

Water Access and Time Allocation: Evidence from Jal Jeevan Mission in India

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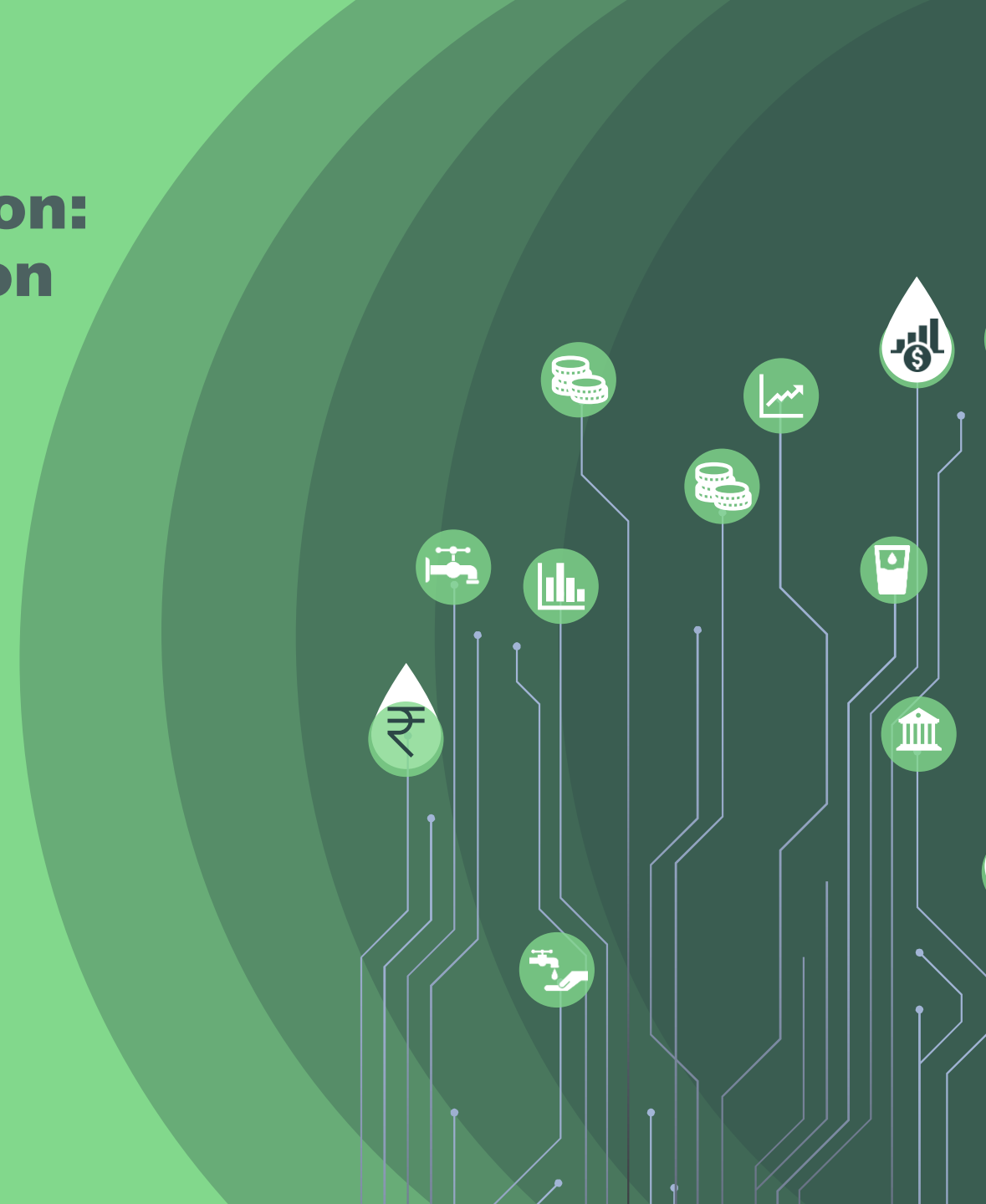
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Introduction

- This study examines the impact of the Jal Jeevan Mission (JJM) on female time allocation, focusing on young girls' educational engagement and the burden of fetching water.
- JJM ensures the installation of Functional Household Tap Connections (FHTCs) to deliver water directly to homes, minimizing the effort required for water collection.
- Jal Jeevan Mission focused solely on providing FHTC in rural households.
- JJM has three key outcome dimensions: health, social, and economic (Annual Report 2019–20).
- The social outcome focuses on reducing the burden on women and girls and lowering dropout rates at the upper primary level.
- This study specifically examines the societal outcome of JJM.

