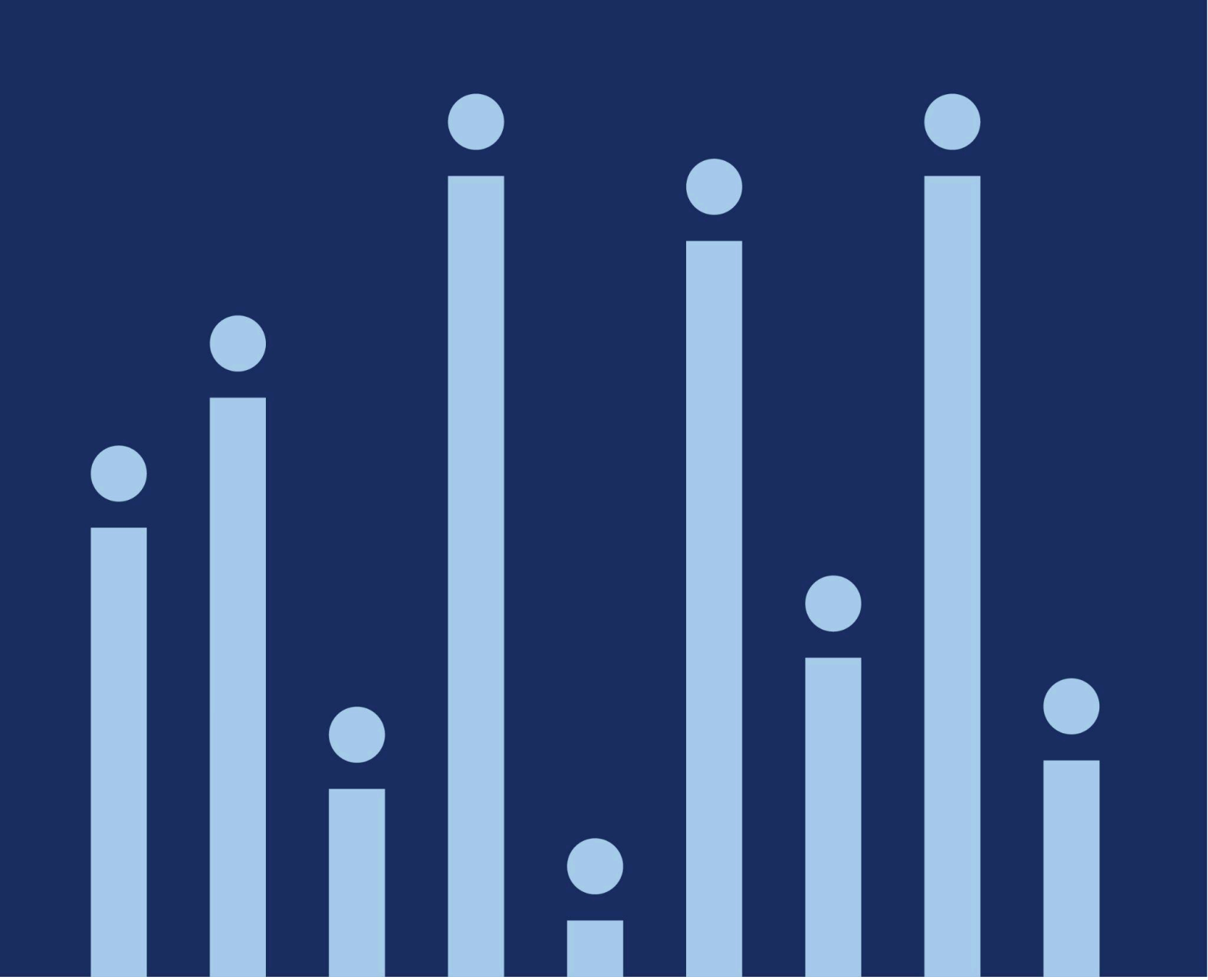

Mobilized Communities Impact Evaluation

Endline II Report

IDinsight

Mobilized Communities Impact Evaluation
Endline Report

September 2025

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About IDinsight

IDinsight uses data and evidence to help leaders combat poverty worldwide. Our collaborations deploy a large analytical toolkit to help clients design better policies, rigorously test what works, and use evidence to implement effectively at scale. We place special emphasis on using the right tool for the right question, and tailor our rigorous methods to the real-world constraints of decision-makers.

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Acronyms

A-WEAI	Abbreviated Women's Empowerment in Agriculture Index
BL	Baseline
BSCs	Bicycle Supervisory Committees
CBVs	Community based volunteers
CSWs	Community Service Workers
DID	Difference-in-Differences
EL1	Endline 1
EL2	Endline 2
HHS	Household Hunger Scale
IPWs	Inverse-probability weights
ITT	Intention-to-Treat
LGMs	Livelihood Group Members
MC	Mobilized Communities
OLS	Ordinary Least Squares
PPI	Poverty Probability Index
RCT	Randomized Controlled Trial
TOT	Treatment-on-the-Treated
WBR	World Bicycle Relief
ZMW	Zambian Kwacha

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Executive Summary

IDinsight partnered with World Bicycle Relief (WBR) to conduct a randomized controlled trial (RCT) of the Mobilized Communities (MC) program in Mumbwa district, Zambia. The program distributed Buffalo Bicycles to Livelihood Group Members (LGMs) and Community Service Workers (CSWs) in July 2023. Endline data was first collected from treatment and control respondents in May-June 2024, one year after distribution, showing large and positive impacts from bicycles on economic livelihoods and productivity during a severe drought. This report presents findings from a second endline conducted in May–June 2025, or two years after the distribution of bicycles.

Key Findings

For treatment LGMs, compared to control LGMs

- The impact of bicycles on economic welfare increased between Endline 1 and Endline 2: At EL2, the effect on household monthly consumption was ZMW 1,190 ($47, 29%), compared to ZMW 875 ($33, 24%) at EL1. The effect on household monthly income was ZMW 743 ($29, 36%), compared to ZMW 625 ($24, 49%) at EL1. The effect on household assets was ZMW 14,653 ($575, 28%), compared to ZMW 14,217 ($537, 33%) at EL1.
- Travel time was lower by 57 minutes per day, and time spent on productive work was 0.7 extra hours greater (which amounts to 4.4 hours over a 6-day work week). Treatment households earned ZMW 262 ($10, 28%) more in monthly business revenue.
- LGMs had 11% higher dietary diversity, with higher spending on protein-rich foods, and experienced fewer events of food insecurity.

For treatment CSWs, compared to control CSWs

- CSWs shifted from walking to cycling, saving time and investing an extra hour daily in farming.
- They transported on average six patients to health centers on the bicycles per month, making bicycles vital for community health and emergencies.
- Whereas at EL1 CSWs primarily used bicycles to reach more clients, at EL2 CSWs shifted use toward improving their livelihoods. The impact of the bicycle on the number of patients reached declined between EL1 and EL2, but the impact on CSW economic livelihoods increased.
- At EL2, the effect on household monthly consumption was ZMW 1,326 ($52, 30%), compared to ZMW 783 ($30, 21%) at EL1. The effect on household monthly income was ZMW 1,438 ($56, 77%), compared to ZMW 180 ($7, 12%, statistically insignificant) at EL1. The effect on household assets was ZMW 20,896 ($820, 34%), compared to ZMW 9,607 ($363, 18%) at EL1.

Endline 1 (2024), conducted during a severe drought, showed that bicycles helped households maintain income and consumption while controls experienced sharp declines. Endline 2 (2025), conducted in a recovery year, shows bicycles also enable faster growth. This highlights their dual role as resilience tools and growth accelerators.

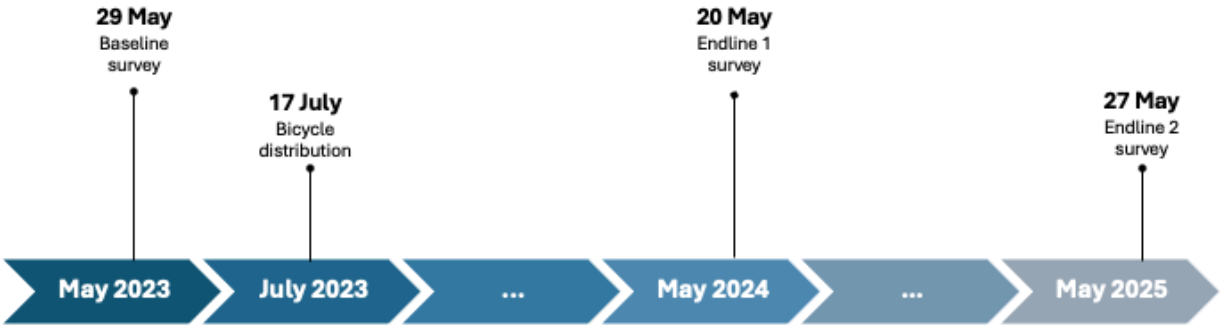
The evaluation confirms MC program as an impactful and cost-effective intervention that reduces transport barriers, improves household welfare, and strengthens community resilience. Scaling bicycle access, investing in maintenance systems, and embedding gender-equity strategies will further amplify impact.

1. Introduction

IDinsight has partnered with World Bicycle Relief (WBR) to conduct a multi-year randomized controlled trial (RCT) to estimate the causal impact of WBR's Mobilized Communities (MC) program on key socio-economic outcomes. The MC program provides purpose-built "Buffalo Bicycles" to individuals in rural communities to help them overcome significant transportation barriers to education, healthcare, and economic opportunities.

This evaluation builds upon a baseline survey (May-June 2023) and a first endline survey (May-June 2024). Buffalo bicycle recipients had $33 (ZMW 867) or 24% higher average monthly household consumption and $21 (ZMW 553) or 43% higher monthly household income compared to the control group after one year from distribution. Community based volunteers (CBVs) who received bicycles, served more clients and experienced fewer transport related challenges. This highlights the bicycle's role in fostering economic resilience, and productivity particularly during a severe national drought experienced from approximately October 2023 through March 2024. Conducted in May-June 2025, the Endline 2 survey assesses the sustained impact of the program over a two-year period. For a detailed overview of the MC program, its theory of change, and findings from Endline 1, please refer to the Endline 1 report (IDinsight, 2024). **Figure 1** shows an overview of the key activities for the Mobilized Communities program and the impact evaluation from its inception in May 2023 through the second endline survey in May 2025.

Figure 1: Timeline of events for the MC program and evaluation



2. Study Design

To estimate the causal impact of the MC program, IDinsight conducted an RCT in Mumbwa District, Zambia, comparing a treatment group that received bicycles in 2023 to a control group.

2.1 Research Questions

The primary research questions for this evaluation were:

A. What is the causal impact of the MC program on the household welfare and well-being of program recipients?
B. What is the causal impact of the MC program on household access to services and livelihood-enhancing activities?
C. What is the causal impact of the MC program on social norms and women's empowerment?
D. How do the treatment effects of the MC program vary by key subgroups of interest?

2.2 Outcomes

The evaluation measured the impact of the MC program on a comprehensive set of outcomes related to participants' socio-economic welfare. **Table 1** outlines the key outcome variables from Endline 2 data collection. Outcomes that were not measured at Endline 1 and were added at Endline 2 are indicated with an asterisk.

Table 1: Key outcome variables

Outcome category	Survey module name	Description
Household welfare & wellbeing	Income (monthly)	The total monthly household income. This includes income for all individuals in the households, including from employment, farm activities, social transfers, and enterprises, among others.
	Income Diversity	The number of sources of income in the households

Outcome category	Survey module name	Description
	Business Activity	Household involvement in a business and its corresponding revenue
	Total household consumption (monthly)	This is the sum of all spending on food and non-food items incurred by the household.[1]
	Total household asset value	The sum of the valuation of durable and agricultural assets owned by the household
	Total transportation expenditure	Total amount of money spent by the household on transportation per month.
	Savings and loans	% of households that saved income in the last 30 days, the amount saved, amount spent on loans annually.
	Poverty Likelihood % (From PPI)	Predicted probability of a household falling under the Zambia national poverty line based on a set of 10 questions validated by Innovations for Poverty Action
	Food Insecurity*	Food insecurity score based on how often and for how long household members went without food.
Individual and household productivity	Time traveled to places of interest	Time spent traveling to places of interest over a 7-day period. Places of interest include markets, public transport station, church, community meeting center, farming

[1] For the consumption modules, we utilized the most commonly purchased goods from the Living Conditions Monitoring Survey from the Central Statistical Office of Zambia in 2015, to find a list of items that accounted for 87.4% of total consumption in the district of Mumbwa. This process resulted in reducing the 217 items to 50. During analysis, we multiplied the consumption value by (1/0.87.4) to estimate total consumption and then winsorized the total values at the 2.5 and 97.5 percentiles.

Outcome category	Survey module name	Description
		field, school, health center, place of voluntary work, place of work, and bank/mobile money agent.
	Distance traveled to places of interest	Average distance traveled to places of interest over a 7-day period.
	Time use*	Hourly activity in the last 24 hours
Access to health services, and other livelihood-enhancing activities	Service recipients	The total number of households that health volunteers report servicing per month
	Access to health services	% of households reporting access to health services
	Travel for business purposes	Time and costs to access markets (customers) for business purposes Time and costs to source supplies for business purposes
Empowerment and social capital of women	Decision-making* Asset Control Women's Empowerment in Agriculture Index: A-WEAI questionnaire developed by IFPRI[2]	Input in productive decisions Ownership of assets (ex. solely vs. jointly) Control over use of income Group membership Workload
	Self-esteem	% of females who value and perceive themselves highly
	Locus of control	% of females who feel they have control over their lives

[2] https://weai.ifpri.info/files/2024/07/a-weai_questionnaire.pdf

Outcome category	Survey module name	Description
	Gender norms	How respondents perceive gender norms such as “A wife should obey her husband, even if she disagrees”, “It is better to be a man than to be a woman”, etc.

