12	-0.15	-0.15	-0.14
	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)
Observations	261	261	261	261	261

Monthly Water Expenditure - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-46.60	-36.33	-21.55	-22.90	-17.90
	(30.33)	(27.18)	(27.08)	(26.81)	(26.96)
Treatment x Public Tap	133.31***	91.80**	67.75*	69.58*	56.92
	(46.91)	(36.95)	(39.40)	(40.02)	(53.59)
Observations	261	261	261	261	261

Minutes spent fetching water past 3 days - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-67.59***	-81.46***	-73.39***	-73.29***	-73.38***
	(19.71)	(23.52)	(18.26)	(18.01)	(18.05)
Treatment x Public Tap	25.62	32.95	19.81	18.62	20.37
	(26.48)	(25.90)	(24.30)	(25.33)	(25.12)
Observations	261	261	261	261	261

Household reports more time for household chores - ITT

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	0.18**	0.23***	0.22***	0.22***	0.23***
	(0.09)	(0.07)	(0.07)	(0.07)	(0.07)
Treatment x Public Tap	-0.41**	-0.45**	-0.44**	-0.44**	-0.42**
	(0.19)	(0.19)	(0.19)	(0.20)	(0.19)
Observations	255	255	255	255	255

BMI Z-Score

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-0.25*	-0.25*	-0.30**	-0.28**	-0.29*
	(0.14)	(0.14)	(0.15)	(0.14)	(0.15)
Treatment x Public Tap	0.33	0.33	0.42	0.36	0.41
	(0.34)	(0.37)	(0.36)	(0.35)	(0.36)
Observations	261	261	261	261	261

Overweight

	(1) Unbalanced	(2) Unbalanced	(3) Balanced	(4) Balanced	(5) Balanced
Treatment	-0.09*	-0.11**	-0.12**	-0.12**	-0.12**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Treatment x Public Tap	0.07	0.11	0.13	0.11	0.13
	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
Observations	261	261	261	261	261

(1) No control variables. (2) Controls for stratification variables used for the randomization. (3) Controls for (2) and for the unbalanced variable, the number of children under 15. (4) Controls for (3), baseline BMIz, age and gender (controls used in the original regressions). 5) Controls for (2), and control variables used by Devoto et al. (2012): number of children under 15, quintile in asset distribution, quantity of water storaged the week before baseline, and distance to the public tap. Standard errors are clustered at the cluster level.