Research Question

- To what extent does the expansion of infrastructure translate into measurable changes in time allocation and human capital investment?
- Does the Jal Jeevan Mission Influence Girls' Learning Outcomes?
- Does the provision of household water connections under JJM enhance school attendance among girls?
- Has JJM reduced the time girls and women spend on water collection?
- If the time spent fetching water decreases, is that time reallocated to other activities?

Objective

- Analyze learning outcomes among unmarried females (ages 6–18) in rural India.
- Categorize individuals into educational cohorts (6–11, 12–14, 15–16, 17–18) to assess cohort-specific impacts of JJM on learning outcomes.
- Examine the reduction in time spent fetching water across all female age groups.
- Evaluate whether the time saved is effectively reallocated toward education, skill development, or other productive activities.

Policy Background: Jal Jeevan Mission

- The Jal Jeevan Mission (JJM), launched in 2019, aims to provide Functional Household Tap Connections (FHTCs) to all rural households under the “Har Ghar Jal” vision.
- The policy addresses the high time burden of water collection in rural India, which disproportionately affects women and girls.
- By improving access to safe and reliable drinking water, JJM is expected to reduce waterborne diseases and enhance overall health outcomes.
- Reduced time spent fetching water can increase participation of women and girls in education and other productive activities.
- The mission also generates rural employment and promotes sustainability through community participation, water conservation, and focus on water-stressed regions and public institutions.

Data

Time Use Survey Data

- The empirical analysis uses nationally representative microdata from the **Time Use Survey (TUS)** conducted by the National Statistical Office (NSO) in **2019 and 2024**.
- TUS captures individual time allocation across activities using a 24-hour diary method (4:00 A.M. to 4:00 A.M.), enabling detailed analysis of behavioral responses to infrastructure interventions.
- Activities are classified into a standardized framework with **9** major groups and **165** sub-categories, covering work, education, domestic services, caregiving, leisure, and personal care.
- The 2019 round includes 138,799 households; the study restricts the sample to rural households (**≈82,890**) after merging with Jal Jeevan Mission (JJM) administrative data.
- The 2024 round covers 454,192 individuals across 139,487 households, with consistent methodology ensuring comparability across survey rounds.
- Combining 2019 and 2024 data creates a **repeated cross-sectional** dataset to assess changes in time use associated with expanded household water access under JJM.

Major Activity Categories in the TUS Dataset

Activity 1	Employment and related activities
Activity 2	Production of goods for own final use
Activity 3	Unpaid domestic services for household and family members
Activity 4	Unpaid caregiving services for household and family members
Activity 5	Unpaid volunteer, trainee, and other unpaid work
Activity 6	Learning
Activity 7	Socializing and communication, community participation and religious practice
Activity 8	Culture, leisure, mass media, and sports practices
Activity 9	Self-care and maintenance

Table 1: Major Activity Number and Their Descriptions

Table 2: Classification of Independent Variables

Category	Variables
Individual-level (Independent variables)	Age, Highest education and marital status
Household-level (Independent variables)	Usual monthly consumer expenditure, Household size, Number of female members in a household, Land possessed as on the date of survey, Type of structure of dwelling unit, Religion, Social Group
Geographical-level (Fixed Effects)	District
Time-level (Fixed Effects)	Day and Subround

Time Use Survey

- The survey period is divided into subrounds, each covering a three-month interval.
- The 2019 TUS consists of four subrounds: January–March, April–June, July–September, and October–December.
- The 2024 TUS follows the same quarterly subround structure, ensuring consistency.
- The combined dataset includes eight subrounds across both survey years.
- This structure allows the analysis to control for seasonal variation in time-use patterns.

Jal Jeevan Mission Data

- The study uses district-level administrative data on the implementation of the Jal Jeevan Mission (JJM), which aims to provide Functional Household Tap Connections (FHTCs) to all rural households.
- The dataset provides monthly information on new FHTCs across districts, enabling the construction of a panel to track program rollout over time.
- It includes total rural households at the district level, allowing computation of coverage rates and assessment of program reach.
- The first recorded connections appear from October 2019, with rollout progressing gradually and unevenly across districts due to administrative and infrastructural differences.
- A cumulative measure of household tap connections is constructed to capture district-level exposure to the program over time.

Jal Jeevan Mission Data

- Monthly data are aggregated into quarterly subrounds to align with the Time Use Survey structure and account for temporal variation.
- The analysis covers **662** rural districts, revealing significant heterogeneity in early implementation.
- By subround 4, **290** districts had received at least some connections, while full coverage across all districts is observed by subround 5 (January–March 2024).

