Mobilized Communities Impact Evaluation

Endline Report

IDinsight

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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.

IDinsight works with governments, foundations, NGOs, multilaterals and businesses across Africa and Asia. We work in all major sectors including health, education, agriculture, governance, digital ID, financial access, and sanitation.

We have offices in Dakar, Lusaka, Manila, Nairobi, New Delhi and Rabat. Visit **www.IDinsight.org** and follow on Twitter **@IDinsight** to learn more.

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Acronyms, list of figures and tables

Acronyms

BSC   Bicycle Supervisory Committee

CSW   Community Service Worker

DiD   Difference-in-Differences

FDR   False Discovery Rate

HDDS Household Dietary Diversity Score

HH   Household

IPW   Inverse-Probability Weight

ITT   Intention-to-Treat

LG   Livelihoods Group

LGM   Livelihoods Group Member

MC   Mobilized Communities

PPI   Poverty Probability Index

RCT   Randomized Control Trial

SD   Standard Deviation

TOC   Theory of Change

TOT   Treatment-on-the-Treated

VSLA Village Savings and Loan Association

WBR   World Bicycle Relief

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Executive Summary

World Bicycle Relief (WBR) is a non-profit social enterprise that supports rural and remote communities by helping adults and children overcome transportation barriers. Through community-led programs and sales, bicycles enhance access to healthcare, education, and economic opportunities. WBR is implementing a program in Mumbwa District in Zambia called the Mobilized Communities (MC) program, to provide bicycles and supportive programming to help communities sustainably increase access to livelihoods, education, and healthcare.

IDinsight partnered with WBR to conduct a randomized controlled trial (RCT) to estimate the causal impact of WBR's MC program on economic outcomes, including household consumption, income, savings, productivity, and empowerment measures. Using WBR's lists of individuals eligible for the program in the study area in Mumbwa district, our final endline survey sample was 1,488 respondents, comprising 1,227 Livelihoods group members (LGM) across 120 livelihoods groups and 261 community service workers (CSWs). This report describes the results of the RCT of the MC program, conducted between May 2023 and June 2024.

Key findings

- **Mobility:** Bicycle recipients saved an average of 4.2 hours in weekly travel time to essential destinations relative to the control group. While we observed no difference in travel distances between treatment and control groups, bicycles shifted the composition of travel destinations, with treatment recipients making more trips to markets and health facilities. 90% of bicycle recipients were able to access healthcare when needed in the past month, compared to just 54% in the control group, showcasing a substantial improvement in accessibility. Community health workers with bicycles served 63% more households monthly, underscoring the impact on service provision.
- **Household Welfare:** Bicycle recipients reported ZMW 867 (USD 33) or +24% higher average monthly household consumption and ZMW 553 (USD 21) or +43% higher monthly household income compared to non-recipients. While the control group experienced a steep drop in living standards during the previous year's drought, bicycle recipients were partly insulated from the shock.
- **Social Norms:** Bicycles led to an 11% increase in life satisfaction among participants and elevated self-esteem.
- **Subgroups:** Subgroup analysis revealed that bicycle provision uniformly benefited all demographic segments—age, gender, and poverty levels—without significant variances across the various subgroups.

1. Introduction and Context

IDinsight partnered with World Bicycle Relief (WBR) to conduct an impact evaluation to estimate the causal impact of WBR's Mobilized Communities (MC) program on economic outcomes, including household consumption, income, savings, improved productivity, and empowerment measures.

WBR is a 501(c)3 not-for-profit that owns 100% of Buffalo Bicycle Limited, a non-profit social enterprise with a retail network in Colombia, Kenya, Malawi, Uganda, Tanzania, Zambia, and Zimbabwe. WBR partners with rural communities to expand access to education, markets, health facilities, and vital services by providing bicycles.

WBR has been operating in Zambia since 2007 and started implementing the five-year MC program in Mumbwa District, Zambia, in 2021. The MC program is designed to support communities in sustainably increasing access to education, healthcare, and livelihoods. The MC program aims to provide Buffalo Bicycles to approximately 14,000 households over five years. In 2023, as part of this evaluation, 1009 bicycles were distributed. Our evaluation sample includes communities in Mumbwa district of Zambia that were not part of programming in 2021 and 2022. The program has a particular focus on women and girls, and building a sustainable bicycle ecosystem to support long-term community impact. **Figure 1** shows WBR's theory of change for how the MC program is intended to impact participating communities.

Figure 1: A theory of change developed by WBR for the MC program

ACTIVIITIES	OUTPUTS	INTERMEDIATE OUTCOMES	LONG-TERM OUTCOMES	IMPACTS
World Bicycle Relief engages communities to determine the transportation needs of community service workers, vulnerable groups, and students.	Communities establish local committees to determine and manage bicycle programs. World Bicycle Relief trains community mechanics and establishes Buffalo Bicycle retail operations.	Bicycles improve access to education, healthcare and livelihoods. Trained mechanics and retail network improves access to bicycle maintenance and spare parts.	Individuals have increased productivity with improved education, income, health, and well-being measures. Bicycle usage and longevity is increased.	Mobilized Communities Individuals and Communities Thrive through the Power of Bicycles.

IDinsight partnered with WBR to conduct a randomized controlled trial (RCT) to estimate the causal impact of the MC program on key economic outcomes. This

evaluation focused on the program's impact on adult beneficiaries who were eligible for bicycle distribution in 2023, specifically members of livelihoods groups and individual community service workers.

We conducted a baseline in May/June 2023, prior to bicycle distribution in July 2023. Endline data was collected one year later, in May and June 2024, to measure the program's outcomes and impact. **Figure 2** shows the timeline of events for the MC program and the evaluation.

Figure 2: Timeline of events for the MC program and the evaluation

27 May
BSC bicycle distribution

17 July
Participant bicycle distribution

15 Nov
Bicycle tracker program implementation

| May 2023 | July 2023 | Aug 2023 | Nov 2023 | May 2024 |

29 May
Baseline survey

1 Aug
Bicycle tracker program pilot

20 May
Endline Survey
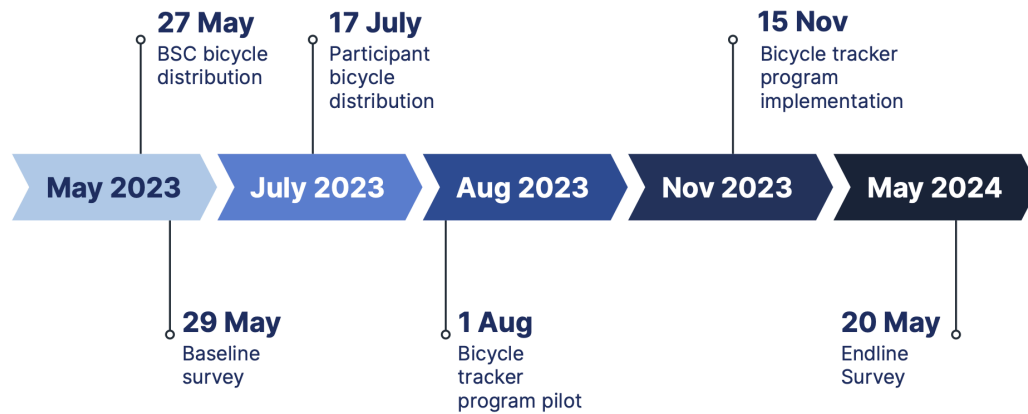
2. Study Design

To estimate the impact of the MC program, IDinsight conducted an RCT in areas of Mumbwa district of Zambia that were not part of WBR's programming in 2021 and 2022. Program impact was estimated by comparing the treatment group that received bicycles in 2023, and a control group that did not receive bicycles. The process of randomization and selection are outlined in Section 2.3.

2.1 Research Questions

Our research questions were:

A. *What is the causal impact of the MC program on household welfare and the 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, including gender norms, locus of control, and self-esteem?*
D. *How do treatment effects of the MC program vary by subgroups of interest, such as gender, being a livelihoods group member or community service worker, or age?*

2.2 Outcomes

This evaluation measures the impact of WBR's Mobilized Communities program on participants' household socio-economic welfare in Mumbwa District. The evidence will shed light on the impacts of bicycles on adult recipients. This information will guide program decisions and potential future scale-up and inform broader systems change to increase access to bicycles for economic growth and opportunity.

Table 1 defines our key outcomes. We present results from our endline data collection for all of these outcomes in the appendix.

Table 1: Key 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
	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 valuation of a set of common durable and agricultural assets owned by the household
	Total transportation expenditure	Total amount of money spent by 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 household falling under the Zambia national

[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
Individual and household productivity		poverty line based on a set of 10 questions tested by Innovations for Poverty Action
	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 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.
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 | % of females who are able to make decisions about general financial administration in the house

% of females who are able to voice out their opinions in community meetings

% of females who are consulted by their partner when making household decisions |

Outcome category	Survey module name	Description
	Self-esteem	% of females who value and perceive themselves highly
	Locus of control	% of females who feel they have control over their lives
	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.

2.3 Sampling and Randomization

The population of interest for this evaluation was livelihoods group members (LGMs) and community service workers (CSWs). Livelihood groups (LGs) are collective entities that were already established and active in these communities prior to the study. LGs are composed of individuals within a community who actively collaborate to enhance the economic well-being and livelihoods of their members. The sampled LGs in our study included village savings and loan associations, co-operatives, women's clubs, and youth clubs. CSWs refer to individuals—either staff or volunteers—committed to fostering development in their communities across a spectrum of sectors: health, nutrition, food production, clean water, livestock health, environment, conservation, and good governance. In our study, the sample included health, environment, and agriculture workers.

To ensure the sustainability of the MC program, a community-led Bicycle Supervisory Committee (BSC) was established in each community and trained to manage and monitor the progress of the program. To identify LGs and CSWs for inclusion in the MC program, WBR conducted a Mobility Needs Assessment. This involved wealth ranking and social network analysis, among other participatory methods, to ascertain the wealth categories in the community and pinpoint key social and economic groups. LGs were selected for the final sample based on the duration of time they have been in existence, their key activities, the existence of by-laws and named officer bearers, and if they are registered

with the government/NGO. Participants for the MC program were chosen based on key criteria aimed at maximizing the impact of bicycle provision in the community. Primary considerations included gender, targeting at least 70% of bicycle recipients to be women to address gender disparities; distance, ensuring the bicycle addresses significant access challenges; potential impact, focusing on how the bicycle can significantly enhance participants' lives or those served by community service workers; and vulnerability, prioritizing poorer community members who stand to gain the most from improved market and resource access, in order to promote future financial autonomy through income-generating activities.

