Causal Effect of Psychic Costs on Vaccination Take-up: Evidence from Rural Nigeria

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Abstract

Conventional wisdom says it that psychological factors play a crucial role in the low vaccine take-up in African countries, without rigorous evidence. We measure the causal effect of such psychic costs of vaccination on its take-up. We implemented the randomized controlled trial in rural Nigeria among women at childbearing age who had no experience of tetanus vaccination. A randomly selected set of respondents, treatment group, was asked to answer a short survey and additionally to receive a vaccine at their house, while other respondents in control group were asked only to answer the same short survey at their house. The difference in the completion of, either the short survey and vaccination among treatment group or solely the short survey among control group, identifies the psychic costs of vaccination. We find that psychic costs of vaccination reduce the take-up by 12.7 percentage points. Distinct from the previous study, we identify the psychic costs of

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vaccination, which are different from psychic costs of clinic visit. We further categorize such women with psychic costs of vaccination into two types; passive refusers of vaccine with zero willingness to pay for the vaccination, and active refusers whose willingness to pay is negative. Out of women with psychic costs of vaccine, slightly more than half of them (52 percent) are active refusers and the remaining 48 percent are passive refusers.

Keywords: Vaccination; Psychic costs; Nigeria

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Despite seemingly-obvious benefits of vaccination to prevent diseases (Ehreth, 2003), the non-compliance with vaccine recommendations is the worldwide phenomenon. In the U.S., only 66 percent of children completed all recommended vaccination (Kurosy, David, and Krishnarajah; 2016). In developing countries, almost 20 millions of infants are estimated to be unreached with routine immunization worldwide in 2016, and 60 percent of such infants are concentrated in 10 countries, one of which is Nigeria, our study site (WHO, 2017). Up to 16 percent global neonatal tetanus deaths, which can be effectively prevented by tetanus toxoid vaccines, are from Nigeria, which remains one of 25 countries still reporting neonatal tetanus as a cause of infant mortality (WHO, 2013).

Conventional wisdom suggests that psychological barriers, such as the fear of needles or the concern for vaccine safety, are large barriers to vaccination. We call these psychological barriers as psychic costs, and we define psychic costs of vaccination as residuals that cannot be explained by monetary factors, such as beliefs and perceptions about vaccines. Fear of needle due to the pain, fear of side effects, and belief that the vaccine might contain harmful virus are the examples of psychic costs.

One famous incidence is the Nigerian vaccination boycott campaign. In 2003, in three northern states in Nigeria, polio immunization campaigns were boycotted due to a suspicion about the vaccine's safety. Islamic leaders propagated a suspicion to the public that polio vaccines

could make women infertile or lead them to contract HIV (Jegede 2007), which resulted in the refusal of polio vaccine take-up within the general population. The boycott caused a decreased take-up of the polio vaccine in northern Nigeria, increased polio-virus transmission throughout the country (Centers for Disease Control and Prevention, 2005), and the spread of polio into 20 countries (Kaufmann and Feldbaum 2009). Similar refusals to participate in vaccination campaigns for polio and tetanus due to distrust have been observed across Africa (UNICEF, 1997; UNICEF, 2001; Feldman-Savlesberg, 2008). These episodes have led to conventional wisdom: a presumption commonly held by researchers that psychic costs of vaccination are large barriers to vaccine take-up (Rainey, 2010). Researchers, however, have not yet demonstrated a causal link regarding the significance of such psychic costs.

This paper reports results of a field experiment explicitly designed to causally measure the effect of psychic costs on tetanus vaccine take-up among women at childbearing age in rural Nigeria. Apart from the direct psychic costs of vaccination, there might be other psychic costs which are indirectly associated with vaccination such as psychic costs of clinic visit or psychic costs of interacting with health staffs. For example, a substantial percentage of respondents in our study mention the odor of the clinic as one of barriers to clinic attendance which can lower the vaccine take-up at the clinic. Other respondents also complain that nurses are harsh and they are hesitant to visit the clinic due to the staffs' attitude. Our study focuses exclusively on psychic costs of vaccination by eliminating other psychic costs, of clinic attendance and of health staffs through the clean research design.

Sato and Takasaki (2017) is the first causal study to systematically examine this conventional wisdom by randomized controlled trial among women at child-bearing age in rural Nigeria. They randomized the condition under which respondents could receive the cash transfer; one condition is to visit an assigned health clinic, and another is to receive a vaccine at the assigned health clinic. If psychic costs of vaccine prevent one from receiving a vaccine, then the clinic attendance should be lower among respondents whose condition was to receive the vaccine than among

respondents whose condition was simply to attend the clinic. They found statistically the same clinic attendance rate by the condition and thus concluded that psychic costs of vaccine are not the major barriers to vaccination. Their research design, however, had an important flaw. Over 10 percent of respondents who were offered the high amount of cash transfer did not show up at the health clinic. This result implies that respondents may have psychic costs of clinic visit. If these psychic costs of clinic visit are correlated with psychic costs of vaccination, then the research design could not evaluate the true effect of psychic costs of vaccination because these 10 percent who did not attend the health clinic might have been the ones who faced the high psychic costs of vaccine. Distinct from their study, our study improves the research design to evaluate the psychic costs of vaccine, separating from psychic costs of clinic attendance. We eliminate the psychic costs of clinic visit by allowing respondents to receive a vaccine at their house, instead of at a health clinic.

We find that psychic costs of vaccine reduce the vaccination take-up by 12.7 percentage points. However, we also find that about half (6.1 percentage points) of women with such psychic costs can easily overcome them, for example by reducing their transportation costs or by peer pressures through the door-to-door vaccination campaign. We call these people passive refusers of vaccine because they have almost zero willingness to pay for the vaccine, but they might not reject the vaccine if it was offered at no cost to them. On the other hand, another half (6.6 percentage points) of women with psychic costs of vaccine seems difficult to overcome them easily. Their willingness to pay for the vaccine is negative, thus we call them active refusers of vaccine. A simple intervention such as door-to-door vaccination is likely to be ineffective to them. Rather, the persistent educational intervention to inform the benefit of vaccines and to change women's preference over vaccines might be the effective policy to induce the behavioral change among such active refusers toward vaccination.