Empirical Strategy

- Uses **district-level variation over time** as water connections expand unevenly
- Applies a **fixed effects model** (district + time) to control for unobserved factors
- Identification comes from **within-district changes in water access**
- Results show **associations, not strict causality**, due to possible correlation with development factors

Construction of Exposure Measures

Dataset records cumulative connections using variables of the form $M_{j_S_{dt}}$, where $j \in \{0,1,2,3\}$ denotes the month within subround t , and $t \in \{1,\dots,8\}$ denotes the survey subround. The variables are reshaped from wide to long format to generate four exposure measures for each district and subround:

- $M_{0_S_{dt}}$: cumulative number of connections at the beginning of subround t ,
- $M_{1_S_{dt}}$: cumulative number of connections after the first month of the subround,
- $M_{2_S_{dt}}$: cumulative number of connections after the second month of the subround,
- $M_{3_S_{dt}}$: cumulative number of connections at the end of the subround.

The four measures capture changes in water access within each subround; one is used as the baseline exposure, while the others (M1, M2, M3) are used to check robustness and assess whether results depend on the timing of infrastructure rollout.

Econometric Specification

The baseline specification is estimated as follows:

$$Y_{ihdt} = \beta_j M_{j,dt} + X'_{iht} \gamma + \delta_d + \lambda_t + \epsilon_{ihdt}$$

Y_{ihdt} represents the time spent on a particular activity by individual i in household h , district d , at time t .

$M_{j,dt}$ denotes district-level exposure to cumulative household water connections, where $j \in \{1,2,3,4\}$ corresponds to exposure measured at the beginning of first month, after one month, after two months, and at the end of the survey subround.

X_{iht} is a vector of individual and household control variables.

δ_d denotes district fixed effects.

λ_t denotes time fixed effects

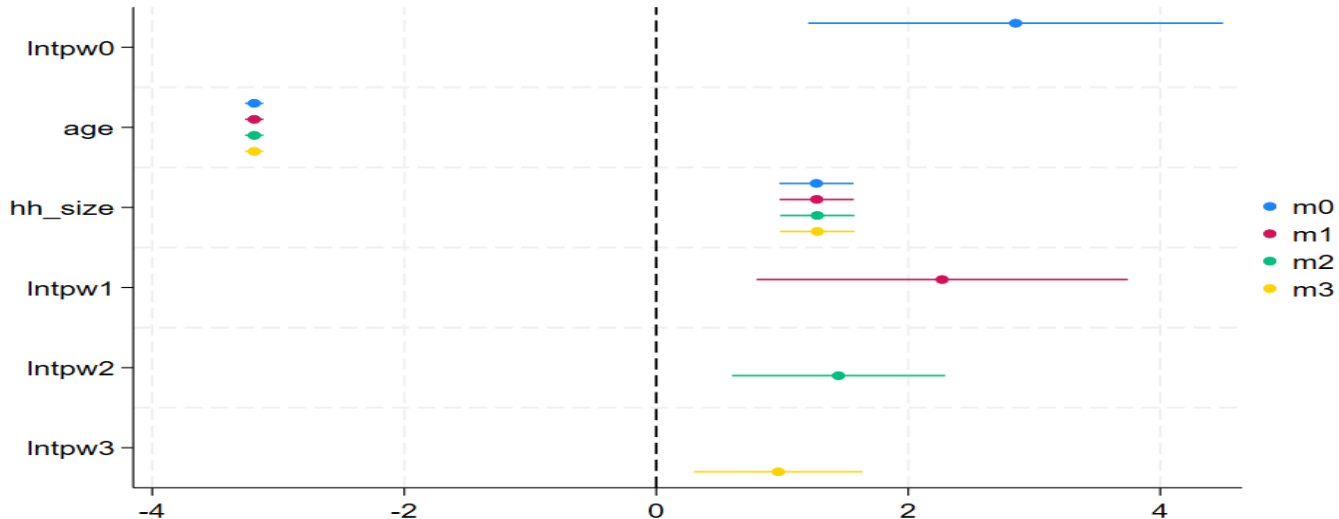
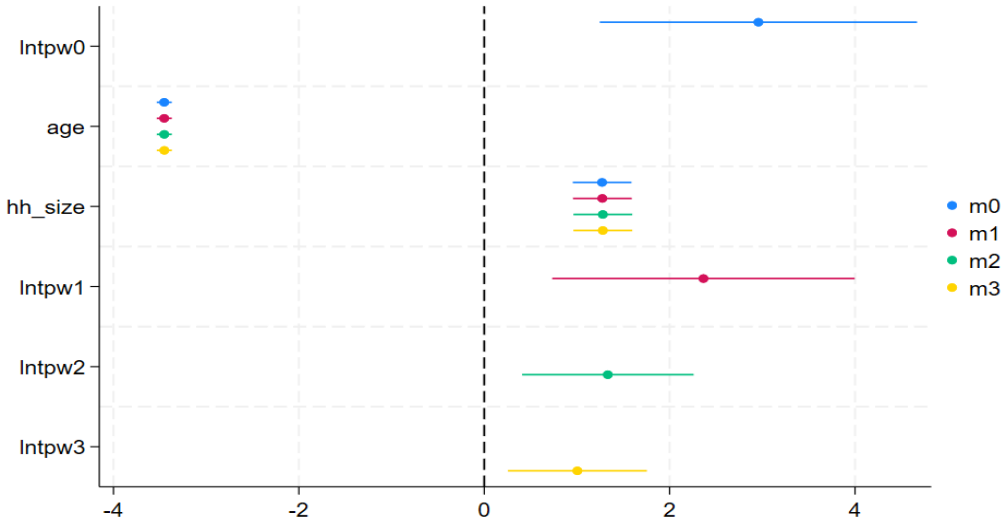
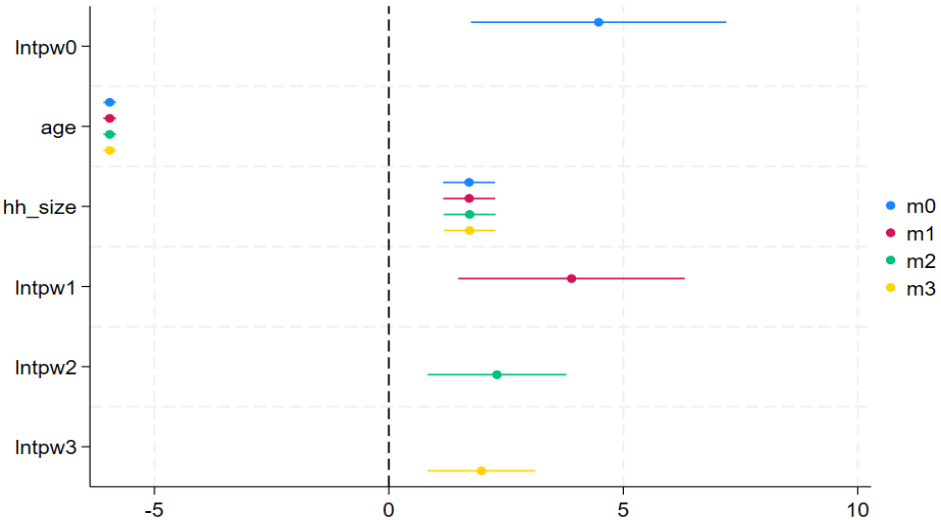
Results