** New variable introduced at Endline 2 which was not collected at Endline 1 or was updated at Endline 2*

2.3 Sampling and Randomization

The study population consisted of two main groups: Livelihoods Group Members (LGMs) and Community Service Workers (CSWs). The evaluation employed a stratified randomization design, with LGs randomized at the group level and CSWs at the individual level. Further details on the sampling, randomization, and stratification strategy are available in the Endline 1 report (IDinsight, 2024). **Figure 2** below shows a map of the study area displaying the geographic distribution of treatment and control households across the area in Mumbwa District. The dispersion of households highlights the rural context of the evaluation and the significant distances that are a part of daily life for participants. The inset provides a closer view of the specific communities included in the study.

Figure 2: Map of Study Area

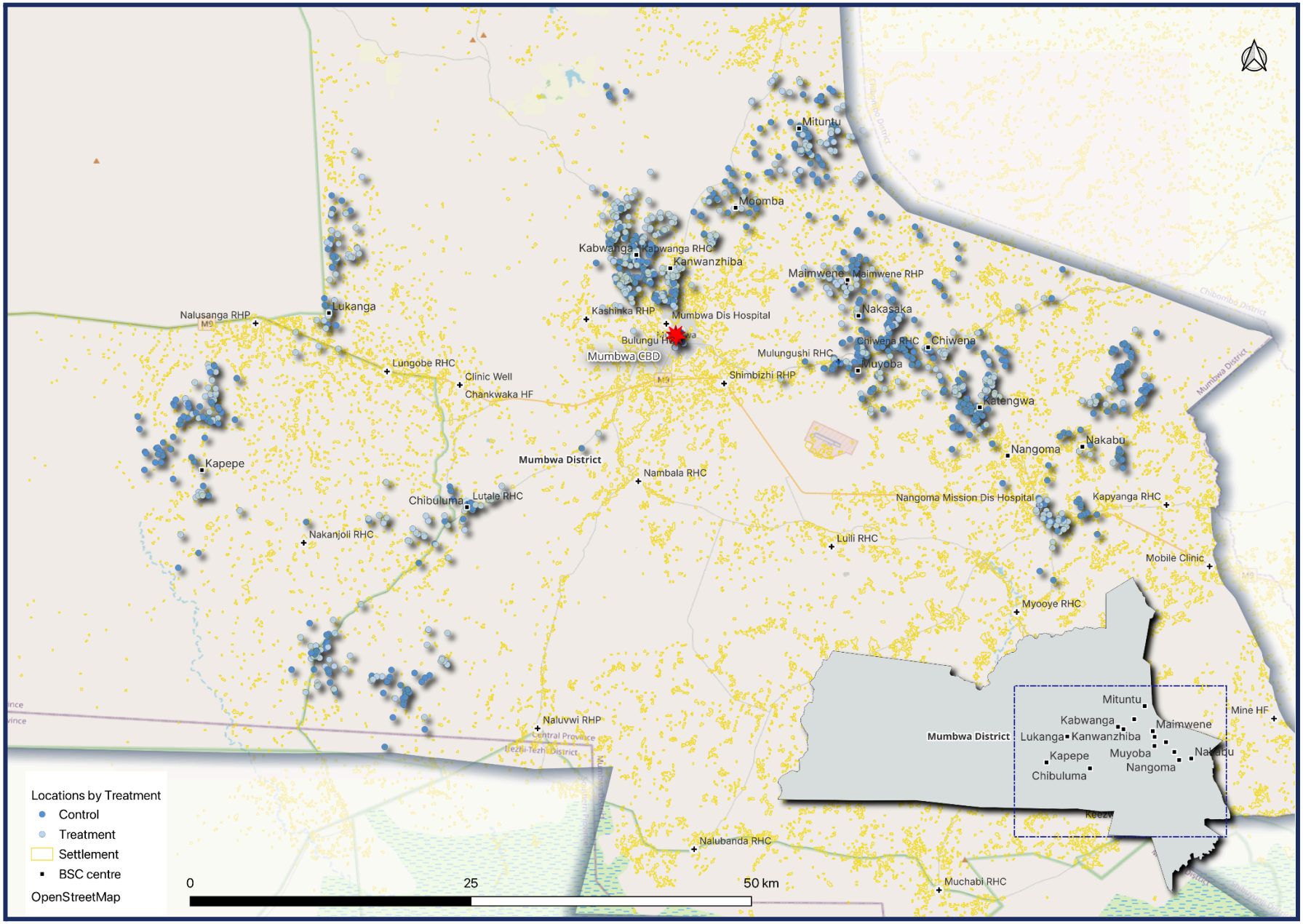
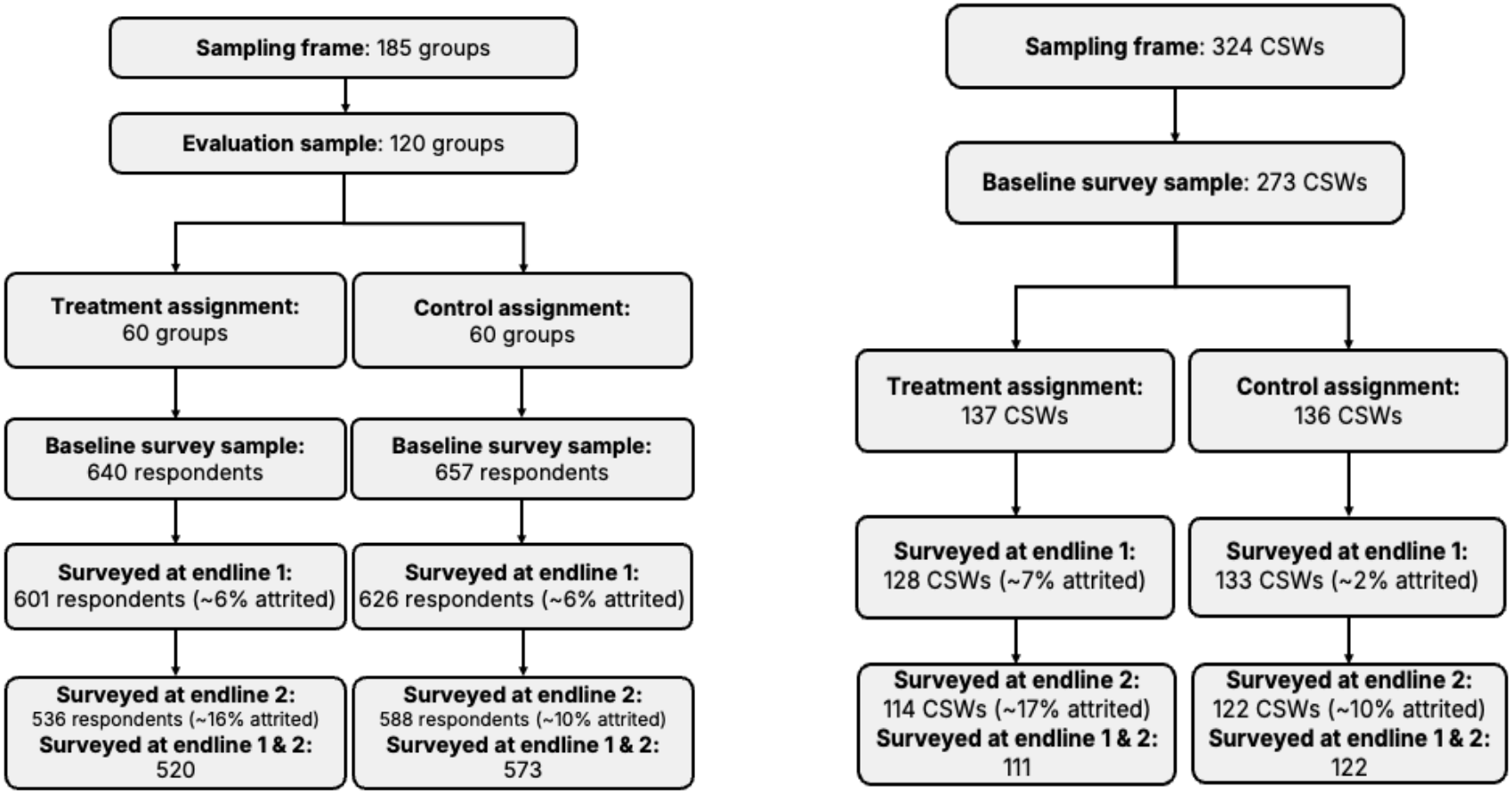


Figure 3: Sampling & Randomization Flowcharts



2.4 Data Collection

Endline 2 data collection was conducted over a 20 day period from May 27th to June 20th, 2025. A team of 20 trained enumerators administered a household survey electronically using SurveyCTO. Prior to the main data collection, a pilot was conducted in a non-evaluation community in Mumbwa to test the survey instrument and logistical processes.

The fieldwork was supported by WBR and local Bicycle Supervisory Committees (BSCs), whose assistance was crucial in locating participants. The majority of interviews (95%) were completed in-person, with 60 additional interviews conducted over the phone. To ensure data integrity, the process included robust quality measures including random audio audits, spot-checks, and daily high-frequency checks. Inconsistencies or outliers flagged during these checks were queried with the responsible enumerator, who then followed up with the respondent to verify the information and make corrections as needed.

Attrition

The second Endline survey reached 86.6% (1,360) of the original baseline sample of 1570. We were unable to survey the remaining sample for a variety of reasons, but the most common reason was respondents moving out of the region for seasonal farming and being unreachable for a phone survey. At Endline 1, 1,488 participants were surveyed (94.8% of the baseline sample), with similar attrition between study arms (6.0% in the treatment group, 4.4% in the control group). However, by Endline 2, attrition was higher in the treatment group (13.2%), compared to the control group (8.2%), a statistically significant difference of 5.1 percentage points ($p < 0.01$).

Despite this, as shown in **Table 2** below, the surveyed Endline 2 sample remains well-balanced on baseline characteristics. We therefore present our main results without model-based attrition adjustments. As an additional robustness check, we present results that adjust for attrition using inverse-probability weights (IPWs), which reweight observations to reflect the original baseline distribution, in **Appendix D**. All substantive conclusions remain unchanged by these checks.

Non-compliance & Spillovers

Minor deviations from the treatment assignment occurred. As in Endline 1, compliance in the treatment group was very high. Of the 641 individuals in the treatment group surveyed, 612 (95%) retained possession of the bicycles at Endline 2. A noteworthy issue during this round of data collection was five instances of attempted impersonation, in which a non-sampled individual from a control household attempted to be interviewed in place of the sampled respondent, who was not available for the survey. This was likely motivated by a fear that the household would not be considered for a bicycle at the end of the study if the sampled individual was not interviewed. Enumerators were trained to verify respondent identity, and these cases were successfully identified with efforts made to reach the right respondents through mop-ups or phone interviews if not available in-person during data the collection period.

Spillover effects from bicycle sharing remain a factor, with 83% of treatment households reporting that they shared their bicycle at least once in the last 12 months of the survey. 59% of control participants also reported having borrowed or rented a Buffalo bicycle. However, typical usage by control households who borrowed bicycles was low compared to treatment households: 46% of control households who borrowed a bicycle reported doing so “Very infrequently”, and 88% of control households who borrowed a bicycle reported doing so less than once per week. In contrast, 91% of treatment households reported using their Buffalo bicycle more than once per week. We attempt to account for spillover effects in the Treatment-on-the-Treated (TOT) estimates presented in **Appendix B1.**

2.5 Analytical Approach

As specified in the pre-analysis plan, the program's effect was estimated using an Ordinary Least Squares (OLS) model. The primary analysis estimated the Intention-to-Treat (ITT) effect, which compares outcomes for the group originally assigned to the treatment with the group assigned to the control, regardless of actual bicycle receipt or use. Our regression model is described in detail in **Appendix A**.

3. Evaluation Results

This section presents the main findings from the Endline 2 survey, conducted two years after the bicycle distribution. **Table 2** compares baseline levels of key outcomes for the original baseline sample (first two columns) with the same baseline outcomes for the subset of participants successfully re-interviewed at Endline 2 (last three columns, N = 1360). Despite attrition being somewhat higher in the treatment group than in the control group, the endline sample remains well-balanced on baseline characteristics, suggesting that the risk of bias from attrition is low.[3]

Table 2: Balance Table of Key Variables (Baseline Values)

Baseline Variable	BL Control Mean	BL Treatment Mean	Diff.	EL2 Control Mean	EL2 Treatment Mean	Diff.
Respondent Age	42.21	40.33	-1.81 *	42.50	41.19	-1.31
Female	0.68	0.66	-0.02	0.69	0.68	-0.02
Household Size	7.24	6.89	-0.35 *	7.28	6.93	-0.34 *
No. School-going Children 6-17 yrs	2.92	2.82	-0.1	2.96	2.89	-0.08
Est. Average Monthly Household Income, ZMW	1728.68	1487.18	-246.26 *	1716.53	1505.62	-229.46
Poverty Likelihood % (From PPI)	0.63	0.60	-0.02	0.63	0.60	-0.03
Est. Total Monthly Consumption, ZMW	4434.75	4478.39	42.99	4401.13	4583.41	166.54
Est. Total Value of HH Assets, ZMW	67503.15	58762.86	-8848.79 *	65967.95	61036.08	-5341.26
Able to ride a bicycle	0.99	0.99	0	0.99	0.99	0.00
HH Owns Bicycle	0.18	0.21	0.02	0.18	0.22	0.03
HH Number of bikes	0.19	0.22	0.03	0.19	0.23	0.03
Weekly Total Distance Traveled	149.93	151.5	1.31	146.05	148.91	3.02
Weekly Time Spent Traveling	1338.44	1314	-25.52	1314.51	1323.99	7.30
Total Monthly Business Revenue, ZMW	1091.12	1002.65	-89.71	1091.98	1062.47	-40.09
Decisions Index	-0.01	0.1	0.11 **	-0.02	0.09	0.11 *
Locus of Control Index	0.00	0.04	0.03	0.01	0.07	0.05

[3] A balance check on the Endline 2 sample shows no statistically significant differences between the treatment and control groups on 16 out of 18 key baseline characteristics, including monthly income, consumption, and poverty likelihood. While minor imbalances in household size and decision index are statistically significantly at the 10% level, the overall balance at Endline 2 is comparable to balance at baseline, suggesting that the risk of bias from attrition is low.