The remainder of the paper is organized as follows. The next section discusses the data. Section 2 conducts empirical analyses on psychic costs. The last section concludes.

1 Data

1.1 Sampling

Our study was conducted in the Jada local government area (LGA) of Adamawa state in the northeastern region of Nigeria. The experiment was implemented in October 2016.

We employed the following two-stage sampling for women. First, we selected 41 villages in Jada LGA based on the following criteria. First, we selected 8 wards out of 11 within Jada LGAs based on the distance from the Jada capital. In each ward, we selected villages which we did not capture in the previous experiment we conducted in 2013[1].

After we selected 41 villages, we made a census list of eligible women in each village. A woman was eligible if she was aged between 15 and 35 and she had never received tetanus vaccine before. The list indicated whether she was pregnant or not. From the census list, we selected one woman from each household. If there were more than one eligible women in a household, we prioritized and selected the pregnant woman if there were any. If there was no pregnant woman or there were more than one pregnant woman, we randomly selected one of them.

The census list identified 1,747 eligible women from 1,249 households from 41 villages. We then selected one eligible woman from each household, thus 1,249 women in total. Out of 1,249, there were 222 cases that women were in fact ineligible but the information in the census list was wrong[2]. At the time of baseline survey, 281 women were absent. The absence rate was

[1]In 2013, we conducted a randomized controlled trial in Jada LGA, covering around 2,500 women at child-bearing age. The project was to evaluate the psychic costs of vaccine for the first time (Sato and Takasaki, 2017). The current project is the second attempt to evaluate the psychic costs of vaccine. The main difference between the first project and the current one is that the current project eliminates any potential threats for the identification of psychic costs of vaccine. We conducted the vaccination at the health clinic at the first project, while it was implemented in each respondent's household for the current project. Vaccination at their houses is to eliminate the concern that we cannot separate out the psychic costs of vaccine from the psychic costs of clinic visit. We also hire nurses as interviewers for the current project while the interviewers were non-health-staffs in the first project. We utilized nurses for the current project to control for the psychic costs of health staffs.

[2]This error occurred when health staffs visited each village to make the census list as they needed to gather the information by asking villagers. For example, one of the eligibility criteria is that a woman never received a tetanus vaccine before. However, there were many misreporting cases on the experience of the tetanus vaccine for a woman because the health staffs needed to ask about the information about her to someone else who happened to be present at the time of visit.

high because the project was conducted during the harvest season. Many women had left their house early in the morning for farming. Twenty-two refused to participate in the project. We have very high attrition rate. Here, the attrition rate means the proportion of women whom we identified in the census list as potential participants of the study, but did not complete the baseline survey or were not eligible for the study. Over all, we have 724 sample who completed the baseline survey. Out of 724 respondents, 125 of them misreported their tetanus vaccination status at the screening question, but they later turned out to be ineligible. Dropping them from the sample, we have our main sample of 599 women.

1.2 Experimental design and Procedure

Once we identify eligible women, interviewers visited each eligible woman for the baseline survey. In the beginning of the baseline survey, women were asked if they were willing to participate in a study at their house. They were orally informed by interviewers about the objective of the study, which is to understand the barriers to health behaviors in general. Once respondents agreed to participate, they orally provided the consent and interviewers indicated the consent on behalf of respondents in the questionnaire form.

After the consent, interviewers conducted baseline survey to each participant to measure underlying attitudes, beliefs and knowledge on vaccines as well as other health behaviors, and demographic and socioeconomic characteristics of women. Baseline surveys took place in the morning at participants' house. The baseline survey took about 15 minutes. At the baseline survey, respondents were informed by interviewers that some nurse would visit them to ask about vaccine-related questions after several hours from the baseline survey on the same day. Interviewers also explained to all the respondents briefly about tetanus-toxoid vaccine at the end of the baseline survey.

Our project hired 15 nurses as interviewers. We hired nurses because the follow-up survey involved vaccinating respondents at each respondent's household. We used the same nurses to go

back to the same household they visited for the baseline survey for the logistic reason. Because of the difficulty in identifying the eligible women in each village as they did not have the official address, using the same nurses for the baseline and follow-up survey made sense logistically. At the baseline survey, respondents did not know that interviewers were health staffs. Similarly, they did not know that it would be the same interviewers who interviewed them for the baseline survey that would come for the follow-up survey. Respondents only knew that some nurse would come to visit them for the follow-up survey for the reason we explain below.

Figure 1 presents the research design. The intervention took place right after the baseline survey. Respondents in control group was informed that some nurse would visit them to ask some questions on vaccination as a follow-up survey at their house several hours later from the baseline survey. Respondents in treatment group was informed the identical information about the follow-up survey as what women in control group received. In addition to that, treatment group was also informed about the opportunity to receive the tetanus vaccine at their house at the same time as the follow-up survey. Interviewers provided each respondent in treatment group a voucher which was redeemable for tetanus-toxoid vaccination. They were instructed to submit the voucher to a project staff who stationed at the village head's house before interviewers would visit them for the follow-up survey, if they were willing to receive the vaccine at the time of the follow-up survey. They were informed that if they submit the voucher, they can receive the vaccine at their household at the same time as the follow-up survey at no cost. We will explain why we introduce this voucher system below.

Randomization took place before the actual village visit for the baseline survey, using the census list of 1,249 eligible women. In each village, we randomly select 45 percent of eligible women into the control group, and another 55 percent to the treatment group. The actual assignment ratio for the control and treatment among the sample of 599 eligible women who completed the baseline survey is 41.4 percent for control group and 58.6 percent for the treatment group. We intentionally assigned more respondents to the treatment group because we planned

to conduct the analysis of differential behavior among treated women, depending on whether they submitted the voucher for the vaccine or not.

After several hours from the baseline survey, same interviewers, who were nurses, went back to the same respondents' houses for the follow-up survey . The follow-up survey, which mainly asked all the respondents why they think some people refuse to take vaccine, took no more than 10 minutes. Respondents in control group were additionally asked the hypothetical questions whether they would have accepted the vaccine if offered free, and if they would not have accepted for free, how much money would have been sufficient for them to accept the vaccine offer.