Table 4: Exposure to Water Connections and Time Allocation: All Females

Activity	$M0_S$	$M1_S$	$M2_S$	$M3_S$
Learning activities	4.474***	3.897***	n.s.	-3.363
Formal education	2.958***	2.365***	n.s.	n.s.
Attending school/university	2.852***	2.269***	n.s.	n.s.
Fetching water (overall)	0.273	0.171	n.s.	n.s.
Fetching water outside household	2.142***	1.844***	n.s.	n.s.
Employment and Related activities	n.s.	2.31*	n.s.	-2.514
Production of goods for own final use	2.825**	1.950*	n.s.	-2.514
Unpaid domestic services	-18.74***	-14.29***	n.s.	-6.148
Unpaid volunteer, trainee and other unpaid work	1.20***	0.829***	-5.11***	15.757***
Culture, leisure, mass media and sports	n.s.	n.s.	n.s.	15.757***
Self-care and maintenance	n.s.	-2.646	n.s.	1.304
District Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Coefficient plot for Learning Outcome



Heterogeneity by Age Group

Table 5: Exposure to Water Connections and Time Allocation: Females Under 18

Activity	$M0_S$	$M1_S$	$M2_S$	$M3_S$
Learning activities	n.s.	n.s.	n.s.	4.65**
Formal education	n.s.	n.s.	n.s.	3.29**
Attending school/university	n.s.	n.s.	n.s.	2.12*
Fetching water (overall)	n.s.	n.s.	n.s.	n.s.
Fetching water outside household	n.s.	n.s.	n.s.	n.s.
Unpaid caregiving services for household and family members	-1.12**	-0.95**	-0.70***	-0.36*
Socializing and communication	n.s.	-5.27*	n.s.	n.s.
Culture, leisure, mass media and sports	n.s.	n.s.	n.s.	n.s.
Self-care and maintenance	n.s.	-4.66**	n.s.	n.s.
District Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