Self-Esteem Index	0.01	0.02	0.01	-0.02	0.02	0.03
Gender Norms Index	0.00	-0.02	-0.03	0.00	-0.02	-0.02

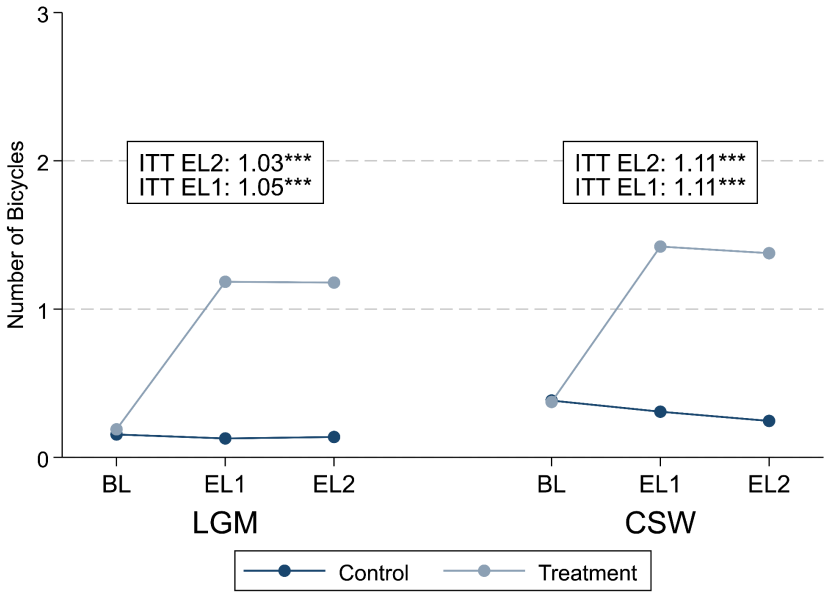
*Note: The p-value symbols in the table are as follows: '***' for p ≤ 0.01, '**' for 0.01 < p ≤ 0.05, and '*' for 0.05 < p ≤ 0.10. No symbol denotes p > 0.10.*

For the remaining figures and tables, we present results separately for our two strata, LGMs and CSWs. We also present Endline 2 results alongside and Endline 1 results to facilitate comparisons of effect sizes over time.

3.1 Bicycle distribution & usage

Two years after distribution, treatment households continue to own and frequently use their Buffalo Bicycles. Participants in the treatment group reported, on average, owning one more bicycle than participants in the control group **(Figure 4)**. This confirms that treatment participants received and retained their bicycles, whereas very few control group members own bicycles or purchase their own bicycles..[4]

Figure 4: Treatment effect on bicycle ownership

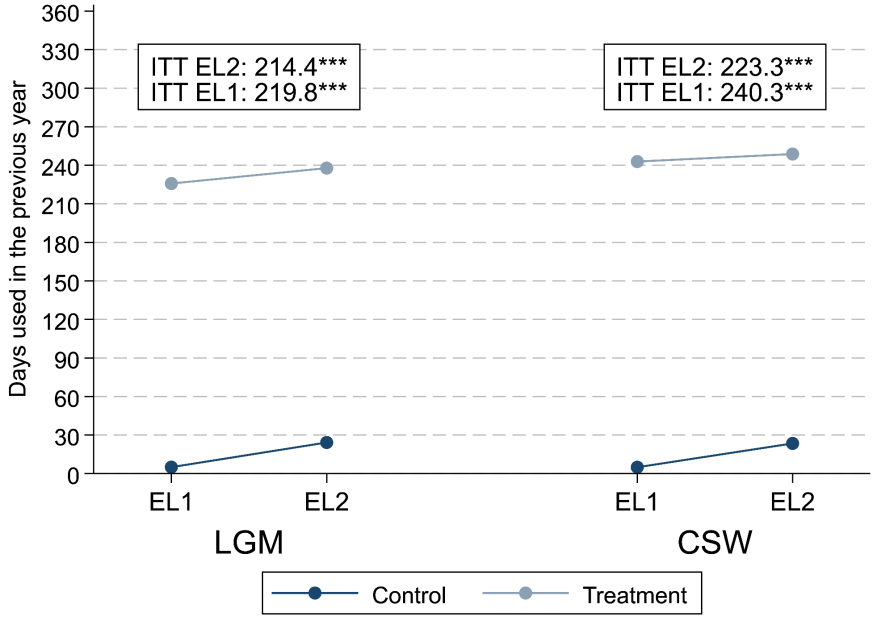


Usage remains high, with 91% of treatment respondents who retained the Buffalo bicycle reporting using it several times per week or daily. (See **Figure 5** below illustrating bicycle usage in the previous year). Sharing of bicycles is common, with 85% of treatment households reporting that they share their bicycle with others

[4] Bicycles will be distributed to control households after the study, and this was communicated to them at baseline

outside their household. The most common reason for sharing is to facilitate healthcare access, highlighting the bicycle's role as a critical community asset.

Figure 5: Bicycle usage, days in previous year (out of 365)

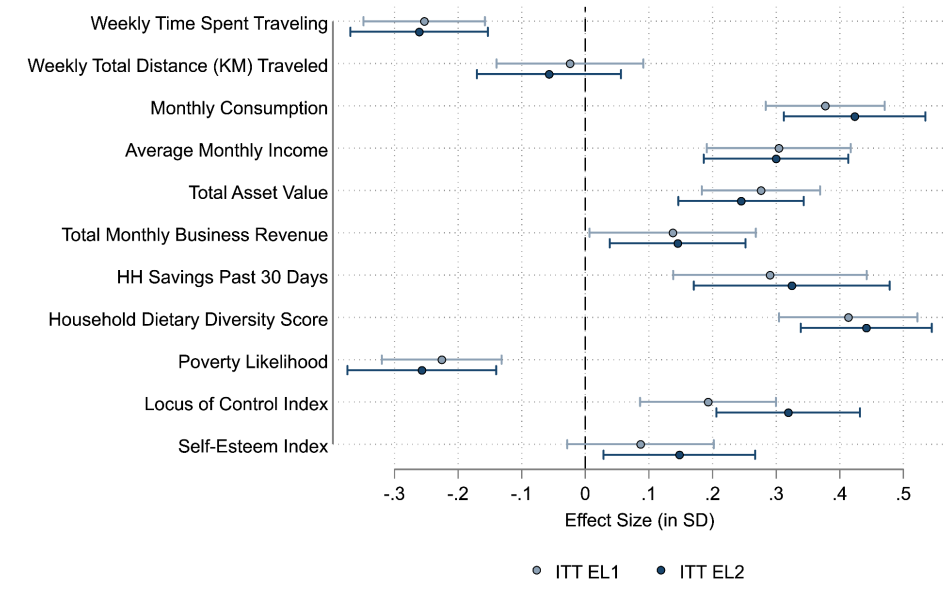


3.2 Impacts of bicycles on main outcomes

Overall Findings

Two years after bicycle distribution, the impacts of the Buffalo Bicycles have not only been sustained but have grown across multiple domains. The program continues to generate large and statistically significant positive effects on household economic welfare, mobility, and productivity **(Figure 6)**. This is particularly noteworthy given the improved economic context; while the Endline 1 results demonstrated the bicycle's role in building resilience during a severe drought, the Endline 2 results suggest that in a period of economic recovery, Buffalo bicycles enable households to accelerate their economic growth. See **Appendix B** for all regression results for all outcomes.

Figure 6: Standardized treatment effects on for main outcome



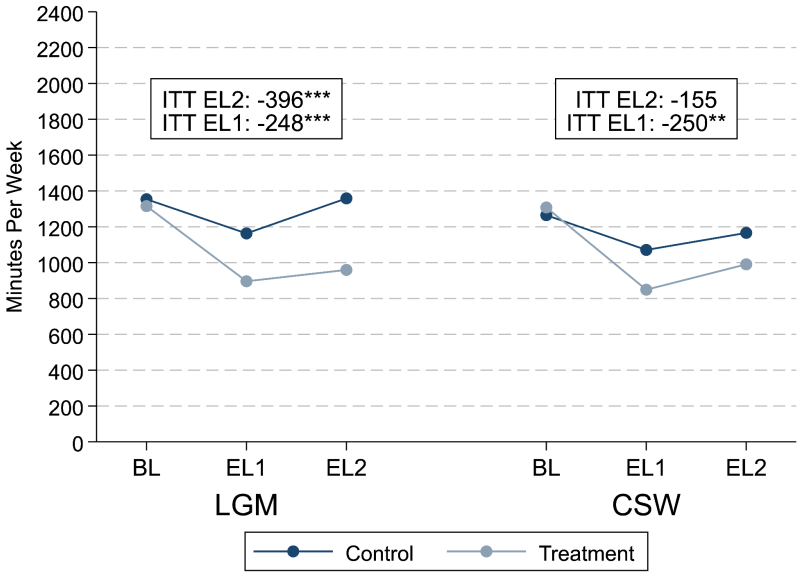
Range bars denote 95% confidence intervals

Mobility Patterns

As at Endline 1, access to bicycles substantially altered the modal choice of treatment participants in Endline 2, shifting travel away from walking and motorised transport towards greater bicycle usage. Treatment LGM households took 10.7 more bicycle trips and 11.4 fewer walking trips per week compared to their control counterparts ($p<0.01$ for both). Similarly, treatment CSW households took 10.3 more biking trips and 10.4 fewer walking trips per week ($p<0.01$ for both). This shift represents a significant increase in efficiency illustrated in **Figure 7** and is likely the primary driver of the large time savings discussed later below.

While the Endline 1 results showed a similar pattern, the Endline 2 data reveals that this behavior has solidified into a new routine. The higher reliance on bicycles has also led to a statistically significant decrease of 0.4 (30%) motorized trips compared to a control mean of 1.3 per week (**Table 3**). This suggests that for many local journeys, the bicycle has become the preferred mode of transport, likely due to its cost-effectiveness and convenience.

Figure 7: Treatment effect on time traveled to places of interest



Interestingly, and consistent with the findings from Endline 1, the increase in travel efficiency has not translated into a statistically significant increase in the total distance traveled per week. This reinforces the conclusion that participants are primarily using the bicycle to complete their existing travel more efficiently, rather than to expand their geographic footprint, which frees up hours for productive activities. It is possible that treatment respondents are shifting their travel toward more economically productive opportunities; it is also possible that respondents' recall of distance traveled in the previous week is somewhat imprecise, and may vary depending on whether they traveled on bicycle or on foot.

Figure 8: Treatment effect on distance traveled to places of interest

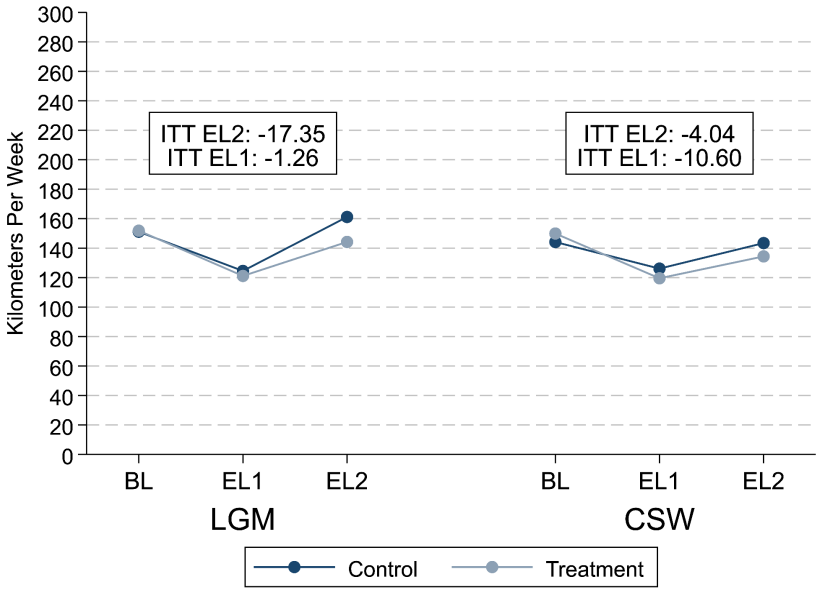


Table 3: Treatment effect on mobility patterns

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Had to cancel plans to travel outside of community in last 30 days	1124	0.86	-0.63 ***	-0.60 ***	236	0.84	-0.61 ***	-0.50 ***
Fares on buses/taxis, monthly (ZMW)	1119	123.72	-17.26	-22.59 **	232	156.91	-8.58	-3.97
Fares on children's school travel, monthly (ZMW)	1121	3.75	-0.09	0.30	235	1.45	2.29	-0.67
Fares on motor vehicle costs, monthly (ZMW)	1118	96.69	-17.82	2.16	234	15.21	24.34	11.58
Fares on maintenance/repairs for motor vehicles/bicycles, monthly (ZMW)	1117	81.12	8.88	9.99	234	33.50	36.41 **	-82.89 *
Est. HH Transport Expenditure in Past 30 Days	1120	274.26	47.9	8.62	233	328.02	9.86	48.76
Weekly Time (Min) Spent Traveling	1124	1318.28	-389.86 ***	-243.93 ***	236	1150.9	-151.98	-248.63 **
Weekly Total Distance (KM) Traveled	1121	151.23	-16.34	-0.69	236	140.37	-9.50	-10.43
Total number of walking trips (7-day recall)	1124	21.20	-11.43 ***	-8.29 ***	236	20.23	-10.22 ***	-8.10 ***
Total number of biking trips (7-day recall)	1124	0.59	10.74 ***	6.89 ***	236	1.02	10.28 ***	6.12 ***
Total number of motorised trips (7-day recall)	1124	1.32	-0.43 **	-0.29 **	236	1.25	-0.45	-0.38 **
Total walking distance in last 7 days (KM)	1124	85.06	-65.38 ***	-54.61 ***	236	57.60	-32.50 ***	-41.19 ***
Total biking distance in last 7 days (KM)	1124	6.44	61.11 ***	63.70 ***	236	13.19	52.15 ***	55.50 ***
Total motorised distance in last 7 days (KM)	1124	57.61	-13.06	-9.20	236	67.39	-26.30	-22.13 *

During the one-week recall period preceding the Endline 2 survey, treatment participants who used their bicycles reported spending an average of 281 minutes per week (approximately 40 minutes per day) cycling to points of interest within their communities. This is comparable to the 232 minutes per week (33 minutes per day) reported during Endline 1 for a similar recall period.