Respondents in treatment group, on the other hand, were not asked hypothetical questions as the option to receive the vaccine was the actual choice. They were asked if they submitted the voucher. The actual submission of the voucher was later reconciled with the receipt of the voucher at the village's head house. For the analysis, we only refer to the actual submission of the receipt, but not the self-reported voucher submission. Then, independent of the submission of the voucher, respondents were asked whether they would like to receive the vaccine right away at the follow-up survey. Even if they did not submit the voucher, they had a chance to receive a vaccine at the follow-up survey if they orally accepted to receive the vaccine at this time of the follow-up survey. Here, it is important to note that respondents did not know at the time of the baseline survey that they could receive the vaccine without submitting the voucher. The offer to provide the free tetanus vaccination at no cost regardless of the voucher submission was a surprise to all the respondents in treatment group. At the follow-up survey, we have 3 outcome variables; completed follow-up survey, submitted the voucher, received vaccination. The latter two variables were applicable only to the respondent in treatment group.

1.3 Interpretation of Research Design

Our main outcome variable is whether respondents completed their task. We define the completion for the control group as the completion of the follow-up survey, while the completion for the

treatment group is the completion of the follow-up survey and vaccination. The difference in the completion rate between control and treatment group reveals the existence of the psychic costs of vaccine. If there exist psychic costs of vaccine among respondents, then the completion rate among respondents in treatment group is lower than that in control group because respondents in treatment group need to accept the vaccine in addition to accepting the follow-up survey to be considered as completing the task.

Among those with psychic costs of vaccine, our research design allows us to further separate out the passive refuser of vaccine and the active refuser by observing the voucher submission and the actual vaccine take-up among respondents in treatment group. There are three types of respondents. First, the submission of the voucher reveals the high willingness to pay for the vaccine, thus their net psychic costs are not positive. They are vaccine accepters. Second, if a respondent does not submit the voucher in advance but accepts to receive the vaccine at their house at no cost, her willingness to pay for the vaccine is non-negative but low, thus her net psychic costs are close to zero. In other words, if vaccination costs even a little bit, either monetary or non-monetary, she does not receive a vaccine. But if the cost of receiving a vaccine is zero, she receives a vaccine. She is a passive refuser of vaccine. Third, if a respondent does not submit the voucher and does not receive the vaccine at the time of follow-up survey, her willingness to pay for the vaccine is strictly negative. She is an active refuser of vaccine

We provided the vaccination for respondents at their houses, instead of having them come to the health clinic for the vaccination. Although not realistic in the practical setting, this is to pursue the clean research design by eliminating the psychic costs of health clinic visits. We also informed respondents in both control and treatment group that interviewers for the follow-up survey were nurses and we in fact employed nurses as interviewers for both baseline and follow-up survey. This is to prevent the psychic costs of health staffs to have the differential influence on the acceptance on the follow-up survey across the treatment; in other words, this is to control for the psychic costs of health staffs across treatment group.

1.4 Attrition

We have very high attrition from 1,249 women identified in the census list to 599 who were eligible and completed the baseline survey. We tested if the attrition rate is significantly different between the treatment status. Table 0 presents that the proportion of ineligible women and of women who refused to participate in the survey are the same between treatment and control group, respectively. However, women who were absent at the time of baseline was 4.4 percentage points higher among control than among treatment, and eligible women who completed the baseline survey was 6.9 percentage points lower in control than in treatment group.

One potential reason why the attrition rate differs by the treatment status is that interviewer's search effort was significantly higher for women in treatment than those in control for the following logic. First, interviewers knew the treatment status of each respondent when they were searching for her. Second, interviewers knew that they would not be able to offer vaccines to women in control group. Third, interviewers were all nurses and they might have had less incentives to look for women whom they cannot offer vaccines.

If the attrition was mostly driven by the interviewers, the attrition rate might be different by interviewers. The treatment status is significantly correlated with the attrition among 5 interviewers out of 15 interviewers. Excluding respondents who were interviewed by these 5 interviewers, the attrition is no longer correlated with treatment status. In the Result section, we will show that the main results are consistent when we exclude women interviewed by these 5 interviewers, confirming the robustness of the result[3].

Since respondents in the original sample among which the random assignments of the treatment were done did not know their treatment status prior to the baseline survey, the systematic attrition at the time of baseline survey is unlikely to be caused by respondents.

[3]We also examine the potential differential attrition by village. The attrition rate was significantly correlated with the treatment status in 7 villages out of 41. However, even after excluding these 7 villages, the treatment status is still correlated with the attrition on average for the rest of 34 villages. This result means that even when the correlation is not significant in each village, the trend that the attrition is higher among control group is consistent across villages.

1.5 Descriptive Statistics and Balancing Tests

Table 1 presents the summary statistics by treatment status. On average, respondents are 22 years old. Over 35 percent of respondents have no education, around 35 percent have the primary school education, and around 14 percent have the secondary-school education or more. Sixty-five percent are married. More than half (58 percent) of respondents belong to Chamba ethnic group and 25 percent are Fulani. Majority of respondents, almost 80 percent, are Muslims as almost all of Fulani are Muslims and half of Chamba are Muslims.

On average, women delivered 2 babies and 1.5 of them are alive. Twelve percent are currently pregnant. On average, it takes 8 minutes for a respondent to walk from each respondent's house to the village head's house, which is the place where they could submit the voucher for the vaccination. The average household earning is 20,000 naira, and most of the material for the roof is metal. About 45 percent of respondents have paid work, and they earned about one-tenth of the household earning. Slightly less than half of respondents have ever received injection-type vaccines before.

Table 1 Panel B presents the subjective belief about vaccines. Only 5 percent have concerns that vaccines give HIV, while 14 percent believe that vaccines give some diseases. About 18 percent believes that vaccines protect them and about 30 percent believe that vaccines keep them healthy. More than 10 percent state that they are afraid of vaccines, and 9 percent acknowledge that vaccines cause headaches and fever. More than 20 percent think that vaccines cure disease. Thirteen percent indicate that their religion is against vaccines, and 19 percent are personally against vaccines. One-thirds (35 percent) does not have strong preference for nor against receiving vaccines, while 15 percent state their willingness to receive a vaccine when they have a chance to do so.