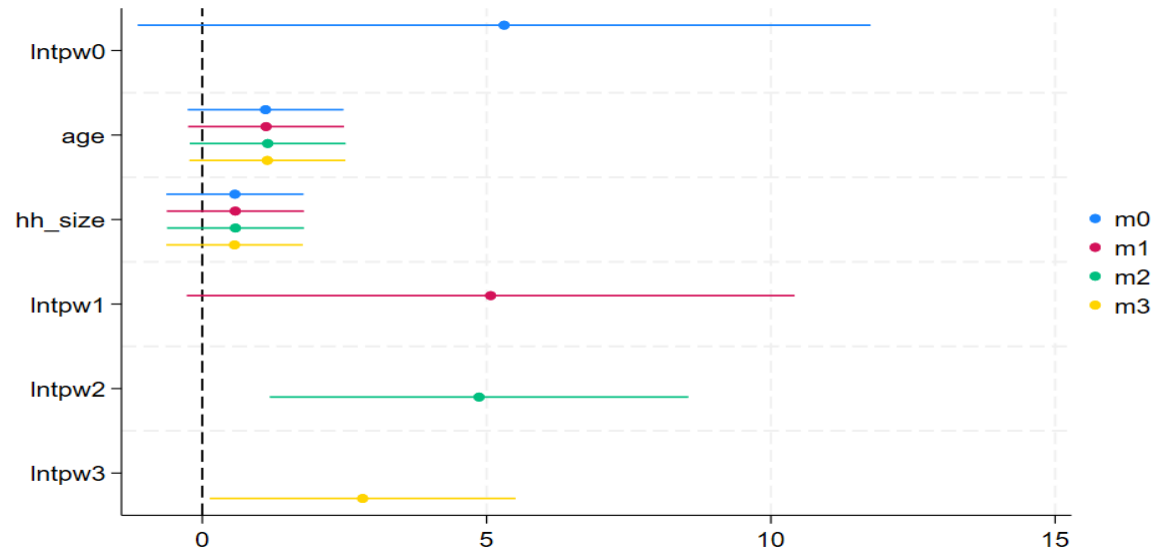
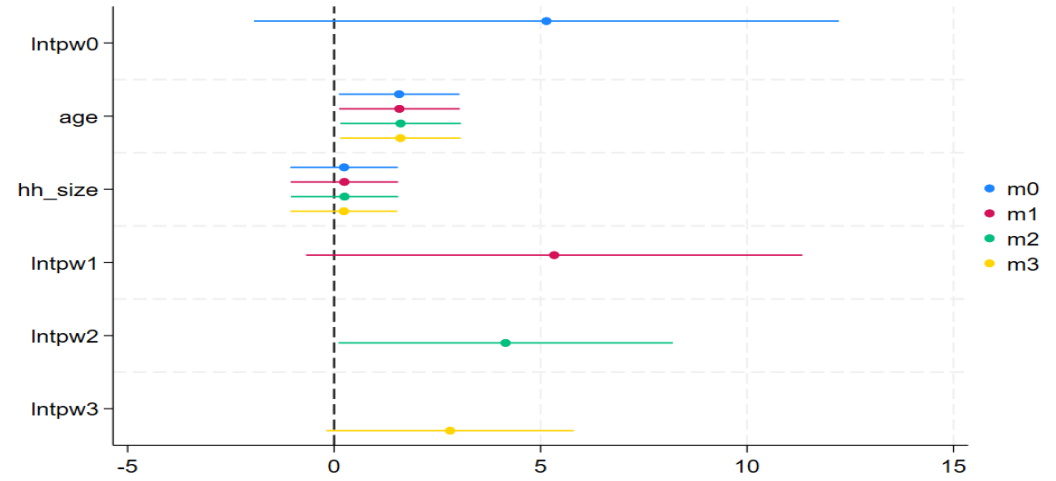
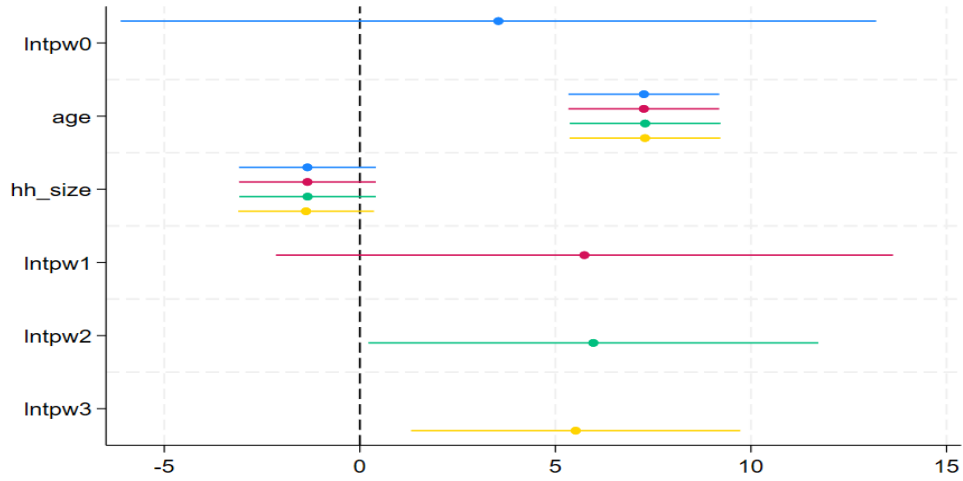
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Sub - group Analysis