To validate these self-reported estimates, we compared them with GPS tracking data from 15 bicycles monitored over a two-month period (May–July 2025). The tracking devices recorded an average of 1.6 hours of cycling per day, covering about 14 kilometres daily. Travel diaries kept by the owners of these bicycles revealed that usage was shared within households: recipients themselves accounted for 61% of trips, while the remaining 39% were made by other household members. This suggests that the total tracked time (1.6 hours per day) reflects combined household usage, and that the survey-based estimates are likely a reasonable measure of the time bicycle recipients themselves spent cycling.

In 2025, gender-disaggregated tracking data showed that women's bicycles averaged 15 kilometres (1.6 hours per day), while men's averaged 12.6 kilometres (1.4 hours per day). This contrasts with the 2023/24 tracking results, when men recorded significantly greater daily distances than women, averaging 20 kilometres compared to women's shorter distances during the harvest season.

By participant group, livelihood group members (LGMs) in 2025 averaged 12.7 kilometres over 1.4 hours per day, compared to community health workers (CSWs) who averaged 15.8 kilometres and 1.8 hours per day. This pattern differs from 2023/24, when LGMs recorded significantly greater daily distances than CSWs, averaging 17.4 kilometres during the harvest season..

Several factors may explain the variations between the 2024 and 2025 estimates from the tracked bicycles. First, men in the current tracking sample were more likely to share their bicycles extensively with household members. In fact, two of the six men tracked both in the livelihoods sector reported sharing their bicycles nearly all the time, potentially reducing the use of bicycles for livelihood activities and lowering average distance estimates. Second, the 2025 harvest period may have reduced the need for longer trips, as participants spent more time on their farms (on average 2.1 km from home) and less time travelling to distant locations to source food or sell their produce. This is consistent with the absence of drought in 2025, which may have reduced the need for long-distance trips.

The primary use of Buffalo Bicycles continues to be for market access. At Endline 2, among treatment participants travelling to local markets in the one-week period preceding the survey, 67% reported using Buffalo Bicycles as their main mode of transport, covering an average distance of 3.3 kilometres. For those travelling to more distant markets, 49% used Buffalo Bicycles and 29% relied on cars or trucks. This is unsurprising given the longer distances involved an average of 23 kilometres

particularly during the harvest period when farmers typically transport produce to larger markets for sale.

Compared to Endline 1, there was a decline in the share of treatment participants using Buffalo Bicycles to travel to both local and distant markets (from 76% to 67% for local markets and from 62% to 49% for distant markets). Overall, market travel itself also declined over time. At Endline 1, 69% of treatment participants and 60% of control participants travelled to local markets, while 49% of treatment and 41% of control participants travelled to distant markets. By Endline 2, these figures had dropped to 57% (treatment) and 56% (control) for local markets, and 45% (treatment) and 38% (control) for distant markets. A potential explanation for this is that both treatment and control households spent more time on their farms, given the harvest season.

Despite the decline in the proportion of participants travelling to markets, treatment participants continued to make more trips on average to both local and distant markets in comparison to control participants, consistent with findings from Endline 1. Notably, treatment LGM households made 22% more market trips than control households (+0.6 more trips on average in the previous week, compared to 2.7 trips in the control group). As in Endline 1, no significant differences were observed between treatment and control CSW households in the frequency of travel to local and distant markets.

Participants who logged travel diaries reported using their bicycle carriers to transport a variety of goods, most commonly farm produce such as maize, soybeans, and sweet potatoes. This pattern is expected given that data collection took place during the harvest period, when households were actively working on their farms. If we consider only trips where respondents reported carting goods, respondents reported carrying on average 34 kilograms per trip. However, in at least 25% of such trips involving load carrying, the weight reached 50 kilograms or more. There were no significant differences in average load weight between women's and men's bicycles As the travel diaries did not record the gender of the actual rider on each trip, it is not possible to fully assess variation in load carrying by gender. However, bicycles belonging to livelihood group members carried significantly heavier loads an average of 47 kilograms on trips where goods were transported compared to community health worker bicycles, which averaged 30 kilograms per load-carrying trip.

Productivity

The significant time savings from bicycle use translated directly into increased productive activity, a link confirmed by new time-use data collected at Endline 2. According to the time-use module, which asked respondents to report how they

spent each hour of the previous 24 hours, LGMs in the treatment group gained approximately 1 additional hour of productive activity per day ($p<0.05$), primarily through increased time spent running their own businesses (0.6h, $p<0.05$). CSWs also gained 1.3 additional hours of productive activity per day ($p<0.05$), largely from increased farming and livestock work (1h, $p<0.05$).

While the time-use module did not show a statistical reduction in time spent on travel within the past 24 hours, the transport and mobility module, which used longer recall periods and collected information on places of interest, distance traveled, and time spent using different modes of transport shows clear evidence of time savings. LGMs reported traveling 57 fewer minutes per day ($p<0.01$), or about 6.6 hours per week ($p<0.01$), with especially sharp declines in trips duration (in minutes to markets (79 from a control mean of 241, 33%) and farms (a decrease of -101 from a control mean of 283.1, 35%).

This reallocation of time appears to be a key mechanism for the program's economic impacts.

For LGMs, the extra time invested in their businesses led to a statistically significant ZMW 262 ($10)[5] higher monthly business revenue compared to control ($p<0.05$), though this impact was smaller than that observed at Endline 1. While reported effects on business revenue declined for LGMs, we still observe larger impacts on overall economic welfare compared to Endline 1, as discussed in the next section. By contrast, for CSWs, the effects on business revenue increased substantially between Endline 1 and Endline 2, potentially suggesting greater use of bicycles for livelihood activities in the second year. We also note that compared to the control group, LGM and CSW treatment households were approximately 60% and 70% less likely to leave goods or crops due to transport challenges ($p<0.01$) respectively (**Table 4**). This suggests Buffalo bicycles increased the carrying capacity for the treatment households.

Table 4: Treatment effect on business activity

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
New type of business/income generating activity in past year	1124	0.24	-0.01		236	0.15	0.05	
Number of businesses 0-2	1124	1.06	-0.07	-0.02	236	0.69	-0.03	0.07
Total Monthly Business Revenue, ZMW	1124	945.35	262.53 **	518.76 **	236	569.41	394.15 *	-169.90
For households with at least one business								

[5] 1 USD using the average exchange rate for the data collection period May 27, 2025 through June 20, 2025 is equivalent to 25.49 Zambian Kwacha (https://www.xe.com/currencycharts/?from=USD&to=ZMW)

HH Business Agriculture	870	0.75	-0.05	-0.01	148	0.68	0.05	0.05
HH Business Trade	870	0.31	0.10 **	0.06 *	148	0.28	0.12	0.02
HH Business Skills/All Other	870	0.09	0.02	-0.01	148	0.20	-0.14 **	-0.06
HH Business is Stationary	870	0.58	0.04	-0.05	148	0.65	0.03	-0.10
HH Business is mobile	870	0.42	-0.04	0.05	148	0.35	-0.02	0.11
HH Business Sources Supplies Elsewhere	870	0.50	0.05	0.04	148	0.54	-0.06	0.13 *
HH Distance (KM) to Business	492	12.34	-0.01	7.66	95	26.78	-18.36	22.77
HH Time (Min) to Travel to Business	377	79.97	-10.32	0.54	72	98.68	-42.68	1.63
HH Mob. Business Distance (KM) Traveled	304	15.90	2.35	-0.87	49	13.21	-0.23	-4.35
HH Business Distance (KM) to Supply Source	407	34.97	-6.82	-4.75	73	61.20	-3.79	4.54
HH Business Time (Min) to Supply Source	432	119.51	-17.1	-17.29	74	130.90	42.29	45.94
Carries goods or products for HH business	870	0.83	-0.01		148	0.73	0.01	
Max weight of goods carried in one trip (kg) for HH business	608	203.84	21.01		101	302.41	217.79	
Left behind goods/crops due to lack of transport	713	0.58	-0.35 ***		109	0.33	-0.23 ***	
Weight of goods left behind (kg) in last 30 days for HH business	253	80.94	150.7		24	33.06	209.85 *	
For households that jointly own businesses with other households								
Group Business Agriculture	293	0.83	0.02	0.04	9	0.60	0.58	1.76 ***
Group Business Trade	293	0.09	-0.04	-0.05	9	0.20	0.13	-0.10
Group Business Skill/All Other	293	0.09	0.00	-0.02	9	0.20	-0.58	-1.55 ***

Based on the time-use data, **Figure 9** shows that the program caused a statistically significant increase in the time participants spent on productive activities (paid work, running their own business, farming, livestock, fishing). Both LGMs and CSWs in the treatment group spent approximately 1 hour more per day on productive work compared to their control group counterparts. See time details on time allocation in **Table 5** below.

Figure 9: Average hours per day spent on productive activities

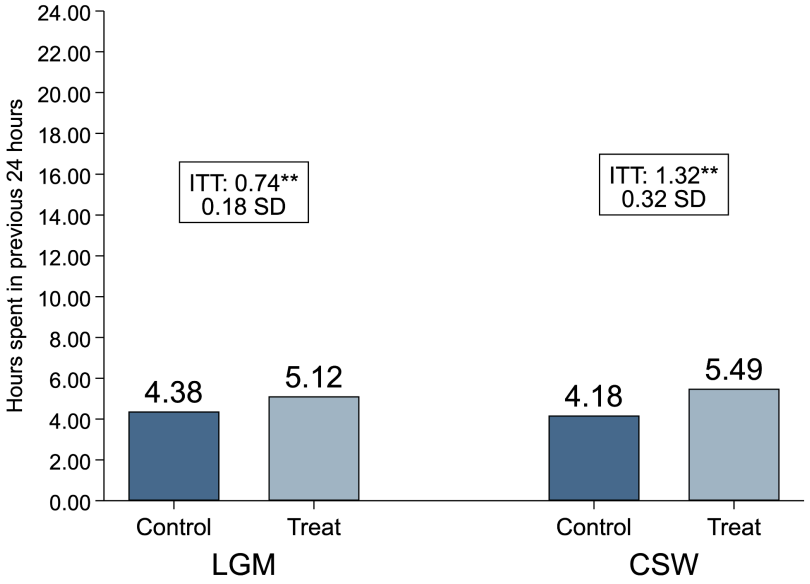


Table 5: Treatment effect on time allocation, 24-hour recall[6]

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW
Hours spent: Sleeping or resting	1124	10.64	-0.35 **	236	10.71	-0.03
Hours spent: Eating or drinking	1124	1.53	0.12 **	236	1.56	0.15
Hours spent: Personal care (e.g., bathing)	1124	0.60	-0.02	236	0.75	-0.12
Hours spent: Attending school or studying	1124	0.00	0.05	236	0.05	-0.05
Hours spent: Paid work (wage or in-kind)	1124	0.25	0.18	236	0.48	0.18
Hours spent: Running own business	1124	1.06	0.64 **	236	0.88	0.18
Hours spent: Farming, livestock, or fishing	1124	3.11	-0.10	236	2.84	0.96 *
Hours spent: Shopping or going to	1124	0.20	-0.10 *	236	0.09	0.05

[6] The time use module is a 24-hour recall that captures how respondents spent their time on the day preceding the interview. The day was divided into 24 one-hour blocks. For each hour, respondents could select all activities they were engaged in from a comprehensive list of productive, domestic, and personal tasks. For the analysis, time in a given hour was allocated equally among concurrent activities reported

services						
Hours spent: Sewing, weaving, or textile work	1124	0.06	-0.01	236	0.09	0.03
Hours spent: Cooking	1124	1.28	-0.02	236	0.91	0.02
Hours spent: Domestic work (e.g., cleaning, fetching water)	1124	1.88	-0.10	236	1.29	-0.12
Hours spent: Caring for children, elderly, or sick	1124	0.28	-0.13 *	236	0.18	-0.11 *
Hours spent: Traveling or commuting	1124	0.62	-0.02	236	0.89	-0.14
Hours spent: Watching TV, listening to radio, or reading	1124	0.10	0.02	236	0.12	0.02
Hours spent: Exercising	1124	0.00	0.00	236.0	0.00	0.01
Hours spent: Socializing or hobbies	1124	0.55	0.07	236	0.61	-0.22
Hours spent: Religious activities	1124	0.43	-0.03	236	0.59	-0.01
Hours spent: Other activities	1124	1.41	-0.22	236	1.96	-0.82 *
Total hours spent on productive activities, winsorized	1124	4.38	0.74 **	236	4.18	1.32 **
Total workload in hours, winsorized	1124	9.71	0.95 **	236	8.51	1.14 *

For CSWs, the bicycle's primary impact continues to be efficiency and productivity, rather than direct income generation, since their services are mostly voluntary. Health workers in the treatment group served 37 more clients per month than their control counterparts. This effect is smaller and no longer statistically significant ($p > 0.10$), unlike the large increase of 111 additional clients seen at Endline 1 ($p < 0.05$, **Table 6**).

This shift likely reflects a strategic adaptation in how CSWs utilized the time saved by the bicycle as economic conditions changed. During the Endline 1 drought, when livelihood activities like farming were less viable, the data suggests CSWs dedicated more time to their community service roles, where the bicycle's main impact was helping them reach more clients. However, in the post-drought recovery period of Endline 2, as agricultural opportunities returned, CSWs redirected their focus toward their own economic growth.

This transition is supported by multiple data points: the impact on CSW household monthly income grew from ZMW 180 at Endline 1 (not statistically significant) to ZMW 1,438 ($56) at Endline 2 ($p < 0.01$). Similarly, household asset value impacts more than doubled from ZMW 9,607 at Endline 1 to ZMW 20,896 ($820) at Endline 2 ($p < 0.01$). The time-use data further confirms this shift, showing treatment CSWs spent an additional hour per day on farming and livestock work compared to control CSWs ($p < 0.05$, Table 5).

Access to Services

The bicycle proved to be a critical tool for both accessing and delivering essential services. For CSWs, it directly addressed their primary work barriers. At Endline 2, only 2% of treatment CSWs reported lack of transportation as a challenge, compared to 88% of control CSWs. Similarly, only 8% of treatment CSWs reported long distances as a challenge, compared to 65% of control CSWs ($p < 0.01$ for both, **Table 6**). Removing these barriers strengthens their ability to serve the community.