There are several characteristics that are statistically different by the treatment status. The number of minutes taken from their house to the village head's house is shorter among women in treatment group than in control group by about 1 minute. More respondents in treatment

group are more likely to have the roof made of metal, more likely to feel that vaccines are scary, but also more likely to think that vaccines keep them healthy. We control for these variables in the regression analysis.

1.6 Follow-up Survey Completion by Treatment

Other than psychic costs of vaccination, there are various potential barriers which could prevent one from receiving a vaccine. One examples of such other factors include the time conflict and the bad physical condition. . To separate such non-psychic costs from the psychic costs, we create the control to compare its completion rate of follow-up survey with the completion of the follow-up and the vaccine take-up of treatment group under the assumption that such non-psychic costs would only influence the fulfillment of the follow-up survey, which should be identical across the treatment status. However, it is possible that the status of follow-up survey fulfilment can be a function of the treatment status, for example, due to the social pressure (DellaVigna, List and Malmendier, 2012). Because we informed respondents in treatment group that some nurse would visit them for the follow-up survey and vaccination, those with psychic costs of vaccine might have been absent from the follow-up survey or refused to complete the follow-up survey.

Table 2 presents if the fulfillment rate of the follow-up survey is different by the treatment status. We find that the treatment status is not associated with the follow-up survey status (Table 2). The intention to participate in the follow-up survey (Table 2 column 1), the actual completion status of the follow-up survey (column 2), whether they have refused the follow-up survey (column 3), and whether they were absent at the time of the follow-up survey (column 4) were all uncorrelated with the treatment status. Unlike the study from DellaVigna et al (2012), however, our respondents might have found it difficult to be absent at the time of the follow-up survey, even though they did not want to participate, due to the house structure; houses are usually constructed in a way that people can see if anybody is at home or not from the outside.

Table 2 also presents the correlation between the status of follow-up survey fulfillment and

the respondents' characteristics. Muslims are less likely to complete the follow-up survey and they are more likely to refuse to participate in the follow-up survey, although the absence rate is not different between Muslims and non-Muslims. This might be an indication of the distrust among Muslims against the health staffs or people outside of their social network. If a respondent is pregnant, she is less likely to be absent at the time of the follow-up survey. Having paid work is negatively correlated with the refusal of the follow-up survey. This result might be due to the correlation between the work status and trust to others. Respondents who have ever received any injection-type of vaccine were more likely to state that they intended to participate in the follow-up survey, more likely to complete the follow-up survey, less likely to refuse the survey and less likely to be absent at the time of the follow-up. Again, this behavior can be explained by the trust to health staffs. Women who have experiences the injection-type vaccines before are more likely to have the accepting attitude towards health staffs who were interviewers at the follow-up survey.

2 Results

Figure 2 represents the completion rate by the treatment status. As defined earlier, the completion for the control group means that the follow-up survey was conducted, , while the completion for treatment group means that the follow-up survey was conducted and also a respondent received a vaccine right after the follow-up survey. The completion rate is the highest among respondents in control group; over 90 percent of women in the control group completed the follow-up survey. About 85 percent of women in the treatment group completed the follow-up survey and received the vaccine. About 80 percent of respondents in treatment group submitted the voucher for the vaccination, completed the follow-up survey, and received the vaccine.

2.1 Specification

To measure the effects of psychic costs of vaccination, we examine whether the completion rate is different by treatment status. To identify whether psychic costs reduce vaccine take-up in a regression framework, we estimate:

$$Y_{ijk} = \alpha + \beta_1 Treatment_{ijk} + X_{ijk}\mu + v_j + u_k + \epsilon_{ijk} \tag{1}$$

where Y_{ij} is a dummy variable that takes 1 if a woman i in village j who were interviewed by k completes the task (either to complete the follow-up survey for control group, or to complete survey and to receive the vaccine for treatment group); $Treatment$=1 if a woman i is assigned to a treatment group. We control for various characteristics such as age, age squared, education level, marital status, ethnicity, religion, the number of babied delivered, pregnancy status, minutes to the village head's house, total number of household members, roof material, whether a respondent has a paid work, whether a respondent has ever received an injection-type vaccination. We control for the village fixed effect v_j, and interviewer fixed effect u_k.

2.2 Psychic costs of vaccination

Table 3 presents the regression results on the effect of treatment on the completion rate. Using village fixed effects, we find that the completion rate is 7 percentage points lower among women in the treatment group than among women in the control group (Table 3 column 1)[4]. This result indicates that the psychic costs of vaccine reduces the vaccine take-up by 7 percentage points. Because we have the different attrition rate by the treatment status, we conduct several robustness checks. First, we exclude respondents who were interviewed by 5 interviewers, whose attrition rate by their respondents was significantly different by their treatment status. Excluding observations from these 5 interviewers, the main outcome is still significant; the treatment reduces the completion rate by 6.8 percentage points, while the main effect size including all respondents

[4]We get the robust results without covariates.

is 7.8 percentage points without any covariates[5].

Next, we conduct the bound analysis. Following Karlan and Valdivia (2011) and Blattman et al (2014), we report the scenarios that would reduce program impacts: for the attrited respondents in the control group, we impute a high outcome; the found control mean plus 0.25 standard deviations of the found control distribution, while for the treatment group we impute a low outcome, which is the found treatment mean minus 0.25 standard deviations of the found treatment distribution[6]. The effect size dropped from 7.8 percentage points to 2.1 percentage points which is no longer significant. But when we use the standard deviation of 0.22 instead, we find the significant effect with the effect size of 2.8 percentage points. Overall, the robustness checks indicate the consistent existence of psychic costs of vaccination.