Table 1: Effect on Learning Activities for the subgroup 6-11

	$M0_s$	$M1_s$	$M2_s$	$M3_s$
Learning	3.54 (4.92)	5.74 (4.02)	5.97** (2.93)	5.52** (2.14)
Formal education	5.14 (3.61)	5.33* (3.06)	4.15** (2.06)	2.81* (1.53)
Attendance	5.31 (3.28)	5.07* (2.72)	4.87*** (1.88)	2.82** (1.37)
District Fixed Effects	Yes	Yes	Yes	Yes
Day Fixed Effects	Yes	Yes	Yes	Yes
Robust standard errors in parentheses				
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$				

Coefficient Plot



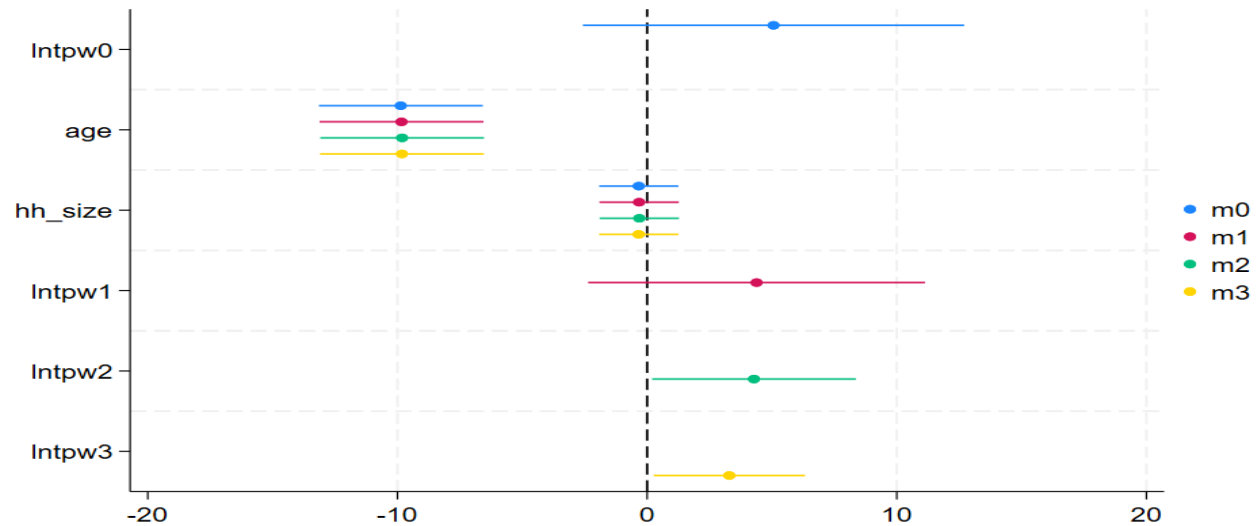
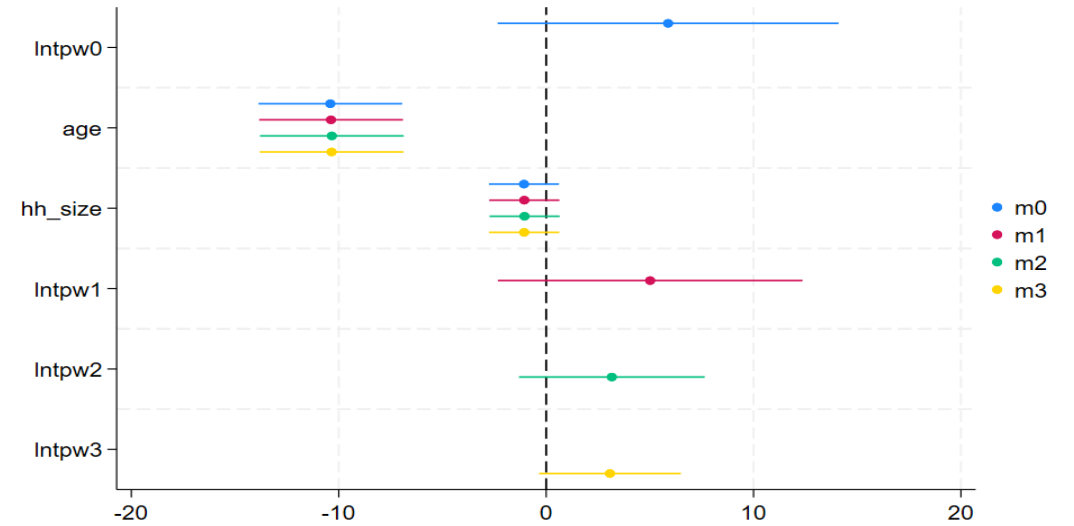
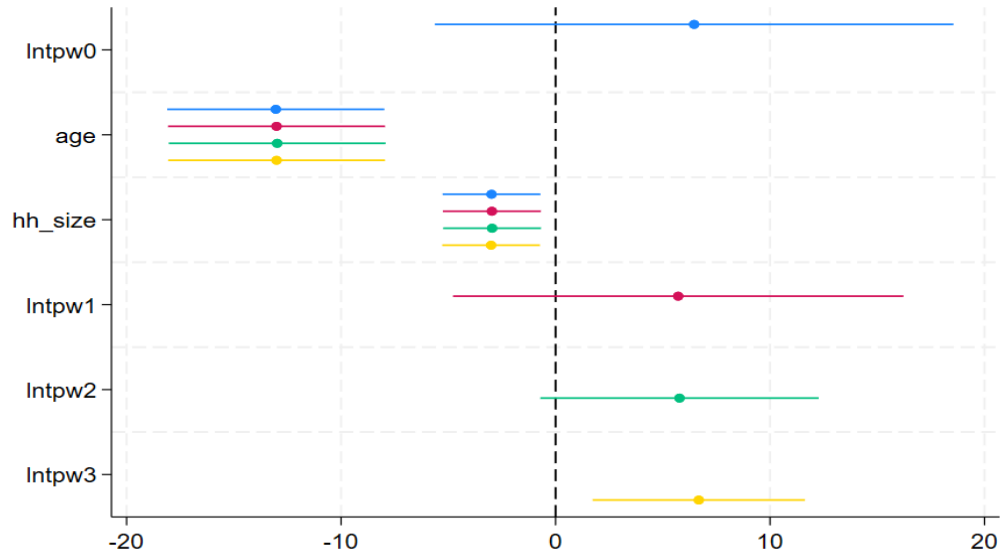
Sub - group Analysis