The Buffalo bicycle has become an important tool for increasing access to healthcare in rural, remote communities. CSWs in the treatment group used it to transport someone, such as a sick patient, an average of six more times per month than those in the control group ($p < 0.01$). This adds to the finding that 85% of all bicycle recipients share their bicycle specifically to facilitate healthcare access, underscoring its vital role in the community's health infrastructure.

Beyond service delivery, the bicycle improves efficiency in meeting household needs. For both LGMs and CSWs, the program significantly reduced the number of monthly trips to collect water and fuel. Treatment households made, on average, seven fewer trips for water and one to two fewer trips for fuel each month ($p < 0.05$ or better, **Table 7**). This pattern suggests households use the bicycle's greater carrying capacity to transport larger quantities per trip, freeing time for other productive or personal activities.

Table 6: Treatment effect on CSW activity

Variable	# Obs, EL2 CSW	Control Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
CSW: Number of times a Buffalo bike was used to transport someone	182	0.61	6.11 ***	15.17 ***
Mobile CSW: Met or exceeded client target	122	0.83	0.12 **	
Stationary CSW: Met or exceeded client target	57	0.39	0.15	
Total Customers Served Per Month	236	92	4.38	76.79 *
Time Spent Travelling for Service Weekly	174	1449.74	-364.15 *	-276.68
Distance Spent Travelling for Service Weekly	169	74.59	3.04	-9.66
Total Service Days Per Month, Health Only	182	6.15	-1.26	-0.39
Mobile CSW - Required recipients to reach monthly, Health Only	85	74.9	37.05	104.82
Total Customers Served Per Month, Health Only	182	72.36	37.46	111.47 **
Met Target for Clients Served, Health Only	85	0.85	0.03	0.09
Time Spent Travelling for Service Weekly, Health Only	128	1261.73	-236.98	-119.08
Distance Spent Travelling for Service Weekly, Health Only	125	75.83	-9.78	-4.05

Service main transport = Walking	236	0.81	-0.78 ***	-0.66 ***
Service main transport = Own Bike (not WBR)	236	0.02	-0.02	-0.03 *
Service main transport = Paid Bike (not WBR)	236	0.02	-0.03 *	-0.04 **
Service main transport = Buffalo Bicycle	236	0.06	0.84 ***	0.80 ***
Service main transport = All Others	236	0.09	-0.01	-0.06 *
Challenges = Long distance	155	0.65	-0.57 ***	-0.33 ***
Challenges = Lack of transportation	155	0.88	-0.86 ***	-0.74 ***
Challenges = Cost of transportation	155	0.15	-0.12 **	-0.13 **
Challenges = Physical fatigue	155	0.23	-0.21 ***	-0.14 **
Challenges = Lack of compensation	155	0.32	-0.03	-0.02
Solution = Money	122	0.34	0.22 **	0.12
Solution = Transportation	122	0.92	-0.83 ***	-0.73 ***
Solution = Incentives	122	0.43	0.04	0.12
Mobile: Minimum amount of time that you spent with each client	76	37.84	-13.64	
Mobile: Last month new clients	152	6.17	3.47	
Mobile: Last month repeat clients	152	24.91	-4.5	
Mobile: Typical day min clients	153	47.72	0.05	
Mobile: Typical day max clients	153	71.27	4.97	

Table 7: Access to Services

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Distance from nearest health center (KM)	1081	8.34	-1.31 ***	-0.76	235	7.68	-0.11	-0.3
Unable to Visit Health Center in Last 30 Days	1124	0.49	-0.42 ***	-0.36 ***	236	0.4	-0.34 ***	-0.34 ***
Time to nearest health center in minutes	1103	84.44	-30.16 ***	-24.93 ***	235	80.96	-21.11 ***	-6.72
Weekly time spent traveling in minutes to health center	1103	22.4	-13.45 ***	-14.15 ***	235	45.29	0.35	-37.92 **
Weekly distance in kilometers to health center	1074	2.62	-1.02 *	-0.54	235	3.98	11.73	-3.68 *
Monthly number of visits to health center	1124	1.08	-0.27 *	0.06	236	2.24	-0.14	-0.68 *
Time to reach the water source, fetch water, and come back (minutes)	908	32.55	-9.62 ***	-4.86 **	192	28.49	-3.08	-7.24 *
Weekly time spent traveling in minutes to water source	908	442.15	-163.19 ***	-95.04 ***	192	309.63	12.11	-78.79 ***

Distance from nearest main source of water (KM)	1124	1.66	-0.75 **	-0.13	236	0.96	-0.02	-0.15
Monthly number of visits to water source	1124	51.42	-7.05 **	-9.13 ***	236	49.55	-5.89	-7.40 *
In a typical trip, how much water do you carry? (Liters)	907	63.51	12.96	12.41 *	191	80.99	-12.96	1.29
Distance from main source of energy	1124	2.18	-0.70 ***	-0.03	236	1.25	-0.26	-0.25
Time to reach the energy source, fetch, and come back (minutes)	673	79.2	-10.15 **	-5.79	138	66.18	-13.98	-6.28
Weekly time spent traveling in minutes to fuel source	673	127.15	-41.04 ***	-31.95 ***	138	98.61	-36.27 **	-28.04 **
Monthly number of visits to fuel source	1124	5.45	-1.17 **	-1.38 ***	236	5.97	-2.63 ***	-1.36

Household welfare

Compared to LGMs in the control group, LGMs in the treatment group reported ZMW 1,190 ($47) (29%) higher monthly household consumption ($p<0.01$) and ZMW 743 ($29) (36%) higher monthly household income ($p<0.01$). While these nominal effects are larger than those observed at the one-year mark, they are roughly in line with Zambia's annual inflation rate of approximately 15% in 2024 (ZamStats, 2024). This indicates that after adjusting for price increases, the real economic benefit of the Buffalo bicycle has remained stable over time **(Table 8)**. Furthermore, the program led to a statistically significant higher treatment household assets value ($p<0.01$), improved food security ($p<0.01$), and a greater sense of life satisfaction among recipients ($p<0.01$).

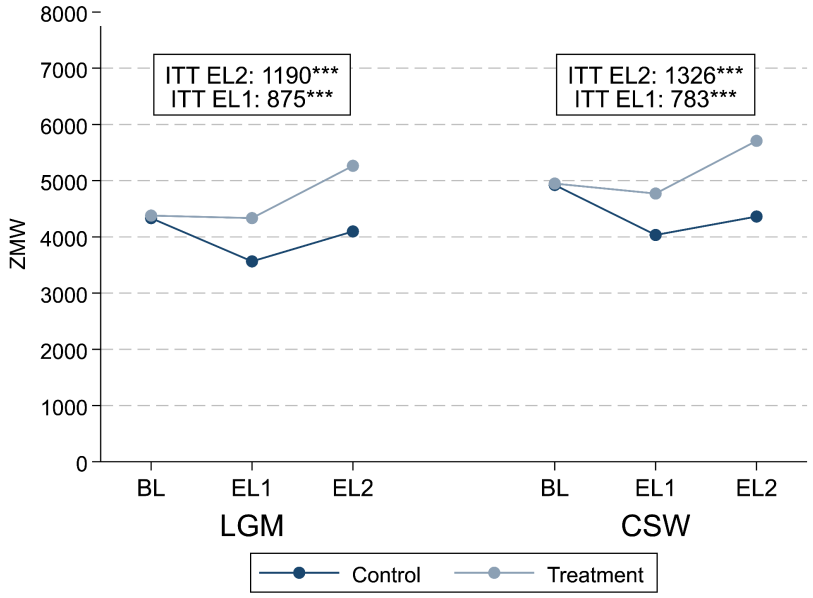
Table 8: Treatment effects of household welfare

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Est. Total Monthly Consumption, ZMW	1124	4097	1190.36 ***	875.37 ***	236	4362	1325.91 ***	782.83 ***
Weekly Food Consumption, ZMW	1124	595	171.07 ***	126.63 ***	236	616	177.26 ***	88.67 **
Est. Average Monthly Household Income, ZMW	1108	2038	743.25 ***	625.37 ***	232	1861	1438.28 ***	180.33
Est. Total Value of HH Assets, ZMW	1123	52092	14652.86 ***	14217.43 ***	235	61208	20896.03 **	9607.41 *

Durable Asset Value, ZMW	1123	10347	3970.64 ***	3221.01 ***	235	12672	4287.83 **	2708.07 **
Agricultural Asset Value, ZMW	1094	42888	10273.95 ***	10469.62 ***	233	48078	15904.44 **	6585.12

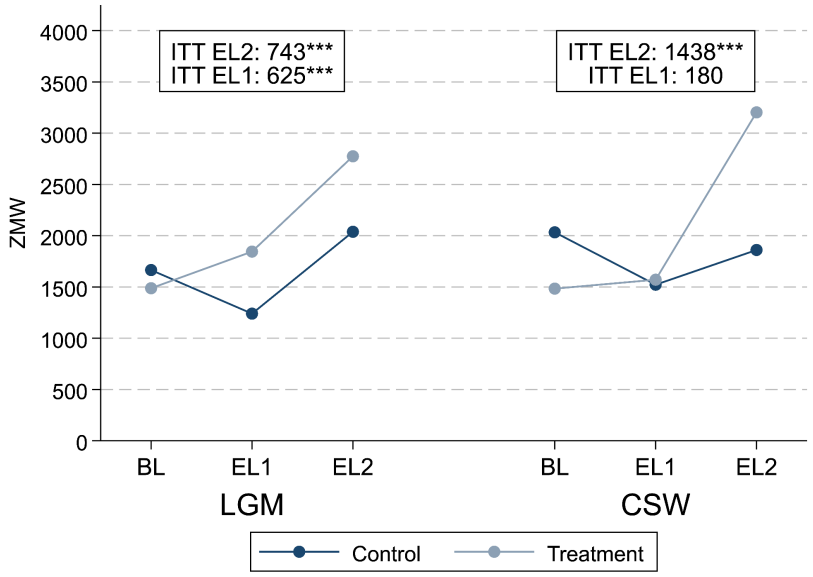
Figure 10 illustrated the sustained and growing impact of bicycle access on household consumption over two years. During the drought year (EL1), control group households saw a decline in consumption followed by only a partial recovery in the subsequent year. In contrast, treatment households were shielded from this shock, maintaining stable consumption during the drought and then experiencing notable gains in the following year. This suggests that bicycle access not only protected households from consumption losses during a period of stress but also enabled stronger recovery and growth thereafter.

Figure 10: Monthly Consumption



As shown in **Figure 11**, during the drought period (EL1) the control group's income declined sharply, whereas treatment group income remained stable for CSWs and even increased for LGMs. In the post-drought recovery period (EL2), control group income rebounded; treatment group income rose at a similar pace for LGMs but at an even faster rate for CSWs. This suggests that bicycle access not only provided resilience during the drought but also accelerated post-drought recovery.

Figure 11: Average monthly Income



Beyond the headline figures for income and consumption, the program has positively driven other main outcomes. Notably, bicycle recipients have significantly increased their savings, with LGMs saving an additional ZMW 624 ($25, 71%) per month ($p<0.01$) at Endline 2, an increase from the significant ZMW 511 monthly savings gain observed at Endline 1. This enhanced financial resilience is further reflected in a statistically significant 8 percentage points decrease in the household's poverty likelihood for LGMs ($p<0.01$).

Food Security

Food is one of the most important components of household consumption in rural Zambia, accounting for over 60% of total household consumption across all the three survey rounds in this evaluation. The findings show that more than two years after bicycle distributions, households with bicycles continue to have higher food consumption levels, compared to those without (**Table 9**).

Table 9: Treatment effects on Food Security

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Household dietary diversity score (HDDS)	1124	8.52	0.94 ***	1.01 ***	236	8.75	0.82 ***	0.45 *
Food Insecurity Score (0-9 scale)	1124	0.65	-0.38 ***		236	0.39	-0.14	
Weekly Food Consumption (ZMW)	1124	594.57	171.07 ***	126.63 ***	236	615.66	177.26 ***	88.67 **

Total cereal expenditure (ZMW)	1124	787.82	-29.41	104.01 ***	236	587.1	142.38 **	18.35
Total roots/tubers expenditure (ZMW)	1124	151.8	36.46 ***	18.36 **	236	149.98	59.12 ***	-0.04
Total vegetables expenditure (ZMW)	1124	261.79	49.35 ***	22.93 *	236	280.49	16.17	-17.89
Total legumes/nuts expenditure (ZMW)	1124	145.7	56.23 ***	30.70 **	236	161.13	12.11	48.84 **
Total fruits expenditure (ZMW)	1124	39.59	8.17	11.37 ***	236	48.48	8.39	-4.03
Total meat expenditure (ZMW)	1124	427.93	125.56 *	181.43 ***	236	290.32	211.12 ***	57.25
Total fish expenditure (ZMW)	1124	178.94	115.88 ***	88.56 ***	236	228.72	106.74 **	111.13 **
Total eggs expenditure (ZMW)	1124	49.51	18.85 ***	13.95 ***	236	40.4	35.68 ***	8.36
Total milk/dairy expenditure (ZMW)	1124	58.56	27.29 ***	-1.1	236	85.51	3.1	-8.61
Total oils/fats expenditure (ZMW)	1124	220.55	41.15 ***	36.86 ***	236	211.14	53.97 ***	17.31
Total sugar/sweets expenditure (ZMW)	1124	135.51	37.87 ***	31.94 ***	236	153.5	49.96 ***	56.85 ***
Total other food expenditure (ZMW)	1124	299.44	99.21 ***	28	236	332.71	102.91	141.36

First, treatment households are less likely to experience severe hunger. Analysis using the Household Hunger Scale (HHS), which measures household food security levels focusing on food quantity (on a scale of 0-9, with higher scores indicating more severe hunger), shows that treatment LGM households have significantly lower HHS scores compared to control group LGM households (a decrease of 0.38 from a control mean of 0.65, 58%, $p<0.01$). While treatment CSW households also recorded lower HHS scores, compared to control groups, the difference was not statistically significant.