To separate the passive refusers and active refusers of vaccine, we introduce the stricter definition of the completion among respondents in treatment group by the submission status of the voucher. Right after the baseline survey, women in the treatment group were first instructed to submit the voucher to a project staff at the house of the village head if they wished to receive a vaccine at the time of the follow-up survey. The stricter definition of the completion for respondents in treatment group is the combination of three conditions; submission of the voucher before the follow-up survey, answering the follow-up survey, and receiving a vaccine right after the follow-up survey. Meanwhile, the stricter definition of the completion remains identical as the definition of the completion among respondents in control group, which is to fulfill the follow-up survey. Table 3 column 2 shows that the strict completion rate is 13.2 percentage points lower among women in the treatment group than among women in the control group.

Combining the result from Table 3 column 1 and column 2, we can separate out the passive refuser and the active refuser of vaccine. From column 2, we find that if the vaccination is costly,

[5]Excluding observations from 5 interviewers reduced the sample size from 599 to 368.

[6]We have the actual observation of the vaccine take-up among many attrited sample. This is because many respondents were found to be ineligible due to the experience of tetanus vaccine or the age after we conducted the survey and experiment. For such cases, we observed whether such ineligible women, who were later considered attrited, decided to take up the vaccine or nor. This attrition due to ineligibility is not correlated with treatment status (Table 0). When conducting the bound analysis, we keep the actual outcome among ineligible sample, whenever available.

for example one needs to visit a health clinic to receive a vaccine, then the vaccine take-up will drop at least by 13.2 percentage points. This 13.2 percentage points include both the active and passive refuser of vaccine. Column 1, on the other hand, captures only the active refuser because women did not have to take any action for them to receive a vaccine. Even if they did not submit the voucher beforehand, they could receive the vaccine at their household if they agreed. Thus, this 7 percentage points of women who refused the vaccine are identified as active refusers who have negative willingness to pay for the vaccine. In other words, these 7 percentage points identify those who refused to receive a vaccine even when the vaccine was available at no cost without having to travel to a clinic. The difference in the refusal rate between column 1 and column 2 indicates the prevalence of the passive refusers because refusers in column 2 (13.2

Overall, we find that psychic costs of vaccine contribute to lower the vaccine take-up by 13.2 percentage points if the vaccination is even slightly costly, such as having to visit a nearby facility. On the other hand, even the vaccination is not costly at all, psychic costs still reduce the vaccine take-up by 7 percentage points.

Table 3 columns 3 and 4 does the same exercise, using village and interviewer fixed effects. By including interviewer's fixed effect, we take into consideration the difference in interviewer's characteristics such as the persuasion. The result is consistent with the one with village fixed effect. Any psychic costs of vaccine reduce the vaccine take-up by 12.7 percentage points (column 4). This 12.7 percentage points include both passive and active refusers. Out of these, 6.6 percentage points (52 percent) are attributed to the active refusers whose willingness to pay for the vaccine is negative (column 3), while the remaining 6.1 percentage points (48 percent) are from the passive refusers whose willingness to pay for the vaccine is close to zero.

2.3 Correlation between Belief and Behavior

Often, convention wisdom is formed from nonexperimental studies using subjective measurement. We compare the subjective measures of psychic costs as barriers to vaccination with the

behavioral effect of psychic costs which we have observed in the previous section.

Table 4 examines the correlation between the subjective belief of the vaccine and the actual vaccine take-up (Panel A) as well as the submission of the voucher (Panel B) among women in the treatment group. We find that some of the subjective measures of the vaccine beliefs are correlated with the actual vaccination behavior. For example, if a respondent indicates that she has a concern that vaccines cause side effects such as fever and headaches, the vaccine take-up is 15.6 percentage points lower than those who did not express the concern of side effects (Panel A column 4). This concern of side effects has larger effect on the stricter completion rate, which is the vaccine take-up and the submission of the voucher. Having the concern of the side effects reduces this stricter completion by 24.2 percentage points, although the difference in coefficients between Panel A and Panel B is not significant.

The similar trend is observed in other variables of subjective measures as well. If a respondent does not care about vaccine, the completion rate is 10.1 percentage points lower than if one cares about the vaccine, and it further reduces the stricter completion by 13.2 percentage points (Table 4 Panel A and B, column 10). If a respondent wants to receive a vaccine when she gets a chance, it increases the vaccine take-up by 16.7 percentage points, and it increases the stricter completion rate, the vaccine take-up and the submission of the voucher, in a similar manner; by 15.2 percentage points (Panel A and B, column 11).

However, the overall correlation between the actual vaccine take-up and the subjective measures of psychic costs of vaccine is weak. Many subjective measures are not significantly correlated with the actual vaccine take-up. Table 5 shows another suggestive, but yet weak, evidence on the correlation between the vaccine take-up and the subjective beliefs on vaccines, from open-ended questions on concerns about vaccines. Table 5 column 1 and 2 compares the actual vaccine take-up among respondents in treatment group by the type of concerns on vaccine take-up. We find that more respondents who did not receive a vaccine state concerns about vaccine, such as being afraid of vaccine, concerns on headache and fever.

This pattern becomes more apparent when we compare respondents in treatment group who submitted the voucher and received the vaccine, and those who did not submit the voucher nor did not receive the vaccine. Particularly, while only 6.32 percent of women who submitted the voucher and received the vaccine listed that they were afraid of vaccines, 15.38 percent of women who did not submit the voucher or did not receive the vaccine mentioned that they were afraid of vaccines (Table 5 column 4 and 3). Similarly, 42.38 percent of women indicated that they did not have any concerns on vaccines among those who submitted the voucher and received the vaccine, while 38.46 percent of women indicated no concerns among those who did not submit the voucher or did not receive the vaccine.

The comparison between column 3 and 4 (Table 5) is more apparent than the comparison between column 1 and 2. This is because column 4 captures accepters of vaccine and column 3 captures both the passive and active refusers, while column 1 captures active refusers and column 2 captures both passive refusers and accepters.

Overall, we find that subjective beliefs of vaccines are associated with the actual vaccine behavior. However, the correlation is not weak. Employing experimental design provides convincing and informative evidence on the existence of psychic costs of vaccine, while observational studies only provide consistent but weak evidence.