Table 2: Effect on Learning Activities for the subgroup 12-14

	$M0_s$	$M1_s$	$M2_s$	$M3_s$
Learning	6.46 (6.16)	5.72 (5.35)	5.78* (3.30)	6.68*** (2.52)
Formal education	5.88 (4.19)	5.02 (3.74)	3.17 (2.28)	3.08* (1.74)
Attendance	5.06 (3.89)	4.38 (3.43)	4.28** (2.08)	3.29** (1.54)
District Fixed Effects	Yes	Yes	Yes	Yes
Day Fixed Effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
 *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Coefficient plot



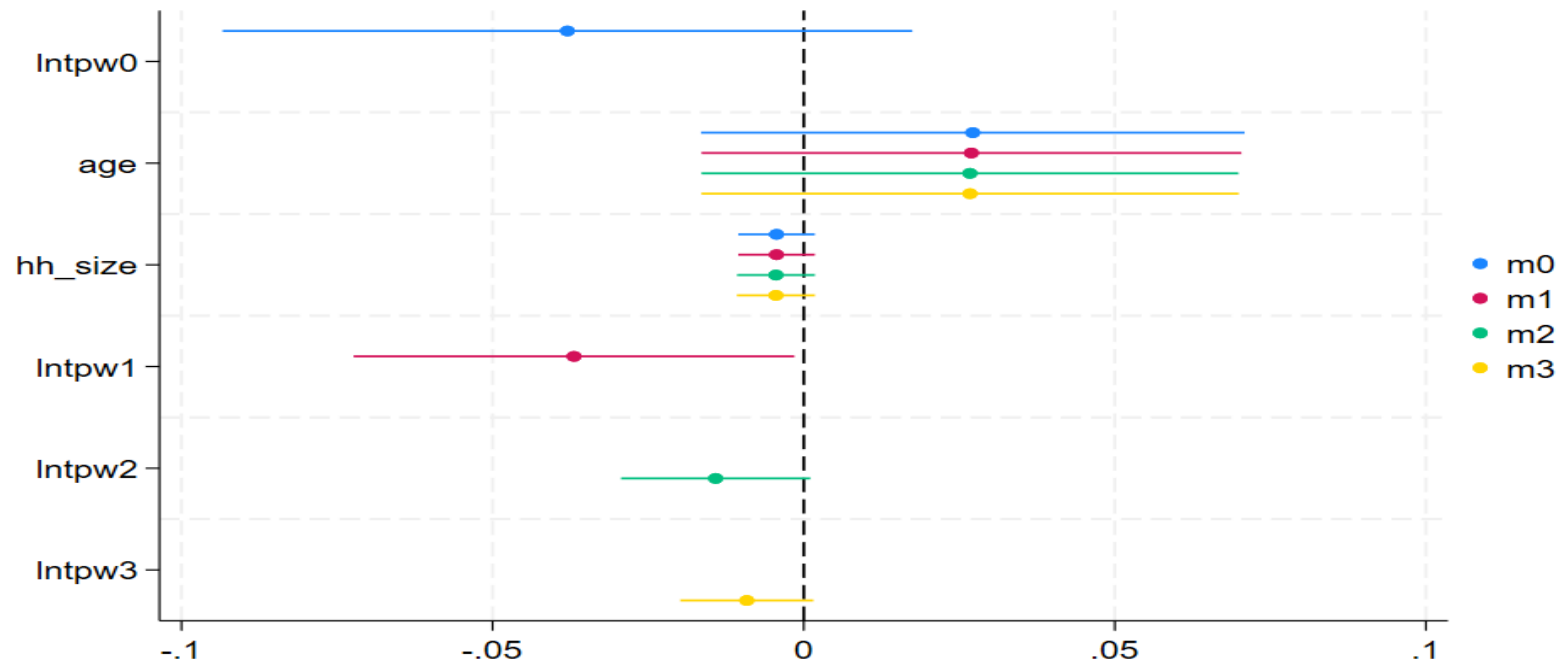
Sub - group Analysis

Table 3: Effect on Fetching water for the subgroup 15-16

	$M0_s$	$M1_s$	$M2_s$	$M3_s$
fetching water from nonfixed location	-0.04 (0.03)	-0.04** (0.02)	-0.01* (0.01)	-0.01* (0.01)
District Fixed Effects	Yes	Yes	Yes	Yes
Day Fixed Effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$



Sub - group Analysis

Table 6: Exposure to Water Connections and Time Allocation: Unmarried Females Aged 30–40

Activity	$M0_s$	$M1_s$	$M2_s$	$M3_s$
Fetching water (total)	-3.369**	-2.644**	n.s.	-1.174*
Fetching water inside household	-1.567	n.s.	n.s.	n.s.
Fetching water outside household	-3.224**	n.s.	n.s.	n.s.
Unpaid domestic services	n.s.	-19.63*	n.s.	15.243***
Unpaid caregiving services	-4.49*	-3.62*	n.s.	14.731***
Culture, leisure, mass media and sports	n.s.	21.43**	16.64***	15.757***
Self-care and maintenance	17.13*	15.54*	n.s.	n.s.
District Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Conclusion

- **Heterogeneous effects:** Impact of piped water exposure varies by age group and activity; not uniform across women.
- **Overall sample:**
 - A modest increase in learning (early exposure(females) and late exposure(6-18age)) and leisure (later exposure)
 - No significant decline in water-fetching time → weak time-saving mechanism
- **Subgroup results:** Learning gains are observed for girls (6–11, 12–14) without any reduction in water-fetching time, indicating no time-reallocation mechanism; for ages 15–16, water-fetching time declines but does not translate into higher learning (no human capital reallocation); in contrast, unmarried women (30–40) experience reduced water collection time, with reallocation toward leisure, self-care, and well-being activities.
- **Economic interpretation & takeaway:** Infrastructure expansion does not automatically reduce time burdens; time-use responses remain limited and context-specific, with little evidence of JJM-driven reallocation toward learning and an important role for behavioural and intra-household constraints.

Conclusion

- Infrastructure access does not automatically translate into welfare gains without complementary behavioural or institutional changes.
- A key limitation is the absence of data on water quality and reliability; therefore, while access to tap connections increases, the lack of consistent supply may explain the limited time reallocation, and the modest improvements in educational outcomes may instead reflect other concurrent policies or broader development trends rather than a direct effect of JJM.

Thank You

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