In consultation with WBR, IDinsight identified livelihoods groups and individual community service workers as the most viable units of treatment assignment. For LGMs, we aimed to balance adequate statistical power and minimize potential spillover effects. As a result, options such as LGM-level and community-level randomization were not viable. Regarding CSWs, the focus was on augmenting statistical power while allowing for stratification by characteristics intrinsic to the CSWs, including their sector and gender, to ensure better balance within the sample. Consequently, cluster-level assignment for CSWs was not viable.

This evaluation was carried out in rural areas of Mumbwa district, specifically within the following 19 communities: Chibuluma, Chibusa, Chiwena, Kabalwa, Kabwanga, Kantengwa, Kanwanzhiba, Kapepe, Kawena, Lukanga, Maimwene, Mituntu, Moomba, Muyoba, Mwamba Nzovu, Nakabu, Nakasaka, Nangoma, Nkolola. Within these 19 communities, WBR identified 185 eligible livelihoods groups covering 2,827 members and 324 CSWs.

Our power calculations showed that we needed 120 livelihoods groups and approximately 10 members per livelihoods group to participate in the baseline and endline survey in order to detect effect sizes of 0.20 to 0.30 standard deviations (SDs). These effect sizes are moderate effect sizes for economic outcomes (our CSW sample, though smaller, is randomized at the individual level, and thus has similar statistical power as the livelihoods group sample).

Based on these power calculations, we selected 120 out of the 185 eligible livelihoods groups, removing groups from the sampling frame that were very small (fewer than 10 eligible participants) or very large (more than 30 eligible participants) to reduce the likelihood of differently-sized treatment and control groups and to facilitate survey and program logistics. Following WBR's guidance, we removed ineligible members from this list, including members who were over 75 years old, members who were also in our CSW sample, members who were part of the bicycle supervisory committee (BSC), members who were listed under multiple names, and households that were listed in multiple livelihoods groups. We sampled up to 12 members per livelihoods group from the remaining list to participate in the baseline survey. If a livelihoods group had fewer than 12 eligible members, we sampled them all. We designated any remaining members as replacements and randomized the order in which they should be used to

replace sampled respondents. We included the full list of 324 CSWs in our baseline sample.

During baseline data collection, we identified additional ineligible participants, including households who had relocated from the study area and households with BSCs not identified in the original sampling frame. Our final survey sample at baseline included 1,297 LGMs from 120 LGs and 273 CSWs, giving a total of 1,570 respondents.

After baseline data collection, we randomized survey respondents into treatment and control arms. We randomized 120 livelihoods groups into 60 treatment livelihoods groups (comprising 640 members surveyed at baseline) and 60 control livelihoods groups (comprising 657 members surveyed at baseline), stratifying on livelihoods group type (savings, women/gender, cooperative & multipurpose, and youth groups) and average reported distance that members had to travel to the group. We separately randomized the 273 surveyed CSWs into 137 treatment CSWs and 136 control CSWs, stratifying on the sector (health, livelihoods, and environment) and gender. **Figure 3** summarizes the sampling and randomization process for LGMs and CSWs, while **Figure 4** shows the location of sampled households within the study region.

At endline, we attempted to conduct interviews with all the 1,570 respondents who were initially captured at baseline. Our final endline survey sample comprised 1,227 Livelihoods group members (LGM) across 120 livelihoods groups, in addition to 261 CSWs, for a total of 1,488 respondents, with 5.2% attrition (4.4% in the control group, 6.0% in the treatment group).

Figure 3: Sampling & randomization flowcharts

Livelihoods groups members

Sampling frame: 185 groups

Eliminate groups with < 10 or > 30 members

Evaluation sample: 120 groups

Assign treatment status, stratifying by group type and distance participants travel (8 strata total)

Treatment assignment: 60 groups

Control assignment: 60 groups

Randomly select up to 12 members per group (or all members if < 12). Remove if in multiple groups, > 75 yo, CSWs, BSCs, relocated.

Baseline survey sample: 640 respondents

Baseline survey sample: 657 respondents

70 not surveyed for various reasons including deceased participants

Surveyed at endline: 601 respondents (~6% attrited)

Surveyed at endline: 626 respondents (~5% attrited)

Community service workers

Sampling frame: 324 CSWs

Eliminate BSCs, relocated, deceased

Baseline survey sample: 273 CSWs

Assign treatment status, stratifying by sector and gender (6 strata total). If CSW or spouse is in a sampled LG, retain treatment status of the LG (11% of CSWs)

Treatment assignment: 137 CSWs

Control assignment: 136 CSWs

12 not surveyed for various reasons including deceased participants

Surveyed at endline: 128 CSWs (~7% attrited)

Surveyed at endline: 133 CSWs (~2% attrited)

Figure 4: Map of study region, with T & C HHs pinpointed in different colors

Control households in blue, Treatment households in red
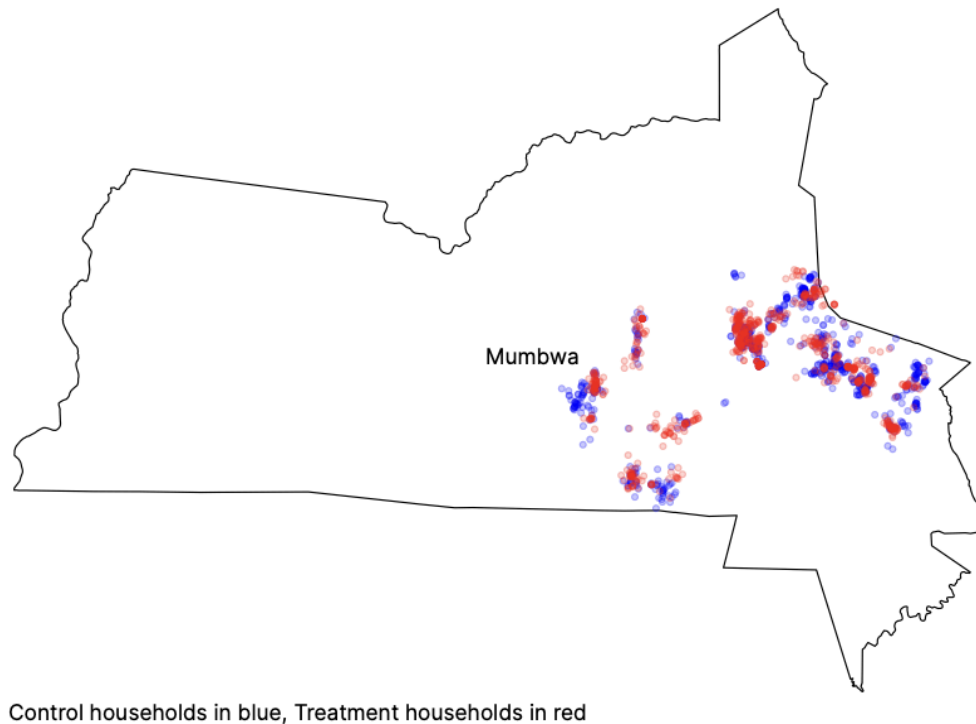
2.4 Data Collection

Like baseline data collection, endline data collection was conducted through a household survey administered to adults. This survey included modules covering the outcomes listed in **Table 1**, and was an adaptation of the baseline instrument and of data collection instruments that WBR deploys in other MC programs both within and outside Zambia. The data collection process was conducted electronically using SurveyCTO, leveraging the efficiency and reliability of tablets and smartphones.

IDinsight assembled a team of 23 enumerators for the endline evaluation. Enumerator selection criteria focused on their skills, research experience, and proficiency in the local language. The selected enumerators were trained on several key areas of this evaluation:

- An overview of IDinsight and WBR organizations and their respective roles within the MC program.
- The specific objectives and desired outcomes of the study.
- A tutorial on using the SurveyCTO platform for data collection.
- The ethical guidelines and standards governing the conduct of research.

- A detailed examination of the survey instrument to be used for the study.

Post-training, enumerators participated in a pilot data collection exercise to evaluate the survey instrument's efficacy and the participant identification processes. This pilot data collection was done in a non-evaluation community in Mumbwa district. Subsequently, the endline interviews were carried out by 20 enumerators over 20 days, from May to June 2024.

The majority of endline interviews (93%) were conducted in-person at respondents' homes. Repeated attempts were made to interview respondents who were unavailable at their homes during initial enumerator visits. We conducted telephone interviews to reach 103 respondents who were not physically present at their households or accessible within their communities for various reasons. WBR supported the fieldwork by providing contact details for BSCs and participants and communicating the fieldwork plan to respondents, thereby facilitating a smooth engagement and coordination.

Data Management & Analysis

The survey instrument was programmed into SurveyCTO and translated into Tonga, the local language mostly used in the study site. Roughly half of surveys were conducted in Tonga and half were conducted in Nyanja, with a handful of surveys conducted in Bemba. When enumerators conducted a survey in Nyanja or Bemba, they used the English version and translated on-the-fly; during training, enumerators indicated that it was easier to translate on-the-fly than to use a separate version pre-translated into Nyanja or Bemba. We added a series of logic checks to reduce systematic errors during data collection. To uphold data integrity, we put in place the following checks:

- Audio Audits: Randomly selected interviews were recorded and audited to affirm the quality of the data collected.
- Spot-Checks: These were carried out to confirm the accuracy of the information gathered.
- High-Frequency Checks: These daily checks were performed to identify outliers, duplicates, and other inconsistencies in key variables. Enumerators were instructed to verify any data that was flagged during these checks directly with the respondents to ensure accuracy and consistency.

Through these checks, surveys with potential issues were queried, and follow-ups were made with the enumerator responsible to address the issues. Additionally, at the end of each work day, daily debriefs with both the enumerators and the WBR field team to further troubleshoot any issues were conducted.

The data was analysed using Stata, both during high-frequency checks and in our endline analysis.

Attrition

From our total baseline sample of 1570 participants, we surveyed 1488, accounting for 95% response rate. Most of those participants who could not be interviewed at endline were out of the community during the data collection period and could not be reached for a phone interview. Attrition was slightly higher in the treatment group (6%) than in the control group (4%), but this difference is not statistically significant at conventional levels (p = 0.14). As shown in the balance table Table 2 in Section 3.1, the endline sample remains well-balanced on baseline characteristics across treatment and control households. Based on this, our main results reported below compare outcomes for respondents who were interviewed at endline without further model-based adjustments. As robustness checks, we present results for the main outcomes with inverse-probability weights (IPWs) in Appendix C; these do not meaningfully change any of our findings.