Second, treatment households show significantly higher food consumption levels. Among LGM households, at Endline 2, total value of foods consumed was 29% higher than control LGM households, compared to 24% at Endline 1. Among CSW households, the total value of foods consumed at Endline 2 was 29% higher among treatment households, compared to 15% at Endline 1.

The composition of food consumed continues to differ across treatment and control households. Across all the survey rounds - baseline, Endline 1, and Endline 2 - cereals remained the most consumed food group, consistent with national dietary patterns, followed by meat and poultry, and vegetables. However, the share of cereals in total food consumption among all households shifted over time. At Endline 1, which coincided with the nationwide drought, cereal consumption increased relative to other food groups, accounting for 36% of the total cost of home food consumption. This increase was more

pronounced among control households whose cereal consumption accounted for 36% of total home food consumption in comparison to 32% for treatment households. By Endline 2, a non-drought year, the share of cereals in the total cost of food consumption declined to 29% for control households, with a sharper reduction to 22% among treatment households.

As in Endline 1, treatment households sustained statistically significant higher food consumption levels across all food groups, apart from fruits and cereals. Among treatment LGM households, the largest gains were seen in consumption of animal-source foods, for example, meat and poultry as well as fish and seafood, similar to Endline 1 findings. In Endline 2, beef and poultry consumption among LGM treatment households was 29% higher than in the control group – a difference smaller than was observed in Endline 1, where LGMs consumed 75% more than control LGMs. Fish consumption among LGM households was 65% higher than control LGMs at Endline 2.

Some differences narrowed over time. For example, cereals consumption was lower among treatment LGMs (by 4%) at Endline 2 in comparison to control LGMs, although this was not statistically significant. A likely explanation is that LGM households prioritised other food groups – such as meat and poultry and fish – which saw increased consumption between Endline 1 and Endline 2. This shift likely reflects a recovery from the 2024 drought that hit Mumbwa that coincided with Endline 1. by Endline 2, treatment households appear to have recovered, enabling increased consumption of nutrient dense, and more expensive foods. Similar to LGMs, treatment CSW households also showed higher consumption of animal-source protein in both Endline 1 and Endline 2. Compared to control households, meat and poultry consumption was 73% higher among treatment CSW households, while fish was 47%.

The above findings are also evident when we examine the household dietary diversity score, a cumulative measure that indicates a household's dietary quality level over a prescribed duration, in this case, a one-week period. Households with higher scores tend to consume more diverse and quality diets. In Endline 2, LGM treatment households recorded dietary diversity scores that were 11% higher than comparable control households – similar to the findings from Endline 1 (13% greater HDDS among treatment LGM households).

Overall, the above findings indicate two key points. First, while all households showed recovery from the drought, treatment households appear to have recovered better than control households. For example, at Endline 2, the average nominal value of total weekly home food consumption among control LGM households was ZMW 595 ($23) comparable to the baseline figure of ZMW 617. In contrast, treatment LGM households recorded an average of ZMW 759 ($30) at Endline 2, higher than both their baseline value of ZMW 643 and the ZMW 640 recorded at Endline 1. Despite rising prices across Zambia during this period (with inflation reaching approximately 15% in 2024 alone), treatment households maintained and even strengthened their advantage in food spending compared to control households. This demonstrates the sustainability of the bicycle's impact observed at Endline 1, as households with bicycles continued to enjoy better food security and dietary diversity two years after receiving them, even in the face of other economic challenges.

Social norms and Women's Empowerment

After two years, the program shows emerging impacts on social norms and empowerment, an area where effects were limited at the one-year mark. The most notable impact is a large and statistically significant increase in general life satisfaction for both LGMs and CSWs (an increase of 0.24 from a control mean of 0.52, 46%, p<0.01 for LGMs; an increase of 0.26 from a control mean of 0.49, 53%, p<0.01 for CSWs; **Table 10**).

Table 10: Empowerment Indices and Components

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Women's Economic Empowerment Index (0-1)	809	0.67	-0.01		118	0.63	-0.04	
Economic Decision-Making Index (0-1)	1115	0.85	0.00		236	0.84	-0.02	
Asset Control Index (0-1)	1124	0.28	0.04 ***		236	0.32	0.02	
Income Control Score (0-1)	1115	0.8	0.00		235	0.79	-0.02	
Female has input in HH expenditure decisions	814	0.94	-0.02		119	0.95	-0.01	
Female has at-or-above-median A-WEAI Index	809	0.52	-0.01		118	0.43	-0.09	
Locus of Control Index	1124	-0.01	0.31 ***	0.27 ***	236	0.03	0.34 ***	-0.14
Agrees/Strongly agrees with 'I feel satisfied with my life'	1124	0.52	0.24 ***	0.12 ***	236	0.49	0.27 ***	0.06
Self-Esteem Index	1124	0.01	0.13 *	0.13 *	236	-0.03	0.23 *	-0.12
Agrees/Strongly agrees with 'I feel I can provide for my family'	1124	0.82	0.06 **	0.05 **	236	0.76	0.11 **	-0.05
Gender Norms Index	1124	-0.04	0.06	-0.17 **	236	0.18	-0.16	0.15

For female participants, our constructed Abbreviated Women's Empowerment in Agriculture Index (A-WEAI), a standardized measure developed by IFPRI to assess women's empowerment in agricultural contexts, shows no significant difference between treatment and control groups at Endline 2, with 52% of control women and a similar proportion of treatment women achieving above-median empowerment scores.

Despite these broader indices showing limited effects, female bicycle recipients in the treatment group show improved asset control compared to their control counterparts (an increase of 0.04 from a control mean of 0.28, 14%, p<0.01 for LGMs). This specific dimension of empowerment suggests that bicycle ownership may particularly influence women's control over physical assets.

The program continues to strengthen participants' sense of agency, with the Locus of Control Index showing substantial improvements for both LGMs and CSWs (an increase

of 0.31 from a control mean of -0.01, p<0.01 for LGMs; an increase of 0.31 from a control mean of 0.03, p<0.05 for CSWs). This effect has grown slightly for LGMs since Endline 1 (from 0.27 to 0.31), suggesting accumulating psychological benefits over time.

Self-esteem measures also show positive trends, with treatment participants more likely to agree they can provide for their families (an increase of 0.06 from a control mean of 0.82, 7%, p<0.05 for LGMs; an increase of 0.11 from a control mean of 0.76, 14%, p<0.05 for CSWs).

While Endline 1 showed a significant impact on gender norms for LGMs (0.17, p<0.05), this effect has diminished by Endline 2 (0.06, not statistically significant). This suggests bicycles contribute to empowerment primarily through practical pathways enhancing mobility, economic opportunity, and household resource control rather than through direct challenges to abstract gender ideologies.

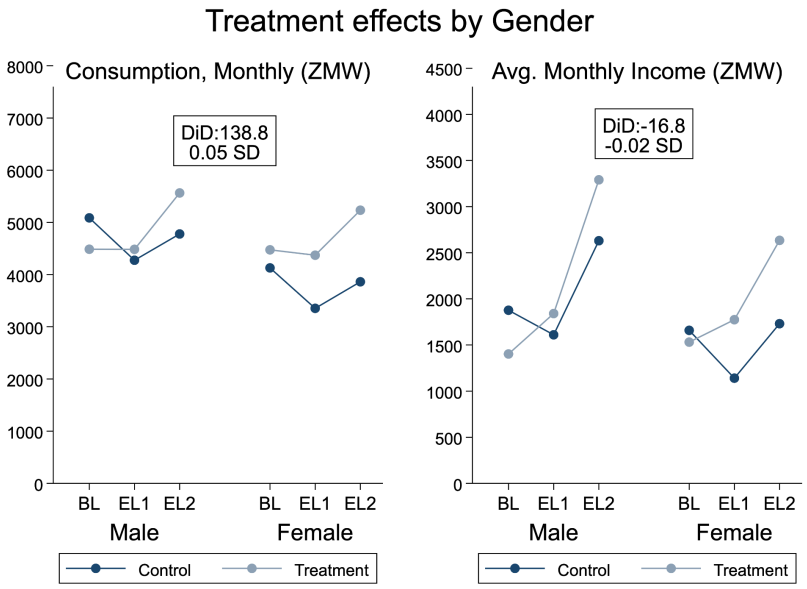
When only comparing female respondents, the Locus of Control, Self-Esteem, and Gender Norms Indices were 0.34 (p<0.01), 0.15 (p<0.01), 0.12 (p<0.1) higher, respectively, for bicycle recipients at Endline 2, showing that the empowerment effect of the MC program is stronger for women (Appendix F).

3.3 Subgroup analysis

Gender

The Endline 2 results confirm that the program's benefits were distributed equitably across genders, resolving some of the ambiguity observed at Endline 1. At the one-year mark, there was marginally statistically significant evidence at the 10% level suggesting a slightly larger impact on consumption for male participants compared to females. By the second year, however, this difference disappeared. As shown in **Figure 12**, the program's positive impacts on key economic outcomes are now consistent for both men and women. The Difference-in-Differences (DiD) estimates are small and statistically insignificant for both consumption and income, suggesting that while there may have been minor early differences in how men and women adapted to using the bicycle, over two years both genders have leveraged it to improve their economic well-being in a comparable way.

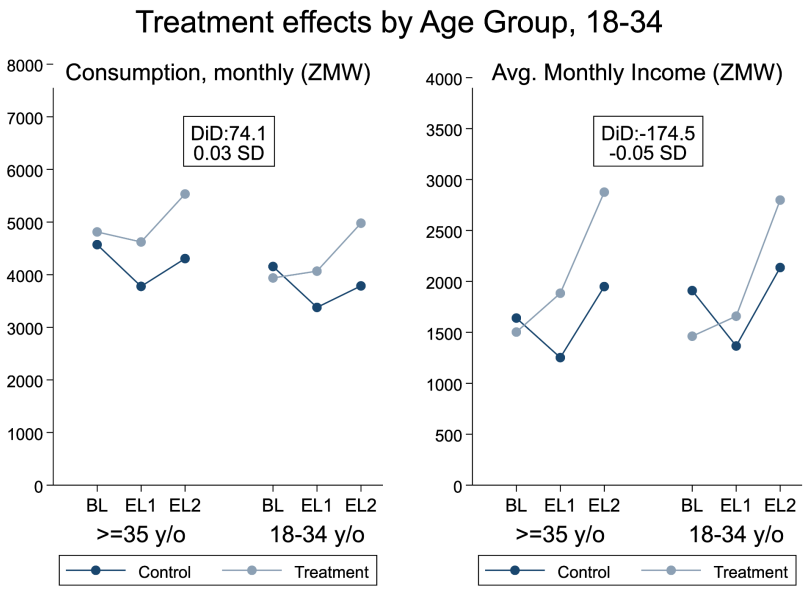
Figure 12: Treatment effects by gender



Age

Consistent with the findings from Endline 1, the program's benefits were distributed equitably across different age demographics. To assess this, we examined the treatment effects for youth (defined as ages 18-34, per Zambian guidelines) compared to older adults. As can be observed in **Figure 13** below, the program's economic impacts on key outcomes like consumption and income were broadly consistent across these groups. The Difference-in-Differences (DiD) estimates, which test for a differential impact, are small and not statistically significant, suggesting that participants benefited from the bicycle regardless of their age.

Figure 13: Treatment effects by age group (Zambia definition)



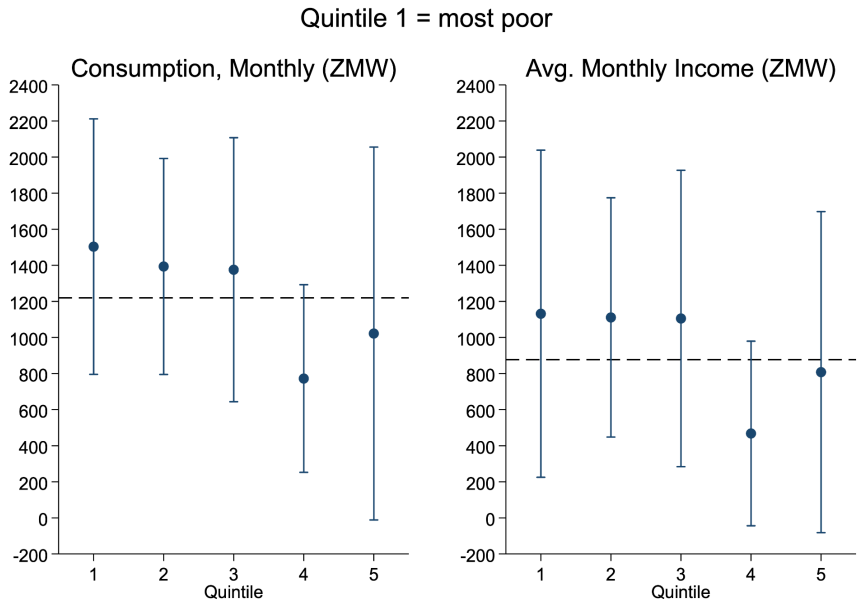
Household baseline socioeconomic level (PPI scores)

We examined whether the program's impacts varied across baseline socioeconomic strata, defined by the Poverty Probability Index (PPI) scores collected at baseline. In our sample, the likelihood of falling below the National Poverty Line ranged from 1% to 97%, with most households between 43% (25th percentile) and 82% (75th percentile). As in Endline 1, households were divided into five poverty quintiles, with Quintile 1 representing the poorest households.

Figure 14 presents the treatment effects on monthly consumption and average monthly income for each quintile. Across the wealth distribution, the point estimates are positive, with the largest consumption gains observed among the poorest quintile, though differences across quintiles are not statistically significant. For income, the estimated effects are broadly similar across quintiles, with no clear gradient by baseline wealth.

Overall, these results suggest that by the second year, the program's benefits extended across the wealth spectrum, with no statistically significant differences in impacts between poorer and wealthier households just as observed at Endline 1.

Figure 14: Treatment effects by baseline wealth level



The dotted lines show the full-sample ITTs for reference.