3 Conclusion

We measure the causal effect of psychic costs of vaccine on its take-up, through the randomized controlled trial in rural Nigeria among women at childbearing age without previous experience of tetanus vaccination. A randomly selected set of respondents, treatment group, was asked to answer a short survey and additionally to receive a vaccine at their house, while other respondents in control group were asked only to answer the same short survey at their house. We attribute the difference in the vaccine take-up to the psychic costs of vaccination in this experiment. We conduct the experiment at each respondent's household to eliminate the psychic costs they might

have for the health clinic.

We find that psychic costs of vaccine reduce the vaccine take-up by 12.7 percentage points. We further categorize women with these psychic costs of vaccine into two types; passive refusers and active refusers of vaccine. Passive refusers are those whose willingness to pay for vaccines are close to zero, but they can easily accept to receive the vaccine if the physical costs of receiving a vaccine are low enough. For example, they might not visit the clinic to receive a vaccine, but they are likely to accept the vaccine if offered at their household; e.g., the door-to-door campaign. Active refusers, on the other hand, are those whose willingness to pay for vaccines are negative. They actively refuse to receive a vaccine due to the psychic costs of vaccine such as concerns on side effects and personal beliefs against vaccines. We identify that, out of respondents with psychic costs of vaccine, slightly more than half of them, 52 percent, are active refusers and the remaining 48 percent are passive refusers.

Our paper extends the research design of Sato and Takasaki (2017) to distinguish psychic costs of vaccination from psychic costs of clinic visit. While Sato and Takasaki (2017) failed to causally detect the existence of psychic costs due to the flaw of the research design, our study improves the design to prove the importance of psychic costs on the vaccination take-up. Additionally, we contribute to the literature by differentiating the vaccine refusers by the degree of willingness to pay for the vaccination.

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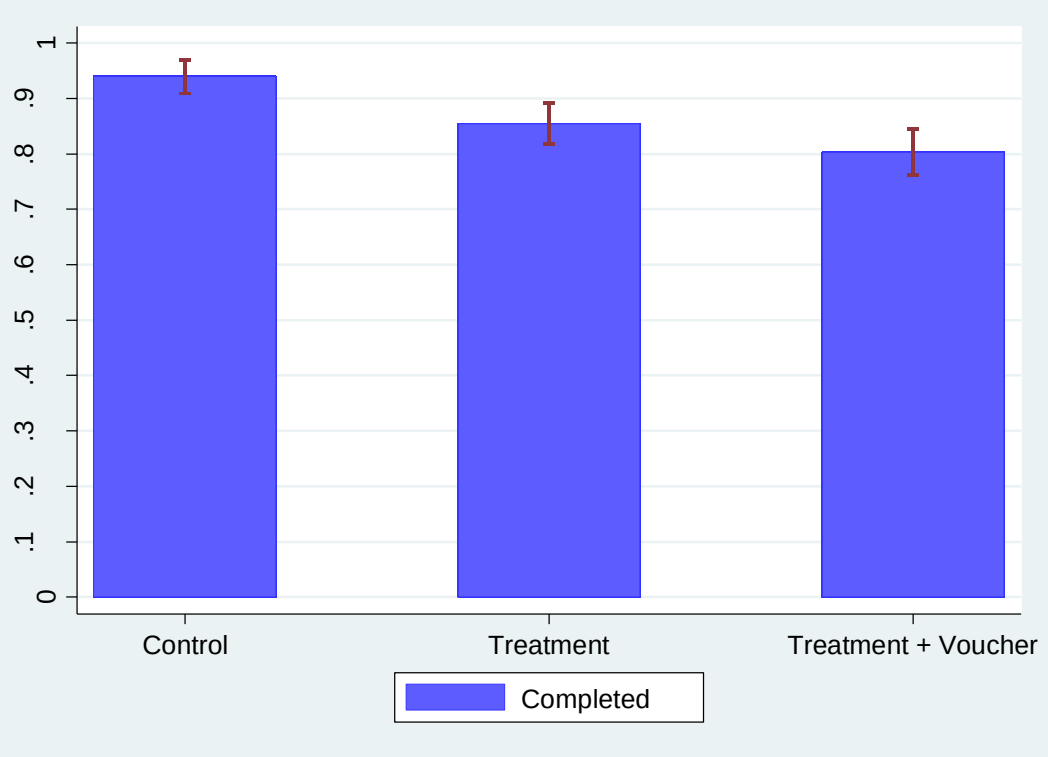
Figure 1: Research Design

	Control group (N=248)	Treatment group (N=351)
"Completion" Condition	Complete Follow-up Survey	Complete Follow-up Survey & Receive Vaccination

Figure 2: Acceptance rate by Treatment Status



Notes: Number of observation = 599. "Completed" under Control = Completed follow-up survey, under Treatment = Completed follow-up survey and received the vaccine, under Treatment + voucher = Completed follow-up survey, received the vaccine, and submitted the voucher

Table 1: Summary Statistics

	N	Control	Treatment	Difference
	(1)	(2)	(3)	(4)
Panel A: Sociodemographic				
Age	599	21.835	21.955	0.120
Education = None	597	0.379	0.358	-0.021
Education = Below Primary	597	0.157	0.129	-0.028
Education = Primary	597	0.335	0.358	0.023
Education = Secondary or more	597	0.129	0.155	0.026
Ever married	598	0.645	0.666	0.021
Single	598	0.355	0.334	-0.021
Ethnicity = Chamba	598	0.573	0.586	0.013
Ethnicity = Fulani	598	0.254	0.254	0.000
Ethnicity = Other	598	0.173	0.16	-0.013
Muslim	599	0.766	0.8	0.034
Number of baby delivered	597	2.020	1.945	-0.075
Number of baby alive	596	1.573	1.526	-0.047
Pregnant	599	0.113	0.145	0.032
Minutes to village head house	566	8.974	6.753	-2.221**
Number of Household members	593	7.976	8.542	0.566
Roof material (Thatch)	593	0.199	0.161	-0.038
Roof material (Palm)	593	0.081	0.072	-0.009
Roof material (Rust)	593	0.049	0.046	-0.003
Roof material (Wood)	593	0.033	0.021	-0.012
Roof material (Metal)	593	0.622	0.686	0.064**
Roof material (Tile)	593	0.016	0.014	-0.002
Has paid work	599	0.435	0.49	0.055
Ever received injection-type vaccine	595	0.494	0.491	-0.003
Panel B: Belief (Strongly agree/agree)				
Vaccines give HIV	599	0.060	0.025	-0.035
Vaccines protect	599	0.181	0.185	0.004
Vaccines are scary	599	0.105	0.16	0.055*
Vaccines give headaches and fever	599	0.089	0.089	-0.000
Vaccines give disease	599	0.141	0.148	0.007
Vaccines help me healthy	599	0.254	0.328	0.074**
Vaccines cure disease	599	0.190	0.231	0.041
My religion is against vaccines	599	0.145	0.122	-0.023
I am against vaccines	599	0.194	0.191	-0.003
I do not care if I receive vaccines or not	599	0.359	0.345	-0.014
I want to receive vaccines if I have a chance	599	0.153	0.165	0.012