Non-compliance & Spillovers

Minor deviations from treatment assignment occurred during program implementation. Of the 730 individuals in the treatment group surveyed, 719 received bicycles (98%). Among these, 693 participants retained possession of the bicycle at endline.[2] 10 control participants (1%) reported receiving a Buffalo Bicycle. We sought to mitigate spillovers from bicycle sharing by randomizing at the livelihoods group-level rather than at the individual-level for livelihoods group members. Moreover, WBR emphasized to treatment households that bicycles are intended for household use and outside use should be limited. However, there was still a risk of spillovers from livelihoods group members sharing bicycles outside their livelihoods groups, and from CSWs sharing bicycles with each other. To estimate the extent of spillovers, we asked both treatment and control households about bicycle sharing and usage at the endline. 54% of control group members report borrowing a Buffalo Bicycle at some point during the study period, and the average (median) control group member used a Buffalo Bicycle 5 days (1 day) over the previous year. We use estimates of Buffalo Bicycle usage from endline interviews to estimate treatment-on-the-treated effects.

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[2] Some participants had their bicycles confiscated for a variety of reasons. Instances of confiscation were typically due to participants attempting to sell the bicycles, relocating, failing to pay for preventive maintenance or service, using the bicycles as collateral for loans, or when multiple members from the same household were program participants.

2.5 Analytical Approach

As specified in the pre-analysis plan registered on the AEA RCT Registry,[3] 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 pooled sample and 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 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 said that their household consumed or owned an item but did 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. The average consumption item was missing 0.6% of quantity responses and 1.7% of cost responses. The

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[3] Study ID AEARCTR-0013282 (link)

average asset item was missing 0.4% of quantity responses and 2.9% of cost responses.

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.

3. Evaluation Results

We successfully interviewed 95% of individuals at endline from our baseline sample (94% T, 96% C). There are no major differences between households in our baseline sample and the subset of households who we re-interviewed at endline, and treatment and control households interviewed at endline remain well-balanced with respect to baseline characteristics. **Table 2** provides a detailed comparison of the key variables at baseline and endline, illustrating the balance across treatment and control groups.

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

Baseline Variable	BL Sample, C	BL Sample, T	Diff.	EL Sample, C	EL Sample, T	Diff.
Respondent Age	42.1	40.1	-1.9 *	42.3	40.3	-1.9 *
Female	0.7	0.6	0.0	0.7	0.7	0.0
Household Size	7.2	6.9	-0.4 **	7.2	6.8	-0.4 *
No. School-going Children 6-17 yrs	2.9	2.8	-0.1	2.9	2.8	-0.1
Est. Average Monthly Household Income, ZMW	1717.6	1505.5	-215.9	1738.7	1480.5	-262.1 *
Poverty Likelihood % (From PPI)	0.6	0.6	0.0	0.6	0.6	0.0
Est. Total Monthly Consumption, ZMW	4418.0	4462.4	41.8	4444.6	4474.3	33.4
Est. Total Value of HH Assets, ZMW	67677.3	58368.5	-9362.5 **	67581.9	58444.5	-9199.5 **
Able to ride a bicycle	1.0	1.0	0.0	1.0	1.0	0.0
HH Owns Bicycle	0.2	0.2	0.0	0.2	0.2	0.0
HH Number of bikes	0.2	0.2	0.0	0.2	0.2	0.0
Weekly Total Distance Traveled	149.4	153.0	3.0	150.5	151.6	1.1
Weekly Time Spent Traveling	1331.0	1337.6	5.3	1345.7	1321.0	-25.8
Total Monthly Business Revenue, ZMW	1102.3	1005.9	-99.2	1103.9	994.0	-110.3
Decisions Index[4]	0.0	0.1	0.1 *	0.0	0.1	0.1 **

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[4] We create four separate summary indices for the questions relating to decisions, locus of control, self-esteem, and gender norms, combining each individual question for the module

Baseline Variable	BL Sample, C	BL Sample, T	Diff.	EL Sample, C	EL Sample, T	Diff.
Locus of Control Index	0.0	0.0	0.0	0.0	0.0	0.0
Self-Esteem Index	0.0	0.0	0.0	0.0	0.0	0.0
Gender Norms Index	0.0	0.0	0.0	0.0	0.0	0.0

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.

3.1 Bicycle distribution & usage

At endline, participants in the treatment group reported, on average, owning one additional more bicycle than participants in the control group, essentially confirming that treatment participants received and retained Buffalo Bicycles whereas the majority of control participants did not receive or purchase bicycles during the study period. **Figure 5** shows the average number of bicycles owned by participants at baseline and endline, first for the pooled sample (i.e. LGMs and CSWs together), and then for LGMs and CSWs separately. Above each set of treatment and control line graphs, we report the ITT estimates in terms of raw units and SDs.

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using a generalized least-squares weighting procedure (Anderson 2008). This procedure assigns less weight to indicators that are highly correlated with one another or missing values, and more weight to indicators that are uncorrelated with others (thereby maximizing the informative value of the index).

Figure 5: Bicycle Ownership
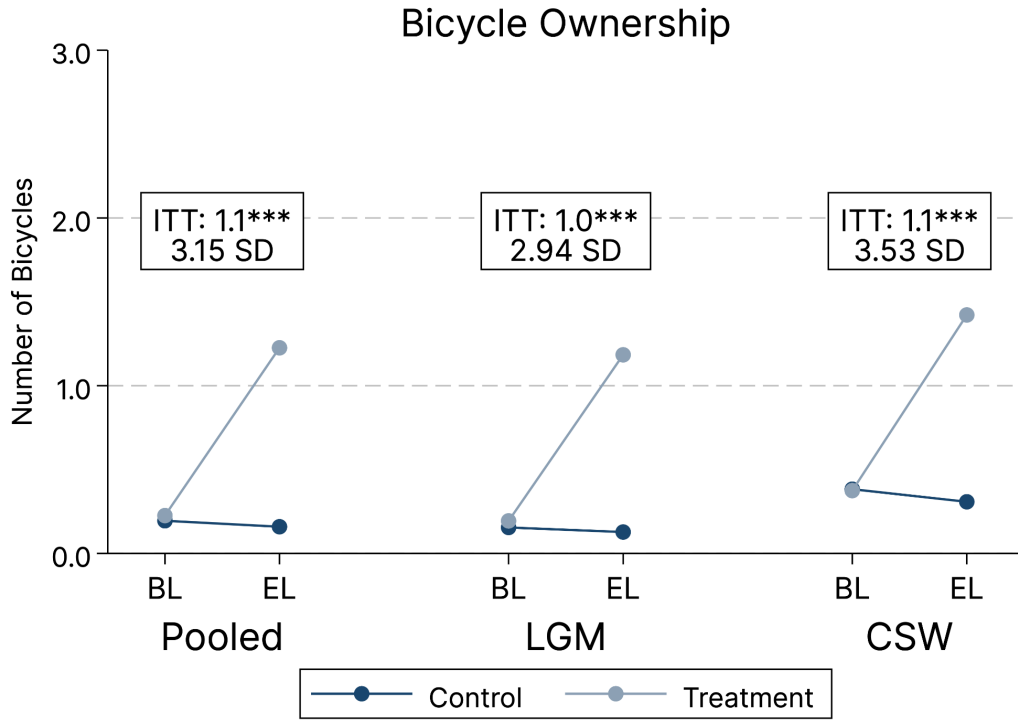
Participants in the treatment group reported significantly higher bicycle usage over the previous year, averaging 223 days of bicycle usage compared to 5 days of usage in the control group. Subgroup analysis showed that treatment LGMs reported using the bicycle for an additional 220 days, while treatment CSWs utilized the bicycles for an even higher average of 240 more days. **Figure 6** shows bicycle usage by participants.

Figure 6: Buffalo Bicycle Usage
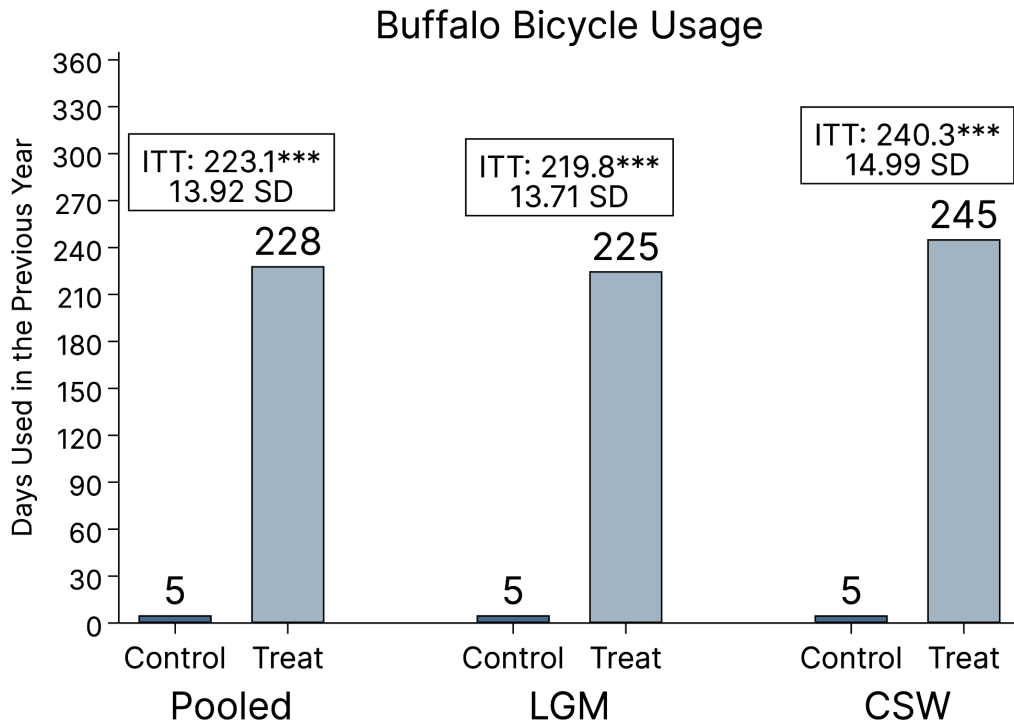
Additional tracking data confirms that Buffalo Bicycles are extensively used. WBR installed GPS tracking devices to monitor bicycle usage among a group of 35 randomly sampled participants who received bicycles, split into two cohorts, and followed bicycle usage for more than an 8-month period from 15 November 2023. The initial cohort of 20 bicycles were tracked from mid-November until the end of April, while the second cohort consisting of 15 bicycles were tracked from early May 2024 until the end of July. Data from the 35 bicycles indicate an average usage duration of 2.1 hours and mean distance traveled of 19.8 kilometres per day. Bicycles were allocated to both men and women, and while the recipients were the primary users, other household members also used the bicycles. On average, bicycles allocated to men recorded significantly longer travel distances and duration (23 kilometres and 2.5 hours per day respectively) than those allocated to women (17.2 kilometres and 1.8 hours respectively). These tracking data were complemented with self-reported travel data from travel diaries that participants were asked to log. Findings from daily trips recorded in the diary data show that on average, 68% of bicycle trips were made by the participants directly, indicating that approximately a third of bicycle trips were by another household member. This supports the idea that bicycle usage is often shared in the household.