4. Discussion

Data collected during Endline 2 of the MC RCT provides compelling evidence that the benefits of the MC program are sustained two years after bicycle distribution. Across domains of economic welfare, mobility, productivity, food security, and empowerment, treatment households recorded significantly higher outcomes compared to their control counterparts. Households reported increased income, consumption, and asset accumulation, while also experiencing improved food security and dietary diversity. Bicycles consistently reduced travel time and costs, enabling participants to reallocate time to productive activities such as farming and business. For CSWs, bicycles facilitated more efficient service delivery and shifted their time savings toward agricultural activities. Importantly, the program also contributed to social and psychological outcomes, with participants reporting greater life satisfaction and agency.

Findings from Endline 1, conducted during the 2024 drought, highlighted the resilience-enhancing role of bicycles. Households with buffalo bicycles maintained consumption and income levels even as control households suffered sharp declines. Endline 2 results, collected in a recovery year, demonstrate that bicycles not only buffer shocks but also allow households to capitalize on improved economic conditions. Treatment households grew their income and assets at a faster pace than controls. This suggests that bicycles are not merely short-term interventions but durable assets that sustain and amplify gains, both in crisis contexts like droughts, and in normal years.

4.1 Limitations of the study

Several limitations should be considered when interpreting these results.

Non-compliance and spillovers

Although compliance was high (95% of treatment households retained their bicycles at Endline 2), widespread sharing of bicycles (82% of treatment households reported sharing; 58% of control households reported access) likely diluted measured program effects. While sharing underscores the bicycle's community value, it complicates attribution of impacts. However, usage data indicate that treatment households used bicycles far more frequently (with 91% reporting use more than once per week) compared to control households who accessed bicycles (88% reported using them less than once per week). This clear usage gap allows us to

separate primary program effects for recipients from limited spillover effects among controls. Treatment-on-the-Treated (TOT) estimates reported in Appendix B1 account for these spillovers and show effects approximately 15% larger than the ITT effects for welfare outcomes, though these differences do not substantively change our main conclusions. For example, the TOT effect on consumption for LGMs is ZMW 1,362 ($53) compared to the ITT effect of ZMW 1,190 ($47).

Attrition

Survey follow-up at Endline 2 reached 86.6% of the baseline sample. Attrition was higher among treatment households (13.2%) than controls (8.2%), a statistically significant difference. However, balance tests and robustness checks using inverse-probability weighting suggest that attrition did not bias results. The IPW results presented in Appendix D show estimates within 1-3% of our main ITT results for most outcomes, with some estimates for CSWs showing slightly larger effects (e.g., the IPW estimate for CSW monthly consumption is ZMW 1,364 or $54 compared to the ITT estimate of ZMW 1,326 or $52). These minimal differences confirm that our main findings are robust to adjustments for differential attrition.

Missing values and outliers

As with all large surveys, missing responses and extreme values presented challenges. We addressed these by applying standard cleaning, winsorization, and robustness checks. While unlikely to alter overall conclusions, residual data issues may slightly affect precision.

Seasonality

All survey rounds (Baseline, Endline 1, and Endline 2) were conducted in May–June, which aligns with the harvest period in Mumbwa. This consistency reduces concerns about seasonal bias when comparing outcomes across rounds. However, findings should still be interpreted in light of this seasonal context, as travel patterns, agricultural workloads, and income flows may differ at other times of the year.

Social desirability

Survey responses may be influenced by participants' perceptions of the program or expectations of future benefits. For example, in five instances, non-sampled individuals from control households attempted to impersonate sampled participants, motivated by fear that their household might be excluded from future bicycle distributions. This illustrates the strong perceived value of bicycles and highlights the potential for social desirability to shape responses. Although enumerator verification procedures prevented fraudulent data entry, subtle forms of over- or under-reporting positive impacts or challenges cannot be ruled out.

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Appendices

Appendix A: Analytical Model

As specified in the pre-analysis plan registered on the AEA RCT Registry[7], the effect of the MC program on household mobility, consumption, income, savings, improved productivity, and empowerment measures is estimated using the following Ordinary Least Squares model:

$$Y_{ij} = \beta_1 T_j + X'_{ij}\gamma + \alpha'_s + \varepsilon_{ij}$$

Where:

- Y_{ij} denotes the outcome variable (household consumption, income, savings, improved productivity, and empowerment measures) for household *i* in livelihood group *j*
- T_j denotes the treatment status of livelihood group or CSW *j* (1 for treatment group; 0 for control group)
- β_1 is the estimated treatment effect of MC compared to control
- X'_{ij} is a vector of household-level covariates, including baseline values of the outcome variable and other controls selected through LASSO regressions performed on the full range of baseline covariates
- γ is a vector of coefficients for the included covariates
- α'_s is a vector of categorical factors corresponding to the LG or CSW stratum that the household is found in
- ε_{ij} denotes the household error term *i*, clustered at the LG-level or CSW-level *j* to reflect the randomization process

We conduct this analysis separately for the LG and CSW subsamples. We estimate intention-to-treat (ITT) effects by comparing households randomized into the treatment group to households in the control group. We estimate treatment-on-the-treated effects (TOT) based on bicycle usage by treatment households and potential contamination of control households (such as

[7] Study ID AEARCTR-0013282 (link)

treatment households sharing bicycles with control households). Our main TOT analysis uses bicycle usage frequency to estimate "treatment intensity" and instruments treatment intensity with treatment assignment.

Missing values occurred in our dataset, particularly in the consumption and asset modules, when the respondent says that their household consumed or owns an item but does not know its cost, quantity, or total value. Although enumerators encouraged respondents to give their best estimate when unsure of a value, some respondents could not reasonably estimate some survey items, and the value needed to be coded as missing. For the consumption and asset survey items, we replaced missing quantities and prices with the median reported by other households in the sample. We do this because households with missing values reported consuming or owning the item in question but were unsure of the value.

Appendix B: Regression Results for all Outcomes

Table B1: Main Outcomes, included Pooled Results

Variable	# Obs, EL2	Ctrl Mean, EL2	ITT EL2, Pooled	ITT EL1, Pooled	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Est. Total Monthly Consumption, ZMW	1360	4142.59	1207.09 ***	866.73 ***	1124	4097.01	1190.36 ***	875.37 ***	236	4362.25	1325.91 ***	782.83 ***
Est. Total Value of HH Assets, ZMW	1358	53658.74	15339.94 ***	13532.96 ***	1123	52092.41	14652.86 ***	14217.43 ***	235	61207.9	20896.03 **	9607.41 *
Est. Monthly Earnings from Work Nature	1347	1305.28	601.26 ***	384.27 ***	1114	1329.42	504.52 ***	420.26 ***	233	1189.38	1070.77 ***	198.45
Est. Average Monthly Household Income, ZMW	1340	2007.88	862.45 ***	552.65 ***	1108	2038.48	743.25 ***	625.37 ***	232	1860.98	1438.28 ***	180.33
Total # of Income Sources	1360	1.74	0.09 *	0.04	1124	1.77	0.09	0.06	236	1.58	0.13	-0.05
Household Per Capita Monthly Income, ZMW	1340	326.28	137.99 ***	69.53 ***	1108	333.2	124.05 ***	80.39 ***	232	293.09	209.42 ***	15.31
Poverty Likelihood % (From PPI)	1360	0.56	-0.07 ***	-0.06 ***	1124	0.58	-0.08 ***	-0.08 ***	236	0.48	-0.02	0.01
HH Saved Income in Past 30 days	1358	0.72	0.05 *	0.11 ***	1124	0.74	0.05 *	0.12 ***	234	0.65	0.07	0.03
HH Savings Past 30 Days, ZMW	1356	900.19	678.46 ***	454.90 ***	1123	877.68	624.47 ***	511.23 ***	233	1010.5	1003.97 *	208.99
Weekly Time (Min) Spent Traveling	1360	1325.52	-357.39 ***	-250.93 ***	1124	1358.62	-395.63 ***	-247.68 ***	236	1165.98	-154.6	-250.36 **
Weekly Total Distance (KM) Traveled	1357	158.1	-15.92	-3.34	1121	161.15	-17.35	-1.26	236	143.44	-4.04	-10.6
Total hours spent on productive activities, winsorized	1360	4.34	0.85 ***		1124	4.38	0.74 **		236	4.18	1.32 **	
Total Monthly Business Revenue, ZMW	1360	880.75	284.90 ***	382.60 ***	1124	945.35	261.65 **	518.54 **	236	569.41	389.58 *	-167.35
Women's Economic Empowerment	927	0.67	-0.01		809	0.67	-0.01		118	0.63	-0.04	

Index (0-1)												
Economic Decision-Making Index (0-1)	1351	0.85	0.00		1115	0.85	0.00		236	0.84	-0.02	
Asset Control Index (0-1)	1360	0.28	0.04 ***		1124	0.28	0.04 ***		236	0.32	0.02	
Locus of Control Index	1360	0.00	0.32 ***	0.19 ***	1124	-0.01	0.31 ***	0.27 ***	236	0.03	0.34 ***	-0.14
Self-Esteem Index	1360	0.00	0.15 ***	0.09	1124	0.01	0.13 *	0.13 *	236	-0.03	0.23 *	-0.12
Gender Norms Index	1360	0.00	0.02	-0.11 *	1124	-0.04	0.06	-0.17 **	236	0.18	-0.16	0.15

Table B2: Main Outcomes, Treatment-on-Treated Estimates

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	TOT EL2, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	TOT EL2, CSW
Est. Total Monthly Consumption, ZMW	1124	4097.01	1190.36 ***	1361.72 ***	236	4362.25	1325.91 ***	1528.48 ***
Est. Total Value of HH Assets, ZMW	1123	52092.41	14652.86 ***	16763.08 ***	235	61207.9	20896.03 **	24080.69 **
Est. Monthly Earnings from Work Nature	1114	1329.42	504.52 ***	577.48 ***	233	1189.38	1070.77 ***	1236.42 ***
Est. Average Monthly Household Income, ZMW	1108	2038.48	743.25 ***	851.23 ***	232	1860.98	1438.28 ***	1660.98 ***
Total # of Income Sources	1124	1.77	0.09	0.1	236	1.58	0.13	0.15
Household Per Capita Monthly Income, ZMW	1108	333.2	124.05 ***	142.07 ***	232	293.09	209.42 ***	241.76 ***
Poverty Likelihood % (From PPI)	1124	0.58	-0.08 ***	-0.10 ***	236	0.48	-0.02	-0.02
HH Saved Income in Past 30 days	1124	0.74	0.05 *	0.05 *	234	0.65	0.07	0.08
HH Savings Past 30 Days, ZMW	1123	877.68	624.47 ***	714.41 ***	233	1010.5	1003.97 *	1147.44 *
Weekly Time (Min) Spent Traveling	1124	1358.62	-395.63 ***	-452.51 ***	236	1165.98	-154.6	-178.19
Weekly Total Distance (KM) Traveled	1121	161.15	-17.35	-19.86	236	143.44	-4.04	-4.66
Total hours spent on productive activities, winsorized	1124	4.38	0.74 **	0.85 **	236	4.18	1.32 **	1.52 **
Total Monthly Business Revenue, ZMW	1124	945.35	261.65 **	299.32 **	236	569.41	389.58 *	449.07 *

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	TOT EL2, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	TOT EL2, CSW
Women's Economic Empowerment Index (0-1)	809	0.67	-0.01	-0.01	118	0.63	-0.04	-0.04
Locus of Control Index	1124	-0.01	0.31 ***	0.36 ***	236	0.03	0.34 ***	0.39 ***
Self-Esteem Index	1124	0.01	0.13 *	0.15 *	236	-0.03	0.23 *	0.27 *
Gender Norms Index	1124	-0.04	0.06	0.07	236	0.18	-0.16	-0.18

Table B3: Livelihoods Group Members

Variable	# Obs, EL2 LGM	Control Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM
Livelihood Group Size	1105	19.55	0.07	0.07
Members of VSLAs	1110	0.48	0.01	0.01
Co-operative members	1110	0.38	0.02	0.02
Women's clubs	1110	0.35	-0.02	-0.02
Youth Clubs	1110	0.07	-0.02	-0.02
Tot. Value of LG Monetary Contribution	1097	93.64	58.20 *	58.20 *
LG Transport Costs Last 30 Days	1106	50.67	-6.65	-6.65
Receives Dividends	1110	0.56	0.03	0.03
Avg. Value of Dividend	1108	1008.56	353.75 **	353.75 **

Table B4: Bicycles

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
HH Owns Bicycle	1124	0.14	0.81 ***	0.84 ***	236	0.24	0.70 ***	0.68 ***
HH Number of bikes	1124	0.14	1.03 ***	1.05 ***	236	0.25	1.11 ***	1.11 ***

HH Access to Bike When Needed	580	0.95	0.03	0.01	135	1.00	-0.03	0.07
Bike use is weekly to daily	1124	0.26	0.54 ***	0.59 ***	236	0.34	0.50 ***	0.54 ***
Bike use is several times a month to monthly	1124	0.40	-0.32 ***	-0.21 ***	236	0.30	-0.20 ***	-0.32 ***
Bike use is rare or never	1124	0.53	-0.39 ***	-0.48 ***	236	0.52	-0.41 ***	-0.36 ***
Bike Shared Outside Household	589	0.80	0.03	-0.05	137	0.90	0.02	-0.05
More bike access for males	580	0.60	-0.14	0.01	135	0.46	-0.06	-0.16
More bike access for females	580	0.10	0.18 **	0.01	135	0.21	-0.11	0.08
Equal bike access for males/females	580	0.30	-0.03	-0.02	135	0.32	0.17	0.09

Table B5: Buffalo Bicycles (Treatment Group Only)

Buffalo Sharing		
Variable	**# Obs**	**Treatment Mean, EL2**
Purpose of sharing bike: Access to education	555	0.02
Purpose of sharing bike: Healthcare access	555	0.78
Purpose of sharing bike: Going to markets	555	0.34
Purpose of sharing bike: Collecting water/firewood	555	0.01
Purpose of sharing bike: Going to the farm	555	0.03
Purpose of sharing bike: Transporting goods/crops	555	0.20
Purpose of sharing bike: Going to business/work	555	0.06
Purpose of sharing bike: Recreational use	555	0.01
Purpose of sharing bike: Emergencies/funerals	555	0.10
Purpose of sharing bike: Visiting friends/family	555	0.01
Purpose of sharing bike: Other	555	0.23
Total count of all sharing occasions in past 12 months	534	11.65
Buffalo Cost of Ownership		