Notes: The total number of observation varies from 566 to 599, depending on the missing values. The estimates are without fixed effects, with clustered standard error (village-level). * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Status of Follow-up Survey

	Follow-up Survey Status							
	Intention to participate	Completed	Refused	Absent	Intention to participate	Completed	Refused	Absent
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-0.030	0.016	-0.011	-0.005	-0.021	0.020	-0.014	-0.005
	(0.023)	(0.023)	(0.015)	(0.016)	(0.021)	(0.024)	(0.015)	(0.016)
Age	-0.011	-0.009	0.011	-0.001	-0.021	-0.016	0.018	-0.002
	(0.015)	(0.014)	(0.013)	(0.007)	(0.016)	(0.015)	(0.015)	(0.008)
Age2	0.000	0.000	-0.000	0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education = below primary	0.047**	0.019	-0.001	-0.018	0.041*	0.009	-0.004	-0.005
(control = none)	(0.020)	(0.026)	(0.017)	(0.018)	(0.021)	(0.028)	(0.019)	(0.018)
Education = primary	0.006	0.015	0.002	-0.017	0.001	0.005	0.000	-0.005
(control = none)	(0.033)	(0.035)	(0.018)	(0.025)	(0.034)	(0.036)	(0.018)	(0.026)
Education = secondary or more	0.046	0.017	-0.006	-0.011	0.040	0.002	0.001	-0.003
(control = none)	(0.043)	(0.057)	(0.029)	(0.033)	(0.043)	(0.061)	(0.030)	(0.036)
Single	-0.013	0.034	-0.013	-0.021	-0.023	0.025	-0.008	-0.017
	(0.032)	(0.035)	(0.021)	(0.028)	(0.032)	(0.036)	(0.021)	(0.027)
Ethnicity = Fulani	-0.019	0.039	-0.013	-0.026	-0.026	0.031	-0.003	-0.028
(control=Chamba)	(0.038)	(0.043)	(0.028)	(0.023)	(0.042)	(0.049)	(0.033)	(0.022)
Ethnicity = other	0.026	0.005	0.012	-0.017	0.025	0.000	0.005	-0.005
(control=Chamba)	(0.029)	(0.042)	(0.026)	(0.033)	(0.033)	(0.038)	(0.025)	(0.029)
Muslim	-0.004	-0.074**	0.057*	0.017	-0.002	-0.067**	0.052*	0.015
	(0.032)	(0.032)	(0.031)	(0.014)	(0.036)	(0.029)	(0.029)	(0.011)
Number of babies delivered	-0.009	0.001	-0.002	0.001	-0.008	0.001	-0.002	0.001
	(0.006)	(0.005)	(0.005)	(0.003)	(0.006)	(0.005)	(0.005)	(0.003)
Currently pregnant	0.020	-0.030	0.049*	-0.020	0.019	-0.029	0.042*	-0.013
	(0.027)	(0.036)	(0.026)	(0.027)	(0.025)	(0.035)	(0.024)	(0.028)
Minutes to village head house	0.000	0.000	0.001	-0.001*	0.000	0.000	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Total number of HH members	-0.003	-0.002	0.003*	-0.001	-0.003	-0.002	0.003*	-0.001
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
Roof material = palm	-0.131**	0.010	-0.005	-0.005	-0.131*	-0.004	0.011	-0.008
(control=Thatch)	(0.058)	(0.036)	(0.021)	(0.027)	(0.072)	(0.042)	(0.027)	(0.029)
Roof material = rust	-0.079	-0.010	-0.010	0.020	-0.084*	-0.051	0.027	0.024
(control=Thatch)	(0.048)	(0.023)	(0.018)	(0.018)	(0.047)	(0.032)	(0.026)	(0.021)
Roof material = wood	-0.036	-0.039	0.020	0.019	-0.046	-0.054	0.030	0.025
(control=Thatch)	(0.034)	(0.030)	(0.021)	(0.021)	(0.051)	(0.039)	(0.032)	(0.021)
Roof material = metal	-0.048**	-0.036	0.025	0.012	-0.033	-0.031	0.022	0.009
(control=Thatch)	(0.021)	(0.024)	(0.017)	(0.016)	(0.022)	(0.025)	(0.020)	(0.016)
Roof material = tile	-0.219*	-0.118	0.120	-0.002	-0.221*	-0.148*	0.134	0.014
(control=Thatch)	(0.129)	(0.084)	(0.099)	(0.025)	(0.110)	(0.088)	(0.091)	(0.030)
Has paid work	0.013	0.046**	-0.027**	-0.020	0.025	0.055**	-0.024**	-0.031
	(0.016)	(0.018)	(0.013)	(0.016)	(0.015)	(0.022)	(0.011)	(0.021)
Ever received injection-type vaccine	0.055***	0.050***	-0.028*	-0.022*	0.048**	0.054***	-0.026*	-0.028**
	(0.020)	(0.017)	(0.015)	(0.012)	(0.022)	(0.019)	(0.015)	(0.014)
Constant	1.131***	1.066***	-0.151	0.085	1.266***	1.246***	-0.275	0.029
	(0.187)	(0.198)	(0.175)	(0.107)	(0.227)	(0.231)	(0.206)	(0.116)
N	553	553	553	553	553	553	553	553
r2	0.068	0.050	0.051	0.029	0.101	0.074	0.082	0.060
Mean of dependent variable among control	0.974	0.939	0.030	0.030	0.974	0.939	0.030	0.030
Covariates	X	X	X	X	X	X	X	X
Fixed Effects (Village)	X	X	X	X				
Fixed Effects (Village + Interviewer)					X	X	X	X