3.2 Impacts of bicycles on main outcomes

Overall Findings

Our analysis revealed that bicycles led to positive impacts on various dimensions of livelihoods, including household consumption, assets, income, poverty likelihood, savings, travel time, positive business and health outcomes, and locus of control. Additionally, there were modest but positive shifts related to business revenue and transport costs for business purposes. Treatment participants had a statistically significant higher score for our locus of control index, but were slightly more likely to agree with statements in favor of traditional patriarchal gender norms. The evaluation did not find statistically significant effects on aggregate household transportation expenditure, distance traveled, decision-making index, or self-esteem index. See **Table 3** and **Figure 7** for the effect of the MC program on all the main outcomes.

On average, participants who received a bicycle had a 6.2 percentage point lower poverty likelihood[5] (p<0.01), compared to those who did not receive a bicycle, and this effect was entirely driven by LGMs, whose average poverty likelihood was 5 percentage points higher at baseline compared to CSWs.

Participants who were provided with a bicycle, on average, reported a reduction in monthly business transport costs by ZMW 48 (2 USD)[6] or (-33%) in comparison to those who did not receive one (p<0.05).

Bicycle recipients reported an average saving of ZMW 455 (17 USD) or (+89%) more than those in the control group. By enabling households to save more income, it appears that bicycle ownership contributed to enhancing household resilience, particularly in the context of the drought which was experienced in the 2023/2024 farming season. The capability to accrue savings during more prosperous periods evidently provided a buffer for these households against financial shocks during leaner times of the year. This effect in savings appears to be driven by more people saving at endline that otherwise weren't saving, as roughly 65% of the sample reported saving at baseline. At endline, the control group average is 65%, compared to 76% of the treatment group.

Recipients of bicycles reported an increase in total household transportation

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[5] Poverty likelihood is calculated from the Probability Probability Index and is the probability that the household likely falls under the 2015 National Poverty Line

[6] 1 USD using the average exchange rate for the data collection period May 20, 2024 through June 14, 2024 is equivalent to 26.47 Zambian Kwacha (https://www.exchange-rates.org/)

expenditures, inclusive of bicycle repairs, by an average of ZMW 19 (0.73 USD) in the preceding 30 days compared to control participants. This difference was however not statistically significant (p>0.1). It is important to highlight that recipients are required to pay a ZMW 5 (0.19 USD) monthly fee for bicycle maintenance check-ups. When disaggregating our transportation expenditures, treatment individuals spend ZMW 20 (0.76 USD) less than control individuals on monthly bus/taxi fares (0.05<p<0.1). Moreover, they reported an average of ZMW 29 (1.10 USD) in additional costs for bicycle repairs in our consumption module. Despite these expenses, the net transportation expenditure increase of ZMW 19 (0.73 USD) remains below the total maintenance and repair costs, suggesting that bicycle recipients may have saved on other transportation expenditures, helping to partially offset the cost of bicycle maintenance.

Table 3: Treatment effect on all main outcomes

Variable	# Obs	Control Mean[7]	ITT, Pooled[8]	ITT, LGM	ITT, CSW
Est. Total Monthly Consumption, ZMW	1488	3646.7	866.7 ***	875.4 ***	782.8 ***
Est. Total Value of HH Assets, ZMW	1488	42504.5	13533.0 ***	14217.4 ***	9607.4 *
Est. Monthly Earnings from Work Nature, ZMW	1482	1006.2	384.3 ***	420.3 ***	198.4
Est. Average Monthly HH Income, ZMW	1474	1289.6	552.7 ***	625.4 ***	180.3
Total # of Income Sources	1488	1.7	0.0	0.1	0.0
Poverty Likelihood % (From PPI)	1488	0.57	-0.06 ***	-0.1 ***	0.0
HH Per Capita Monthly Income, ZMW	1474	219.6	69.5 ***	80.4 ***	15.3
HH Saved Income in Past 30 days	1485	0.7	0.1 ***	0.1 ***	0
HH Savings Past 30 Days, ZMW	1483	513.5	454.9 ***	511.2 ***	209
Total Monthly Loan Payment Expenditures, ZMW	1487	75.3	3.3	-7.7	61.2 *
Est. HH Transport Expenditure in Past 30 Days, ZMW	1483	234.8	18.9	8.6	49.3
Weekly Time (Min) Spent Traveling	1488	1146.8	-250.9 ***	-247.7 ***	-250.4 **
Weekly Total Distance (KM) Traveled	1488	124.8	-3.3	-1.3	-10.6
Unable to Visit Health Center in Past 30 Days	1484	0.5	-0.4 ***	-0.4 ***	-0.3 ***
Had to Cancel Plans to Travel out of Community, Past 30 Days	1488	0.8	-0.6 ***	-0.6 ***	-0.5 ***
Number of businesses 0-2	1488	1.1	0.0	0.0	0.1
Total Monthly Business Revenue, ZMW	1488	728.4	382.6 **	518.5 **	-167.4
Total Business Transport Costs in Typical Month, ZMW	1488	145.5	-47.7 **	-47.4 *	-27.8

[7] The control mean is the average for the control group at endline
[8] The ITT columns show the difference between the treatment and control group at endline. A positive (negative) value means the treatment group had a higher (lower) average than the control at endline.

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Intra-HH Index[9]	1482	0.0	0.1	0.0	0.2
Decisions Index	1488	0.0	0.0	0.0	-0.2 **
Locus of Control Index	1488	0.0	0.2 ***	0.3 ***	-0.1
Self-Esteem Index	1488	0.0	0.1	0.1 *	-0.1
Gender Norms Index	1488	0.0	-0.1 *	-0.2 **	0.1

*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.*

Figure 7 shows treatment effects in terms of standardized effect sizes. Standardized effect sizes allow us to compare the magnitude of effect sizes across outcomes with different units of measurement. This figure demonstrates that the effects of bicycles on time spent traveling and on household consumption and income are especially large.

Figure 7: Treatment effect on each main outcome

All effect sizes measured in standard deviations of the control mean

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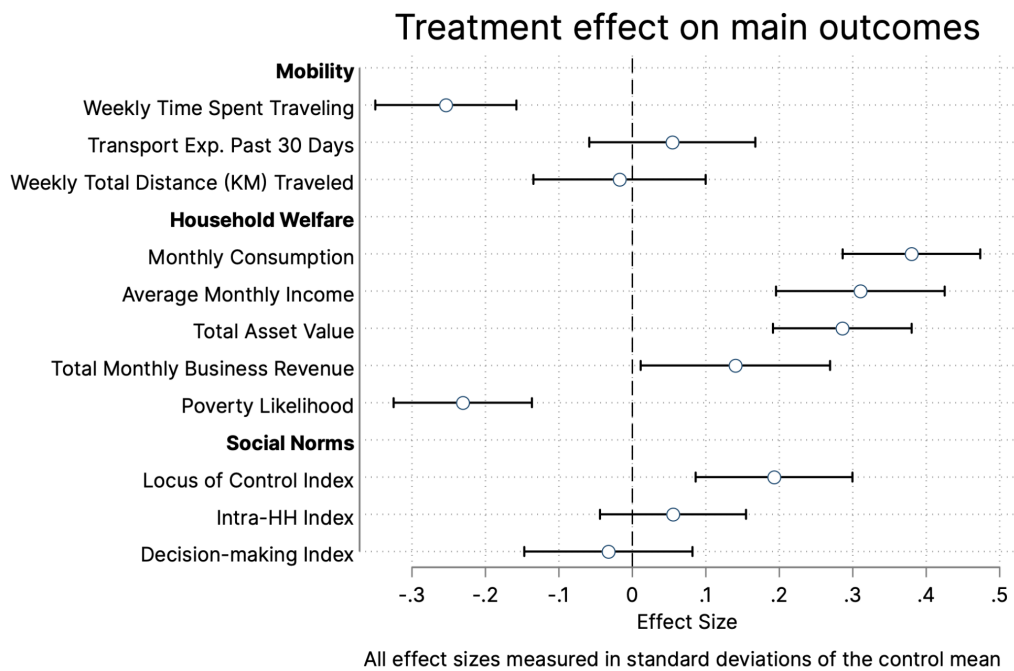
[9] We create four separate summary indices for the questions relating to decisions, locus of control, self-esteem, and gender norms, combining each individual question for the module using a generalized least-squares weighting procedure (Anderson 2008). This procedure assigns less weight to indicators that are highly correlated with one another or missing values, and more weight to indicators that are uncorrelated with others (new information).

Mobility Patterns

The MC program had a positive and statistically significant impact on the time spent traveling to places of interest.

On average, participants who received a bicycle experienced a reduction in travel time by 251 minutes (4.2 hours) or (-22%) per week (p<0.01) to places of interest, compared to those who did not receive a bicycle. LGMs with bicycles saved an average of -248 minutes (4.1 hours) in time savings or (-21%) per week (p<0.01). CSWs who received a bicycle saved 250 minutes (4.2 hours) or (-23%) on travel(p<0.05). **Figure 8** shows the treatment effect on time traveled to places of interest.