Variable	# Obs	Treatment Mean, EL2
Annual Cost of Preventative Maintenance (ZMW)	650	80.92
Annual Cost of Spare Parts (ZMW)	647	271.53
Total Annual Cost of Ownership (ZMW)	650	376.53

Table B6: Community Service Workers

Variable	# Obs, EL2 CSW	Control Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Service Nature = Health	231	0.8	-0.04	0.01
Service Nature = Agri	231	0.08	-0.02 *	0.01
Service Nature = Environ	231	0.11	0.05	-0.02
CSW: Number of times a Buffalo bike was used to transport someone	182	0.61	5.98 ***	15.01 ***
Service from Home	231	0.02	0.03	0.01
Service from Stationary Place	231	0.3	-0.01	0.04
Service from Moving	231	0.68	-0.02	-0.05
Total Service Days Per Month	236	5.88	-0.59	-0.39
Mobile CSW - Required recipients to reach monthly	123	77.48	20.04	101.7
Mobile CSW: Met or exceeded client target	122	0.83	0.12 **	
Stationary CSW: Met or exceeded client target	57	0.39	0.16	
Total Customers Served Per Month	236	92	5.16	79.64 *
Time Spent Travelling for Service Weekly	174	1449.74	-283.6	-261.26
Distance Spent Travelling for Service Weekly	169	74.59	3.12	-7.32
Total Service Days Per Month, Health Only	182	6.15	-1.21	-0.34
Mobile CSW - Required recipients to reach monthly, Health Only	85	74.9	49.32	106.09
Total Customers Served Per Month, Health Only	182	72.36	38.08	115.42 **

Variable	# Obs, EL2 CSW	Control Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Met Target for Clients Served, Health Only	85	0.85	0.04	0.1
Time Spent Travelling for Service Weekly, Health Only	128	1261.73	-140.18	-110.5
Distance Spent Travelling for Service Weekly, Health Only	125	75.83	-8.68	-1.87
Service main transport = Walking	236	0.81	-0.78 ***	-0.67 ***
Service main transport = Own Bike (not WBR)	236	0.02	-0.02	-0.03 *
Service main transport = Paid Bike (not WBR)	236	0.02	-0.02 *	-0.03 **
Service main transport = Buffalo Bicycle	236	0.06	0.84 ***	0.80 ***
Service main transport = All Others	236	0.09	-0.01	-0.06
Challenges = Long distance	155	0.65	-0.56 ***	-0.34 ***
Challenges = Lack of transportation	155	0.88	-0.86 ***	-0.74 ***
Challenges = Cost of transportation	155	0.15	-0.11 **	-0.12 **
Challenges = Physical fatigue	155	0.23	-0.21 ***	-0.15 ***
Challenges = Lack of compensation	155	0.32	-0.03	0
Solution = Money	122	0.34	0.23 **	0.14
Solution = Transportation	122	0.92	-0.85 ***	-0.72 ***
Solution = Incentives	122	0.43	0.03	0.13
In a typical day providing this service to the community members, what is the mi	76	37.84	-11.93	
Mobile: Last month new clients	152	6.17	3.05	
Mobile: Last month repeat clients	152	24.91	-3.63	
Mobile: Typical day min clients	153	47.72	-1.03	
Mobile: Typical day max clients	153	71.27	3.67	

Appendix C: Detailed Consumption & Asset Results

Here, we report individual treatment effects on the components in our consumption and asset modules. Table C1 shows that our pooled ITT estimate for **monthly** consumption (ZMW 1207) was primarily driven by differences in expenditure for fish, chicken, rice, wheat, bread, sugar, oil, and remittances. Table C2 shows that our pooled ITT estimate for assets (ZMW 15,340) was driven primarily by differences in the value of furniture, kitchen utensils, cellphones, solar panels, chickens and goats.

Table C1: Treatment effect on Consumption Items

Variable	Control Mean	ITT (ZMW)	q-value
Fish	117	73.91	0.001
Kapenta	55	19.54	0.014
Chicken	210	95.35	0.001
Beef	85	-5.13	0.357
Goat	77	18.24	0.158
Breakfast Mealie Meal	22	-9.98	0.112
Hammer Mealie Meal	426	-132.77	0.112
Rice	57	25.86	0.04
Wheat	22	31.55	0.002
Maize	53	3.86	0.213
Beans	54	22.74	0.001
Green Maize	20	2.48	0.329
Tomatoes	67	5.08	0.133
Potatoes	7	8.75	0.027
Groundnuts	83	14.14	0.074
Pumpkin Leaves	13	2.42	0.155

Rapeseed	73	1.71	0.329
Pumpkin	53	7.75	0.178
Onions	17	6.96	0.001
Okra	20	1.88	0.181
Sweet Potatoes	132	18.95	0.022
Eggs	44	17.61	0.003
Bread	92	37.85	0.001
Sugar	127	30.3	0.001
Alcohol Beverage	22	14.06	0.076
Milk	58	17.94	0.034
Munkoyo	277	71.54	0.021
Maheu	3	3.15	0.09
Oil	201	28.55	0.014
Seasonal Fruit	38	6.1	0.142
Outside Food	70	31.69	0.055
Cosmetics	68	5.81	0.084
Detergent	68	8.99	0.013
Soap	15	1.85	0.094
Charcoal	19	8.37	0.071
Petrol	60	39.84	0.063
Rent	11	1	0.354
Electricity	36	2.39	0.329
TV	13	8.92	0.013
Phone Fees	56	12.79	0.007
Public Transport	219	-0.72	0.377

Vehicle	66	58.24	0.162
Motor Bike	25	-2.76	0.329
Bike Repair	15	48.7	0.001
Loan Pay	71	15.04	0.22
Remittance	27	12.07	0.002
Men's Clothes	31	6.87	0.063
Women's Clothes	33	12.22	0.001
Children's Clothes	37	13.23	0.002
Gifts	39	1.95	0.341
Contributions	25	6.17	0.045
School Fees	21	10.28	0.141
School Expenses	45	19.81	0.035

Table C2: Treatment effect on Asset Items

Variable	Control Mean	ITT (ZMW)	q-value
Bed	1168	367	0.001
Mattress	1212	323	0.001
Mosquito Net	112	30	0.001
Table	274	83	0.011
Sofa	1471	361	0.012
Radio	536	91	0.093
TV	1916	421	0.105
Satellite TV	619	99	0.211
DVD/VCR	304	191	0.124
Cellphone	1049	409	0.001

Clock	158	-54	0.163
Brazier	40	5	0.062
Stove	1993	-661	0.254
Iron	81	13	0.053
Axe	106	11	0.11
Pick	127	-9	0.254
Hoe	182	56	0.001
Hammer	74	1	0.357
Shovel	99	14	0.02
Plough	1498	118	0.124
Crop Sprayer	600	79	0.11
Ox Cart	6182	807	0.11
Solar Panel	939	407	0.009
Kitchen	1033	308	0.002
Oxen	21312	3	0.375
Cows	24175	-519	0.357
Calves	6112	477	0.241
Goats	3591	910	0.036
Sheep	3764	1492	0.071
Pigs	4834	948	0.211
Chickens	1152	231	0.053
Other Animals	402	2275	0.11
Land	32419	3167	0.241

Appendix D: Inverse-Probability Weight Regressions

As robustness checks, Table D1 shows our ITT estimates for our main outcomes when using inverse probability weights (IPW) to account for attrition. These do not meaningfully change any of our findings

Table D1: Treatment effect on Main Outcomes with IPW

Variable	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	TOT EL2, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	TOT EL2, CSW
Est. Total Monthly Consumption, ZMW	1124	4097.01	1187.62 ***	1359.37 ***	236	4362.25	1364.31 ***	1568.95 ***
Est. Total Value of HH Assets, ZMW	1123	52092.41	14629.57 ***	16746.13 ***	235	61207.9	20922.79 **	24053.33 **
Est. Monthly Earnings from Work Nature	1114	1329.42	500.63 ***	573.36 ***	233	1189.38	1084.50 ***	1249.30 ***
Est. Average Monthly Household Income, ZMW	1108	2038.48	737.08 ***	844.63 ***	232	1860.98	1426.85 ***	1643.82 ***
Total # of Income Sources	1124	1.77	0.09	0.1	236	1.58	0.12	0.14
Household Per Capita Monthly Income, ZMW	1108	333.2	124.00 ***	142.09 ***	232	293.09	211.72 ***	243.81 ***
Poverty Likelihood % (From PPI)	1124	0.58	-0.08 ***	-0.10 ***	236	0.48	-0.02	-0.02
HH Saved Income in Past 30 days	1124	0.74	0.05 *	0.05 *	234	0.65	0.07	0.08
HH Savings Past 30 Days, ZMW	1123	877.68	620.83 ***	710.65 ***	233	1010.5	1033.78 *	1178.93 *
Weekly Time (Min) Spent Traveling	1124	1358.62	-388.74 ***	-444.91 ***	236	1165.98	-158.01	-181.7
Weekly Total Distance (KM) Traveled	1121	161.15	-16.31	-18.68	236	143.44	-2.92	-3.36
Total hours spent on productive activities, winsorized	1124	4.38	0.75 **	0.86 **	236	4.18	1.35 **	1.55 **
Total Monthly Business Revenue, ZMW	1124	945.35	251.93 **	288.36 **	236	569.41	392.27 *	451.08 *
Women's Economic Empowerment	809	0.67	-0.01	-0.01	118	0.63	-0.04	-0.04

Index (0-1)								
Locus of Control Index	1124	-0.01	0.31 ***	0.36 ***	236	0.03	0.34 ***	0.40 ***
Self-Esteem Index	1124	0.01	0.13 *	0.15 *	236	-0.03	0.23 *	0.27 *
Gender Norms Index	1124	-0.04	0.05	0.06	236	0.18	-0.15	-0.18

Appendix E: HDDS Food Classification

Table E1 shows household dietary diversity score classifications for the food in our consumption module.

Table E1: HDDS Food Group Classification

HDDS food group	Food item (Zambian-specific items italicized)
Cereals	Packaged breakfast mealie, Hammer mealie, Rice, Wheat and/or flour, Maize Grain, Green maize, Bread
Vegetables	Pumpkin, Pumpkin leaves, Rape, Onion, Okra, Tomatoes
Pulses, legumes, nuts	Beans, Groundnuts
Roots and tubers	Potatoes, Sweet potatoes
Fruits	Mangoes, Pineapple, *Masuku*, Wild fruit
Eggs	Eggs
Fish and seafood	Fish, *Kapenta*
Meat, poultry, offal	Chicken, Beef, Goat
Milk and milk products	Milk
Oil/fats	Cooking oil
Sugar/honey	Sugar

Miscellaneous	*Mukonyo/Chibwatu, Maheu*

Appendix F: Female-Only Treatment Effects

Table F1 shows our ITT estimates for our main outcomes for female households.

Table F1: Female-Only Treatment effects

Variable	# Obs, EL2	Ctrl Mean, EL2	ITT EL2, Pooled	ITT EL1, Pooled	# Obs, EL2 LGM	Ctrl Mean, EL2 LGM	ITT EL2, LGM	ITT EL1, LGM	# Obs, EL2 CSW	Ctrl Mean, EL2 CSW	ITT EL2, CSW	ITT EL1, CSW
Est. Total Monthly Consumption, ZMW	932	3862.58	1276.18 ***	1001.90 ***	813	3742.93	1360.27 ***	1059.37 ***	119	4694.31	466.48	495.15
Est. Total Value of HH Assets, ZMW	930	45935.39	15560.45 ***	15457.90 ***	812	43877.8	15501.98 ***	15522.87 ***	118	60238.97	14424.15	12476.63 *
Est. Monthly Earnings from Work Nature	923	1054.06	569.35 ***	413.96 ***	804	1058.29	561.73 ***	430.08 ***	119	1025.11	385.48	98.79
Est. Average Monthly Household Income, ZMW	915	1731.28	889.31 ***	648.04 ***	798	1716.56	793.59 ***	697.76 ***	117	1831.94	1365.05 **	81.24
Total # of Income Sources	932	1.77	0.13 ***	0.08	813	1.79	0.1	0.08	119	1.61	0.35 **	0.05
Household Per Capita Monthly Income, ZMW	915	286.99	135.35 ***	67.83 ***	798	290	127.57 ***	81.19 ***	117	266.39	159.33 *	-41.76
Poverty Likelihood % (From PPI)	932	0.59	-0.10 ***	-0.08 ***	813	0.6	-0.11 ***	-0.10 ***	119	0.5	-0.03	0.02
HH Saved Income in Past 30 days	931	0.73	0.05 *	0.07 ***	813	0.74	0.04	0.09 ***	118	0.65	0.1	-0.04
HH Savings Past 30 Days, ZMW	929	772.42	541.34 ***	499.08 ***	812	697.01	632.09 ***	519.45 ***	117	1305.25	-650.03	221.22

Weekly Time (Min) Spent Traveling	932	1338.16	-422.99 ***	-282.75 ***	813	1359.24	-454.58 ***	-265.22 ***	119	1191.58	-197.49	-421.62 ***
Weekly Total Distance (KM) Traveled	929	144.09	-28.51 ***	-10.53	810	146.87	-30.59 **	-9.51	119	124.89	-18.95	-16.24
Total hours spent on productive activities, winsorized	932	3.81	0.88 ***		813	3.84	0.86 **		119	3.56	0.85	
Total Monthly Business Revenue, ZMW	932	691.52	378.21 ***	590.38 ***	813	714.86	393.47 ***	658.90 **	119	529.25	73.39	58.87
Women's Economic Empowerment Index (0-1)	925	0.67	-0.01		807	0.67	-0.01		118	0.63	-0.04	
Locus of Control Index	932	-0.01	0.34 ***	0.24 ***	813	-0.01	0.32 ***	0.28 ***	119	0	0.46 ***	0.05
Self-Esteem Index	932	-0.05	0.15 ***	0.1	813	-0.04	0.14 *	0.1	119	-0.09	0.2	0.01
Gender Norms Index	932	0.04	0.12 *	-0.06	813	-0.01	0.15 **	-0.09	119	0.38	-0.14	0.21

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