Notes: Sample used here is the main sample of 599 women. 46 observations are dropped due to the missing values mainly in the variable of minutes to village head's house. Robust standard errors clustered by villages (41 villages) are presented. Mean of dependent variable is the value among the control group. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Main Results

Definition of "Completed"	Completed For Control: Follow-up Interview For Treatment: Received Vaccine + Follo-up Interview	For Treatment: Submitted Voucher + Received Vaccine + Follo-up Interview	For Treatment: Received Vaccine + Follo-up Interview	For Treatment: Submitted Voucher + Received Vaccine + Follo-up Interview
	(1)	(2)	(3)	(4)
Treatment Status (=1 if Treatment)	-0.070**	-0.132***	-0.066**	-0.127***
	(0.029)	(0.037)	(0.032)	(0.038)
N	553	553	553	553
r2	0.066	0.092	0.166	0.171
Mean of dependent variables	0.939	0.939	0.939	0.939
Covariates	X	X	X	X
Fixed Effects (Village)	X	X		
Fixed Effects (Village + Interviewer)			X	X

Notes: Sample used here is the main sample of 599 women. 46 observations are dropped due to the missing values mainly in the variable of minutes to village head's house. Robust standard errors clustered by villages (41 villages) are presented. Covariates are age, age squared, education level, marital status, ethnicity, religion, the number of babied delivered, pregnancy status, minutes to the village head's house, total number of household members, roof material, whether a respondent has a paid work, whether a respondent has ever received an injection-type vaccination. Mean of dependent variable is the value among the control group. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Beliefs and Vaccine Take-up among Treated Women

Sample	Only Treatment																					
Dependent variable	Completed											Completed										
Definition of "Completed"	For Control: Follow-up Interview For Treatment: Received Vaccine + Follo-up Interview											For Control: Follow-up Interview For Treatment: Submitted voucher + Received Vaccine +										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Vaccine causes HIV	-0.000											0.000										
	(0.133)											(0.150)										
Vaccine protects me		-0.092											-0.079									
		(0.101)											(0.088)									
Vaccine needle is scary			-0.106											-0.050								
			(0.074)											(0.084)								
Vaccine causes fever/headache				-0.156*											-0.242**							
				(0.083)											(0.100)							
Vaccine gives disease					-0.083											-0.028						
					(0.069)											(0.070)						
Vaccine helps me stay healthy						-0.031											-0.121					
						(0.080)											(0.083)					
Vaccine cures disease							-0.013											0.046				
							(0.073)											(0.069)				
My religion is against vaccine								-0.054											-0.009			
								(0.065)											(0.070)			
I am against vaccine									-0.104											-0.098		
									(0.070)											(0.080)		
I do not care about vaccine										-0.101*											-0.132**	
										(0.060)											(0.062)	
I want to get vaccine when I have a chance											0.167**											0.152*
											(0.070)											(0.077)
Constant	1.487***	1.473***	1.502***	1.495***	1.509***	1.491***	1.500***	1.522***	1.546***	1.493***	1.404***	1.286**	1.274**	1.293**	1.298**	1.293**	1.302**	1.241**	1.292**	1.342**	1.294**	1.210**
	(0.381)	(0.369)	(0.360)	(0.372)	(0.392)	(0.373)	(0.373)	(0.382)	(0.389)	(0.372)	(0.362)	(0.528)	(0.514)	(0.510)	(0.511)	(0.532)	(0.511)	(0.512)	(0.526)	(0.526)	(0.503)	(0.512)
N	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322
r2	0.256	0.260	0.265	0.269	0.262	0.257	0.256	0.258	0.266	0.268	0.270	0.277	0.280	0.279	0.305	0.278	0.287	0.279	0.277	0.285	0.295	0.287
Covariates	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fixed Effects (Village + Interviewer)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Notes: Sample used here is the sample of 322 women under Treatment group. 29 observations are dropped due to the missing values mainly in the variable of minutes to village head's house. Robust standard errors clustered by villages (41 villages) are presented. Covariates are age, age squared, education level, marital status, ethnicity, religion, the number of babied delivered, pregnancy status, minutes to the village head's house, total number of household members, roof material, whether a respondent has a paid work, whether a respondent has ever received an injection-type vaccination. Mean of dependent variable is the value among the control group. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Concerns on Receiving Vaccine

	What are the concern when receiving vaccine? (%)			
			Only Treatment	
Sample:	Did not receive vaccine	Received vaccine	Did not submit voucher | Did not receive vaccine	Submitted voucher & Received vaccine
	(1)	(2)	(3)	(4)
I am afraid of vaccine	10.42	7.69	15.38	6.32
Headache	2.08	0.35	1.54	0.37
Fever	6.25	4.20	4.62	4.46
Swelling	2.08	1.40	3.08	1.12
Sick	0.00	1.75	0.00	1.86
Painful	16.67	19.93	16.92	20.07
Afraid of needle	14.58	13.64	12.31	14.13
Vaccine is harmful	2.08	1.05	1.54	1.12
Vaccine make women infertile	2.08	0.70	1.54	0.74
Distance to clinic	2.08	2.10	1.54	2.23
No vaccine at clinic	0.00	0.70	0.00	0.74
Smell of clinic	0.00	0.35	0.00	0.37
Long waiting time	0.00	0.35	0.00	0.37
Husband does not allow	0.00	0.35	0.00	0.37
No knowledge about vaccine	2.08	3.15	3.08	2.97
Do not know where to get vaccin	0.00	0.35	0.00	0.37
No concern	39.58	41.96	38.46	42.38
Number of observations	48	286	65	269

Notes: Sample used here is the sample of 351 women under Treatment group who has the information on open-ended vaccine questions.