Figure 8: Treatment effect on time traveled to places of interest
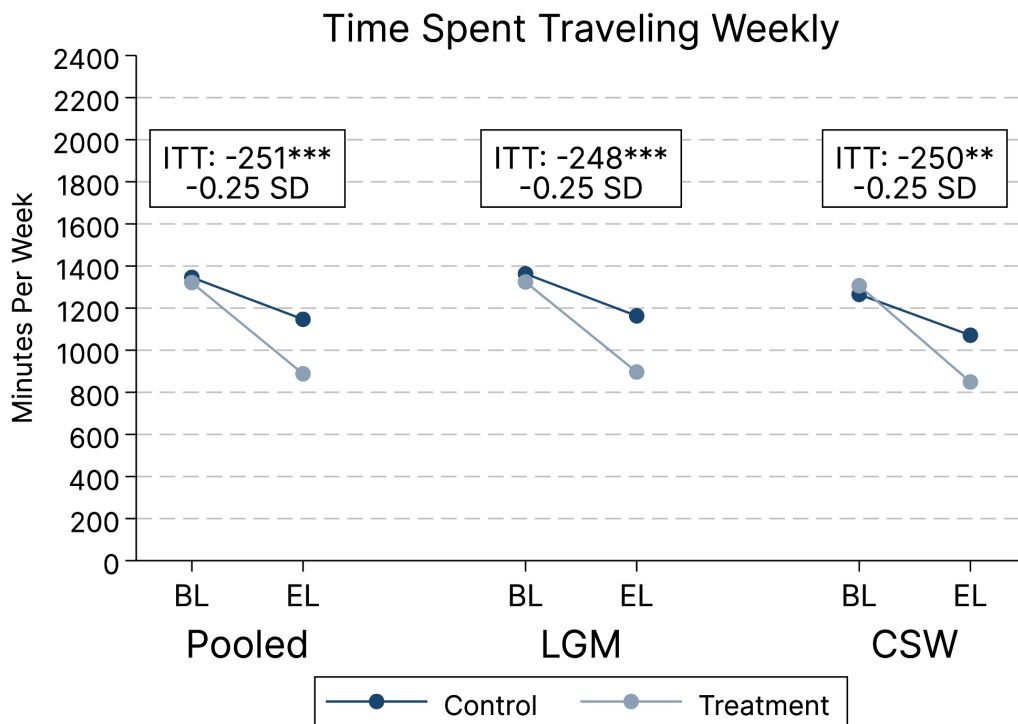
Surprisingly we find no difference between treatment and control groups in terms of distance traveled per week. For both treatment and control participants, distance traveled per week fell over 20% between baseline and endline. **Figure 9** shows the treatment effect on distance traveled to places of interest.

Figure 9: Treatment effect on distance traveled to places of interest
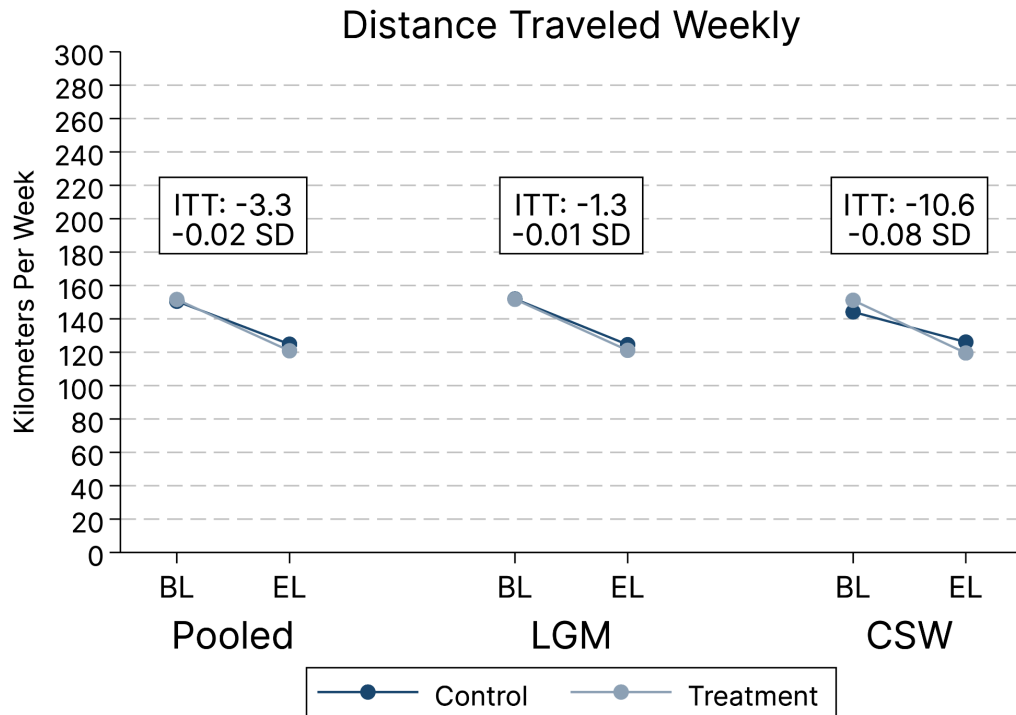
Among treatment group participants, bicycles have become the primary mode of travel for the majority of trips. More than half of weekly trips to places of interest made by treatment participants were on Buffalo Bicycles. Treatment group participants used Buffalo Bicycles for a wide range of travel purposes, including to access health care facilities and markets, and to visit friends or relatives. Just over three quarters (76%) of treatment participants who traveled to local markets used Buffalo Bicycles. Travel to more distant markets was also commonly done on Buffalo Bicycles; this was reported by 62% of those who frequented main district markets. Thus, Buffalo Bicycles are predominantly utilized for livelihood and income generation purposes.

While overall, there were no significant differences in travel distances to places of interest, treatment participants made 19% more trips per week to local or main markets, compared to control participants, with livelihoods group participants in the treatment group making 22% more trips. Moreover, compared to the control arm, treatment participants traveled 19% more kilometres per week to local and main markets. To square these findings with the result that treatment participants did not travel further, it may be that treatment participants changed the composition of their travel (shifting more toward markets) without changing the overall distance traveled, and/or it may be that respondents had difficulty in recalling and estimating distance traveled. Given that the drought may have negatively impacted income generation, it is possible that the impact of bicycles

on travel to markets may be different in settings not experiencing economic and climatic shocks.

Focusing on travel patterns by participants, the findings show significant changes between the baseline and endline, and differences between treatment and control groups with respect to transportation modes. At endline, treatment participants walked 58% fewer trips than control group participants. This finding was evident across livelihoods group participants and community service workers. Related to this, the distance walked (in kilometres) was on average 74% lower among treatment group participants. The findings also show reduced reliance on motorized transportation after the introduction of the Buffalo Bicycles. Relative to control participants, treatment participants on average took 38% fewer trips on motorized transportation and traveled 29% fewer kilometres. The decline in use of motorized transport was more pronounced among community service workers who recorded an average 50% decline in motorized trips and nearly 46% average decline in distances traveled by motorized transport modes.

The reduction in walking and use of motorized transportation among treatment group participants was matched by a significant shift to bicycle usage, with treatment participants traveling 6.7 more trips per week on bicycles than control participants. The latter averaged less than one bicycle trip per week. Conversely, the number of kilometres cycled by treatment group participants was on average 589% higher (or nearly 6 times more) than control participants. These findings indicate that with better access to bicycles (through ownership), bicycles replace other travel modes for the majority of trips, likely being preferred due to improved accessibility, affordability and convenience.

Table 4: Treatment effect on mobility patterns

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Fares on buses/taxis, monthly	1481	124.7	-19.7 *	-22.4 *	-3.8
Fares on children's school travel, monthly	1486	3.9	0	0.3	-0.7
Fares on motor vehicle costs, monthly	1485	74.2	2.1	1.8	12.7
Fares on maintenance/repairs for motor vehicles/bicycles, monthly	1483	56.9	-3	10.1	-81.9 *
Total number of walking trips per week	1488	14.4	-8.3 ***	-8.3 ***	-8.2 ***
Total number of biking trips per week	1488	0.7	6.7 ***	6.9 ***	6.1 ***
Total number of motorized trips per week	1488	0.8	-0.3 ***	-0.3 **	-0.4 **
Total walking distance per week	1488	70.1	-52.3 ***	-54.7 ***	-41.4 ***
Total biking distance per week	1488	10.5	61.8 ***	63.5 ***	55.3 ***

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Total motorized distance per week	1488	41.5	-11.9 *	-9.4	-21.9 *
Total trips to local and main markets per week	1488	2.7	0.5 ***	0.6 ***	-0.2
Total distance (KM) traveled to local and main markets per week	1488	41.8	7.6 *	9.3 **	-0.4

Productivity

We asked bicycle recipients a set of questions regarding the impact of the Buffalo Bicycle on time. 84% of respondents said the amount of daily travel time has reduced since receiving the bicycle. Of those who saved time, 46% said they used their time savings for business or work, and 45% said household chores, and 40% said farm work. Less than 10% of these respondents mentioned activities like leisure or visiting friends. This suggests that time savings primarily are allocated to productive activity. With regards to business activity, participants who were provided with a bicycle, on average, reported higher monthly business revenue of ZMW 383 (15 USD) or (+53%) in comparison to those who did not receive a bicycle ($p < 0.05$). This effect is driven by LGMs who were given bicycles to explicitly support their small businesses. Interestingly, we see few significant differences in intermediate business outcomes, including time or distance spent traveling for the business. However, we observe that treatment participants are slightly more likely to engage in trade or retail businesses, and slightly more likely to have mobile businesses, compared to control participants. We suspect that the effect on business revenue is driven by households being able to spend more time at the market (given that the number of market trips and distance is higher in the control group, while time spent traveling is lower as seen in **Table 4**) and anecdotal findings that participants with bicycles are able to carry large loads of produce, indicating they may be able to sell larger quantities for their business compared to households without bicycles. In a separate cohort of bike recipients that WBR is tracking in Mumbwa, 62% of business owners reported that the ability to carry goods and farm produce to markets was a significant impact of Buffalo Bicycles on their business. Additionally, 47% reported that their ability to reach households directly, by traveling around their community with goods was an important impact and nearly 50% report reaching more customers due to frequent travel to markets (WBR 2024).

Table 5 shows treatment effects on business activity.

Table 5: Treatment effect on business activity

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Number of businesses 0-2	1488	1.1	0.0	0.0	0.1
HH Business Agriculture	1258	0.8	0.0	0.0	0.1
HH Business Trade	1258	0.3	0.1 *	0.1 *	0
HH Business Skills/All Other	1258	0.1	0.0	0.0	-0.1
HH Business is Stationary	1258	0.6	-0.1 *	0.0	-0.1
HH Business is mobile	1258	0.4	0.1 *	0.0	0.1
HH Business Sources Supplies Elsewhere	1258	0.5	0.0	0.0	0.1 *
HH Distance (KM) to Business, Stationary	658	10	10.7	7.6	22.4
HH Time (Min) to Travel to Business, Stationary	503	96.2	6	0.1	-7.8
HH Mobile Business Distance (KM) Traveled	548	24.5	-1.6	-1	-4.4
HH Business Distance (KM) to Supply Source	627	30.7	-3.9	-4.7	4.5
HH Business Time (Min) to Supply Source	638	129.8	-12.5	-17.4	45.9
Total Monthly Business Revenue, ZMW	1488	728.4	382.6 **	518.5 **	-167.4

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

CSWs in the health sector who received bicycles reported serving an average of 115 additional clients (or +63%) per month relative to those who did not receive bicycles ($p<0.05$). These results support the hypothesis that enhancing mobility can lead to significant improvements in productivity and efficiency within health service delivery.

CSWs in the treatment group reported an average of 261 fewer minutes (4.4 hours) or (-16%) per week spent traveling and a reduction of 7.3 kilometers in weekly travel distance for service delivery in comparison to the control group's CSWs. However, these improvements in travel time and distance were not statistically significant at the 5% level. Notably, among control participants, 69.5% (91 individuals) deliver their services by traveling from one location to another, compared to 63.5% (80 individuals) within the treatment group.

Conversely, when it came to the challenges encountered during service delivery, CSWs who received bicycles experienced fewer transportation-related difficulties, with this difference being statistically significant ($p<0.05$). This suggests that bicycle provision was perceived by the recipients as an effective solution to their transportation hurdles. **Table 6** provides details of the Treatment

effect on CSW activity.

Table 6: Treatment effect on CSW activity

Variable	# Obs	Control Mean	ITT, CSW
Service Nature = Health	257	0.8	0.0
Service Nature = Agri	257	0.1	0.0
Service Nature = Environ	257	0.1	0.0
CSW: Number of times a Buffalo Bicycle was used to transport someone	216	2.0	15.0 ***
Service from Home	257	0.0	0.0
Service from Stationary Place	257	0.3	0.0
Service from Moving	257	0.7	-0.1
Total Service Days Per Month	261	7.5	-0.4
Mobile CSW - Required recipients to reach monthly	170	242.6	101.7
Total Clients Served Per Month	261	184.3	79.6 *
Time Spent Traveling for Service Weekly (Min)	198	1674.8	-261.3
Distance Spent Traveling for Service Weekly (Km)	194	113.3	-7.3
Total Service Days Per Month, Health Only	217	7.2	-0.3
Mobile CSW - Required recipients to reach monthly, Health Only	135	265.1	106.1
Total Clients Served Per Month, Health Only	217	183.8	115.4 **
Met Target for Clients Served, Health Only	135	.8	0.1
Time (Min) Spent Traveling for Service Weekly, Health Only	159	1573.2	-110.5
Distance (KM) Spent Traveling for Service Weekly, Health Only	156	108.5	-1.9
Service main transport = Walking	261	0.7	-0.7 ***
Service main transport = Own Bike (not WBR)	261	0.0	-0.0 *
Service main transport = Paid Bike (not WBR)	261	0.0	-0.0 **
Service main transport = Buffalo Bicycle	261	0.1	0.8 ***
Service main transport = All Others	261	0.1	-0.1
Challenges = Long distance	171	0.5	-0.3 ***
Challenges = Lack of transportation	171	0.8	-0.7 ***
Challenges = Cost of transportation	171	0.2	-0.1 **
Challenges = Physical fatigue	171	0.2	-0.2 ***
Challenges = Lack of compensation	171	0.2	0.0
Solution = Money	139	0.2	0.1
Solution = Transportation	139	0.9	-0.7 ***
Solution = Incentives	139	0.1	0.1

*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.*

Access to services

The Buffalo Bicycles are also important aids to healthcare access, with 88% of treatment participants reporting that they use them as primary mode to healthcare facilities whenever needed. They are also used to transport the sick. Among treatment group participants, 89% reported that they had used their Buffalo Bicycles to transport sick household members to health facilities. Moreover, 83% of community health volunteers reported using their Buffalo Bicycles to transport sick patients to health facilities.

Participants were surveyed regarding instances in which they, or any household member, were unable to visit a health center or care provider despite needing care in the preceding 30 days. We found statistically significant benefits for all groups that received bicycles. Specifically, 10% of those who received bicycles reported being unable to visit a health care facility when needed, compared to 46% of control group participants. Additionally, of the individuals who reported being unable to visit a health center or care provider, approximately 82% attributed this to transportation issues, underscoring the critical role that transportation plays in access to health care.

Figure 10 graphically represents the treatment effect on access to health services.

Figure 10: Treatment effect on access to Health Services
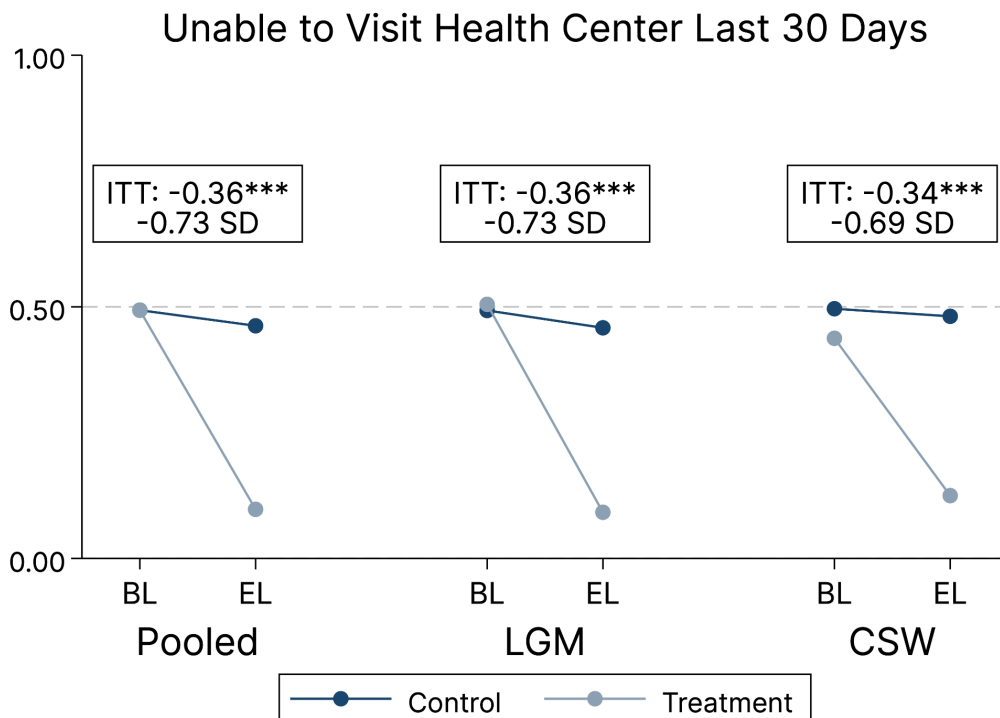
We also asked respondents about access to water and energy sources. On average, treatment households make 9 fewer monthly visits to water sources and 1 fewer monthly visit to energy sources (p<0.01). This is potentially driven by households being able to carry more water and energy with the Buffalo Bicycle; treatment households carry 11 more litres than their control counterparts on a typical trip (p<0.05). When asked about challenges accessing water or energy sources, treatment households were 37% more likely (p<0.01) to say "No challenges" for water and 29% more likely to say the same for energy sources (p<0.01). These findings suggest that in addition to access to health services, bicycles address constraints on time, distance, and carrying capacity for water and energy.

Household welfare & wellbeing

The MC program had a positive and statistically significant impact on consumption, income, savings, asset ownership, food security, and the probability of falling below the National Poverty Line.[10]

Consumption

Participants who were provided with a bicycle, on average, reported higher consumption of ZMW 867 (33 USD)) or (+24%) in comparison to those who did not receive one (p<0.01), with similar effect sizes for LGMs and CSWs. This effect is entirely driven by a reduction in consumption levels in the control group between baseline and endline, whereas the treatment group maintained similar consumption levels as at baseline, highlighting the importance of the bicycle in helping treatment participants to maintain living standards in the midst of the nationwide drought and economic recession. The treatment effect on household consumption is graphically represented in **Figure 11**.

In Appendix B we report the treatment effect on each item in the consumption module. While we observe positive treatment effects across many of these consumption items, the largest effects are on fish, meat, bread, sugar, oil, and petrol.

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[10] ZMW 214.26 per adult equivalent per month in 2015 (2023 inflation-adjusted: ZMW 495)

Figure 11: Treatment effect on household consumption

Consumption, Monthly

ITT: 867*** 0.38 SD (Pooled)
ITT: 875*** 0.38 SD (LGM)
ITT: 783*** 0.34 SD (CSW)

Y-axis: ZMW (0 to 7000)
X-axis: BL, EL for Pooled, LGM, CSW

Legend: Control, Treatment
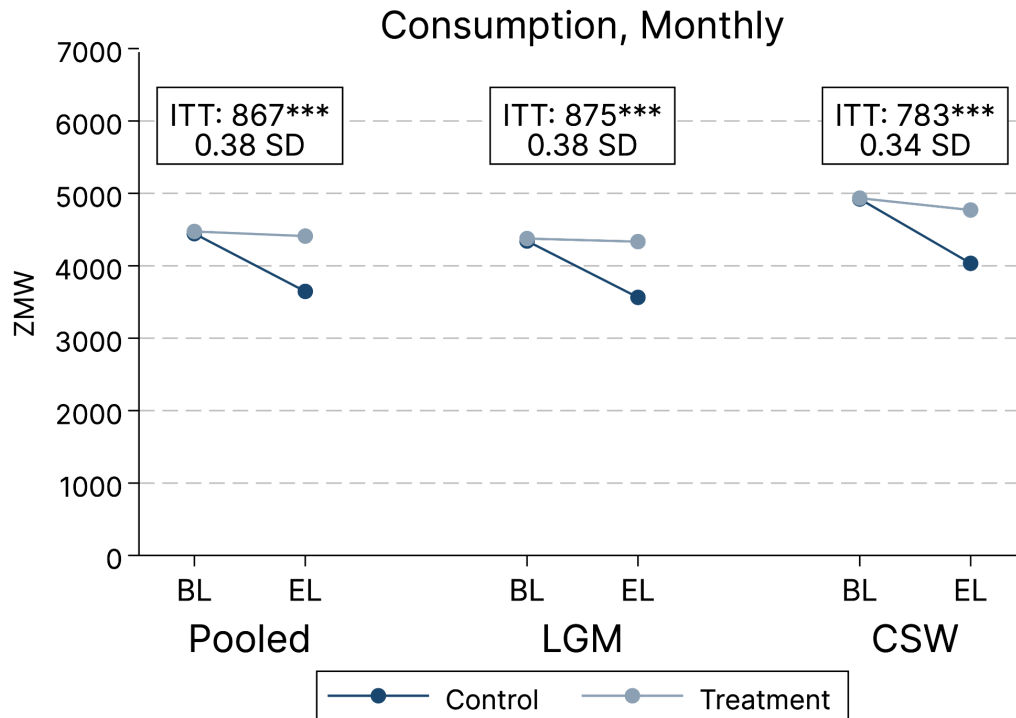
Assets

Similarly, we find a statistically significant effect on household assets (which does not include the Buffalo Bicycle or other bicycles). While both treatment and control households experienced a significant decline in the value of household assets between baseline and endline, the decline for the control group was steeper. This finding suggests that having a bicycle enabled treatment households to save more income, meaning that they had to sell off fewer assets than control households to cope with the economic recession. Particularly, less control households own common agricultural assets like chickens, cows, oxen, land at endline when compared to baseline in both quantity and valuation. We report individual treatment effects on each asset in Appendix B. Of note, the asset effect of ZMW 13,533 (511 USD) does not include the value of a new Buffalo Bicycle, which is ZMW 4,459 (168 USD). This indicates that this effect is not driven by the value of the bicycle provided to treatment households, as the bicycle's value was not factored into the asset calculation. **Figure 12** graphically represents the treatment effect on household asset value.

Figure 12: Treatment effect on household asset value

Assets Value

ITT: 13533***
0.28 SD

ITT: 14217***
0.29 SD

ITT: 9607*
0.20 SD

Pooled — LGM — CSW

Control · Treatment
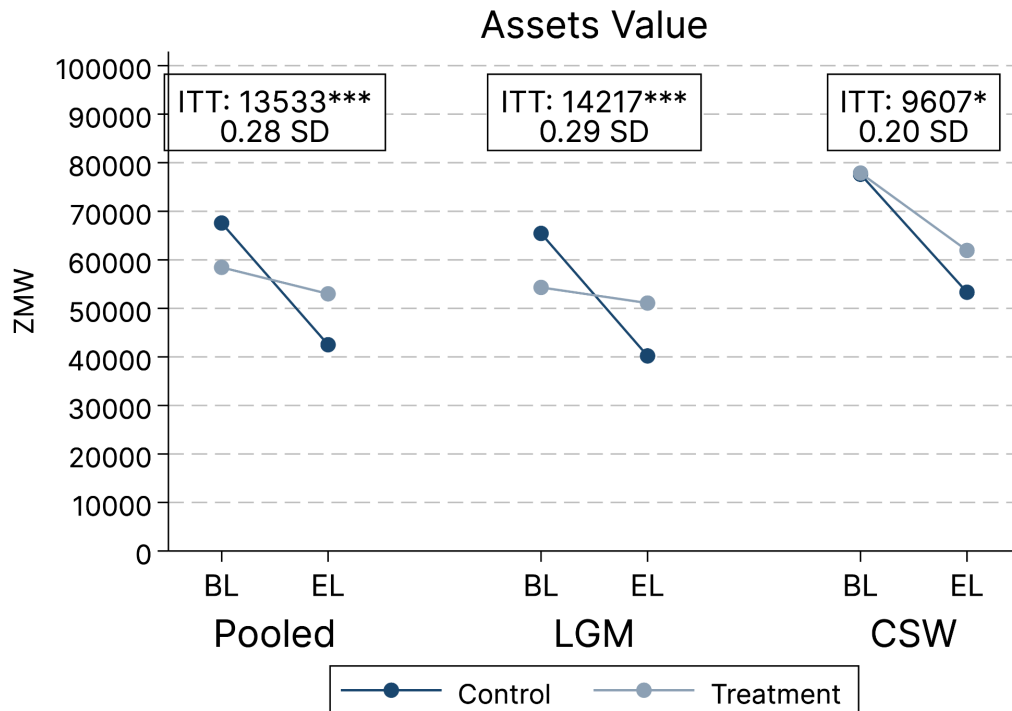
Income

Our analysis revealed a statistically significant positive effect on reported income levels among the participants receiving bicycles. On average, participants who received a bicycle reported a higher monthly income by ZMW 553 (21 USD) or (+43%) compared to those who did not receive a bicycle (p<0.01). LGM bicycle recipients reported an even higher monthly income by ZMW 625 (24 USD) or (+49%) compared to the control group (p<0.01). In contrast, CSWs who received a bicycle reported a monthly income of ZMW 180 (7 USD) or (+12%) more than the control, although this difference was not statistically significant (p>0.1). Whereas the control group reported a fall in income over the study period, the treatment group, especially LGMs, reported a rise in income.[11] The treatment effect on household income is graphically represented in **Figure 13**.

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[11] Although the difference in household income between treatment and control households at baseline appears to be large in the graph, the difference is not statistically significant since reported income has high variance. As with other outcomes, we control for baseline income in the ITT regressions, and so this difference is accounted for in the analysis.

Figure 13: Treatment effect on household income

Average Monthly Income
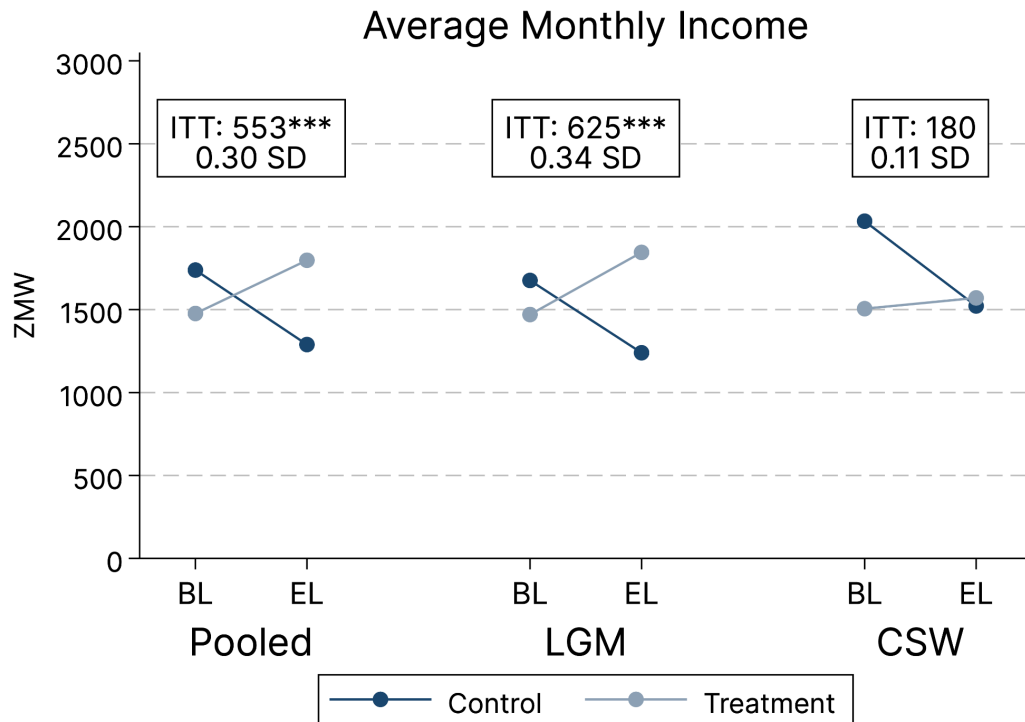
Food Security

Food security is crucial for good health, general functioning, and wellbeing. Adequate dietary intake has been linked to better maternal and child nutritional/anthropometric outcomes. Mobility can influence dietary intake in various ways. Among individuals and households, access to transportation can impact food availability by affecting production through accessibility to farms or travel to markets for food acquisition. It can also influence physical and economic access to food, its utilization through processing and/or storage, and the stability to be able to access and utilize food at all times, including during periods of crises. We compare food security outcomes among treatment and control households, focusing on food consumption and dietary diversity as the two key indicators of food availability and access, diet quality and socio-economic status. Food consumption represents the value of all foods consumed in the household, excluding foods consumed outside the home. Dietary diversity is proxied by a household dietary diversity score (HDDS), defined as the number of food groups consumed over a 7-day reference period (FAO, 2013). Both measures draw on the data on the most commonly consumed foods in Mumbwa, including packaged breakfast mealie, hammer mealie, rice, wheat, maize grain, green maize, bread, eggs, fish, kapenta, seasonal fruit

(mangoes, pineapples, masuku), chicken, beef, goat, milk, mukonyo/chibwatu, maheu, cooking oil, beans, groundnuts, potatoes pumpkins, sweet potatoes, sugar, pumpkin leaves, rape, onion, okra, and tomatoes. Food items were classified into 12 broad food groups based on nutritional characteristics in line with HDDS guidelines: cereals, roots and tubers, vegetables, fruits, meat, poultry and offal, eggs, fish and seafood, pulses, legume and nuts, milk and milk products, oils/fats, sugar/honey, and miscellaneous. More details on the food item allocation to food groups are available in Appendix D.

Table 7 summarizes the endline survey estimates for HDDS, total food consumption as well as disaggregated 12 food groups. At baseline (prior to bicycle receipt), no significant differences were observed in all outcome measures between treatment and control households. However, the endline found significant differences between treatment and control households. HDDS was higher (by an average of 12%) among treatment households than among control participants, indicating that diet quality is higher for households with bicycles.

HDDS is a simple count of the food groups consumed and although it provides insights into the quality of diets consumed, it does not account for the frequency and quantity of consumption. An assessment of total food consumption, which provides insights on both diet quantity and quality, showed that treatment households were significantly better off than control households, with an estimated higher consumption of 23% on average. Moreover, disaggregated analysis showed that treatment households had significantly higher consumption for 10 out of 12 food groups. This is especially evident for nutrient-dense animal source protein food groups which tend to be costly if purchased: when compared to control households, treatment households consumed on average 64% more meat (beef, goat and poultry). Treatment households with livelihood group members recorded approximately 70% higher consumption of meat relative to control households. Fish consumption was also significantly higher among treatment households, who consumed an average of 66% more per month than control households. Consumption of pulses and roots/tubers were on average higher among treatment households than control households by 29% and 27% respectively. Similarly, consumption of eggs was 29% higher among treatment households, compared to control households. Fruits were the least consumed foods across the board, but consumption was higher among treatment households compared to control households. Overall, the higher food consumption (aggregate and food groups) and dietary diversity signify that food quantity and quality were higher in households that received Buffalo Bicycles. Potential contributors to this include increased income and monetary savings that are then apportioned to the food budget. Moreover, food consumption levels were sustained among those who received Buffalo bicycles. At endline, control

group participants recorded a decline in HDDS and consumption levels across food groups, relative to the baseline, potentially due to the adverse effects of the drought on food production and access to markets. For example, more than three quarters (77%) of all participants had observed an increase in food prices in the 12-month period preceding the endline survey, and a similar share (74%) reported that they had been affected by food insecurity. However, among treatment group participants, food consumption levels and HDDS were largely unaffected, pointing to the idea that Buffalo Bicycles supported continued food access and utilization, thus ameliorating the negative impact of drought.

Table 7: Treatment effect on Food Security

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Household Dietary Diversity Score (HDDS)	1488	7.6	0.9 ***	1.0 ***	0.5 *
Total Monthly Food consumption, ZMW	1488	2332.0	524.3 ***	550.6 ***	388.1 **
Monthly Consumption by Food Group					
Cereals	1488	810.4	88.9 ***	104.0 ***	18.3
Roots and tubers	1488	72.4	15.3 **	18.4 **	0
Vegetables	1488	270.6	16.1	22.9 *	-17.9
Pulses, legumes and nuts	1488	128.5	34.5 ***	30.7 **	48.8 **
Fruits	1488	23.4	8.5 **	11.4 ***	-4
Meat & poultry	1488	256	165.0 ***	181.4 ***	57.2
Fish and seafood	1488	125.7	91.6 ***	88.6 ***	111.1 **
Eggs	1488	47.2	12.7 ***	14.0 ***	8.4
Milk and milk products	1488	58.5	-1.2	-1.1	-8.6
Oils/fats	1488	175.6	33.1 ***	36.9 ***	17.3
Sugar/honey	1488	100.7	36.9 ***	31.9 ***	56.9 ***
Miscellaneous	1488	226.9	48.8	28	141.4

Social norms and women's empowerment

The MC program exhibited a positive and statistically significant influence on various empowerment measures.[12] Recipients of bicycles expressed a greater degree of satisfaction with their lives in general. Additionally, they reported an increased sense of capability in providing for their families and fulfilling their household needs.

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[12] We employed a Likert scale on questions related to locus of control, self-esteem, and gender norms.

The results from our analysis suggest that the provision of bicycles had a positive effect on general life satisfaction for the combined participant groups, with treatment participants being 11% more likely (+0.47 on the Likert scale) to Agree or Strongly Agree[13] that they are satisfied with their life (p<0.01), indicating a statistically significant increase in self-reported life satisfaction. LGMs were 12% more likely (+0.52 on the Likert scale) to Agree or Strongly Agree with this statement (p<0.01) than the control group. Among CSWs, treatment participants were 7% more likely (+0.20 on the Likert scale), but this difference was not statistically significant (p>0.1).

In summary, the MC program generally led to increased self-reported satisfaction with life in the treatment group compared to the control group, especially among LGMs. However, the same level of impact was not observed statistically among CSWs.

While there were few differences between treatment and control participants on survey items related to gender norms, we observed that women in the treatment group reported slightly more agency over financial decisions. 85% of female participants who received bicycles reported that they were likely to decide on their own how to spend a sizable amount of money, compared to 80% of their female counterparts who did not receive bicycles.

Recipients of bicycles in the study reported a modest but statistically significant increase in self-esteem related to their perceived ability to provide for and meet their family's needs, with an average increase of 0.12 on the Likert scale (p<0.05) and 3% more likely to agree/strongly agree with the statement[14], in comparison to the control group. Treatment LGMs demonstrated even greater levels of self-esteem, reporting an average increase of 0.18 (p<0.01) above the control group and 5% more likely to agree/strongly agree with the statement. In contrast, treatment CSWs reported a decrease in self-esteem by 0.16 on the Likert scale as opposed to their control counterparts and 5% less likely to agree/strongly agree with the statement, although this finding is not statistically significant. **Table 8** shows treatment effects on social norm indices.

Table 8: Treatment effect on social norm indices[15]

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Have you attended any community meetings in the past 12 months?	1487	0.9	0.0	0.0	0.0

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[13] Here, we create a dummy variable that takes 1 if the respondent Agrees/Strongly Agrees for interpretability

[14] Ibid

[15] To construct our indices, we employ a method described by Anderson (2008) which takes into account the variance and covariance of the individual components of a given outcome family and creates a composite measure.

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW
Voice Opinion in Community Meetings: Never	1446	0.1	0.0	0.0	0.0
Voice Opinion in Community Meetings: Sometimes	1446	0.4	0.0	0.0	0.0
Voice Opinion in Community Meetings: Often	1446	0.2	0.0	0.0	0.0
Voice Opinion in Community Meetings: Always	1446	0.2	0.0	0.0	0.0
Can Spend Sizable Amount, Female	997	0.8	0.05 **	0.05 *	0.1
Can Make Finance Decisions, Female	997	0.7	0.0	0.0	-0.1
Can Decide on Assets, Female	997	0.7	0.0	0.0	-0.1
Partner Consults You, Female	1024	0.8	0.0	0.0	0.1
Voices Opinion in Community Meetings, Female	961	0.4	0.0	0.0	0.1
I think I am satisfied with my life in general	1488	3.0	0.47 ***	0.52 ***	0.2
I feel I have control over the direction my life is taking	1488	3.6	0.13 *	0.18 **	-0.1
I feel there is always a solution to any problem when you make effort	1488	4.3	0.1	0.10 *	-0.1
Whatever happens to me is because of my own doing	1488	3.1	0.0	0.1	-0.34 *
I feel that I have a number of good qualities	1488	4.2	0.0	0.1	-0.1
I am able to do things as well as most other people	1488	4.2	0.0	0.0	0.0
I feel that my life will improve in the future	1488	4.5	0.0	0.1	-0.1
I expect good things to happen to me in the future.	1488	4.6	0.06 *	0.09 **	-0.1
I feel I can provide for my family and meet my family's needs.	1488	4.0	0.12 **	0.18 ***	-0.2
Boys should be allowed to get more opportunities for education than girls	1488	2.3	0.17 *	0.24 **	-0.2
It is better to be a man than to be a woman	1488	2.6	0.1	0.17 **	-0.2
A wife should obey her husband, even if she disagrees	1488	3.3	0.1	0.17 *	-0.1
It is the job of men to be leaders, not women	1488	2.8	0.1	0.1	-0.1
Decisions Index	1488	0.0	0.0	0.0	-0.21 **
Intra-HH Index	1482	0.0	0.1	0.0	0.2
Locus of Control Index	1488	0.0	0.19 ***	0.27 ***	-0.1
Self-Esteem Index	1488	0.0	0.1	0.13 *	-0.1
Gender Norms Index	1488	0.0	-0.11 *	-0.17 **	0.2

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.

3.3 Subgroup results

We report results by subgroups such as participant gender, participant age and baseline wealth level.

Gender

Male participants reported slightly higher levels of both household consumption and income compared to their female counterparts. Despite this difference, the distinction in treatment effects between male and female participants was not statistically significant at the 5% significance level. Consequently, this suggests that the impact of bicycles was similar for households when the recipient was male or female. **Figure 14** shows the treatment effects by gender; a positive (negative) difference-in-differences (DiD) estimate indicates that treatment effects were larger (smaller) for female participants than for male participants.

Figure 14: Treatment effects by gender

Treatment effects by Gender
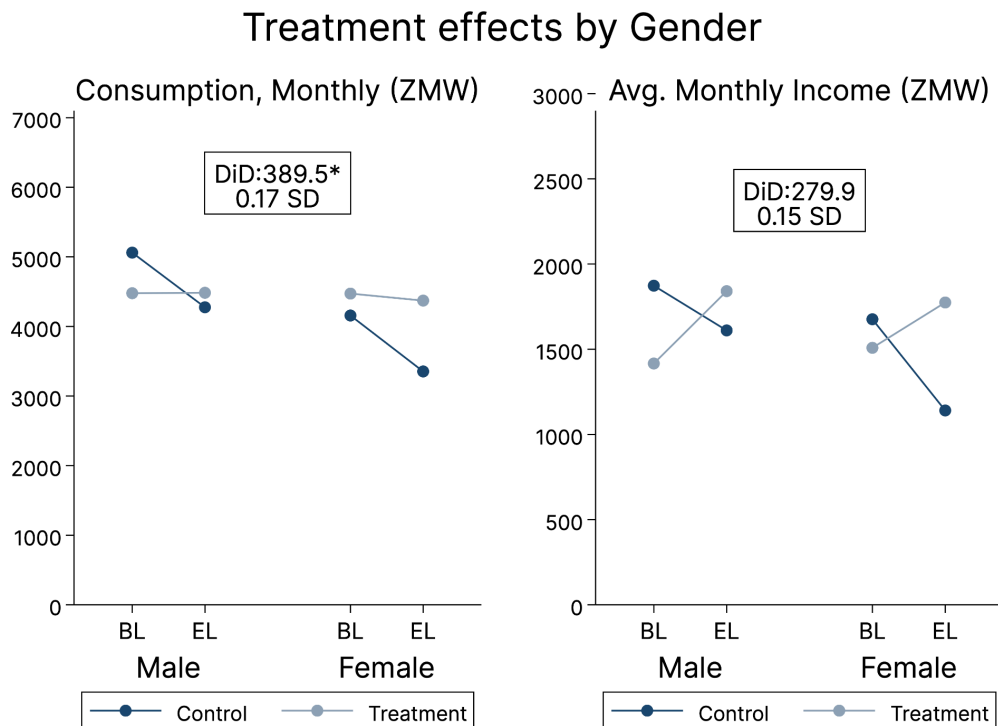
Age

In assessing the impact of the program by age, our analysis includes subgroup findings that utilize two distinct age categorizations for youth. The first categorization adheres to the United Nations' definition, identifying individuals aged between 15 and 24 as youth; 8% of our endline sample are considered youth per this definition. The second aligns with Zambian guidelines, which expand the youth category to include those aged between 15 and 34; 35% of our endline sample are considered youth per this definition.

Under both definitions, youth participants reported lower levels of household consumption (ZMW -268 for ages 18-23, -36.5 for ages 18-34) and income (ZMW -114 ZMW for ages 18-23, ZMW -227 for ages 18-34) in comparison to older adults. However, differences in treatment effects were not statistically significant at the 5% significance level. Thus, the data suggest that the benefits of bicycle receipt were distributed similarly between youth and adult participants. **Figure 15** graphically depicts the treatment effects according to the Zambian age group definition.

Figure 15: Treatment effects by age group (Zambia definition)
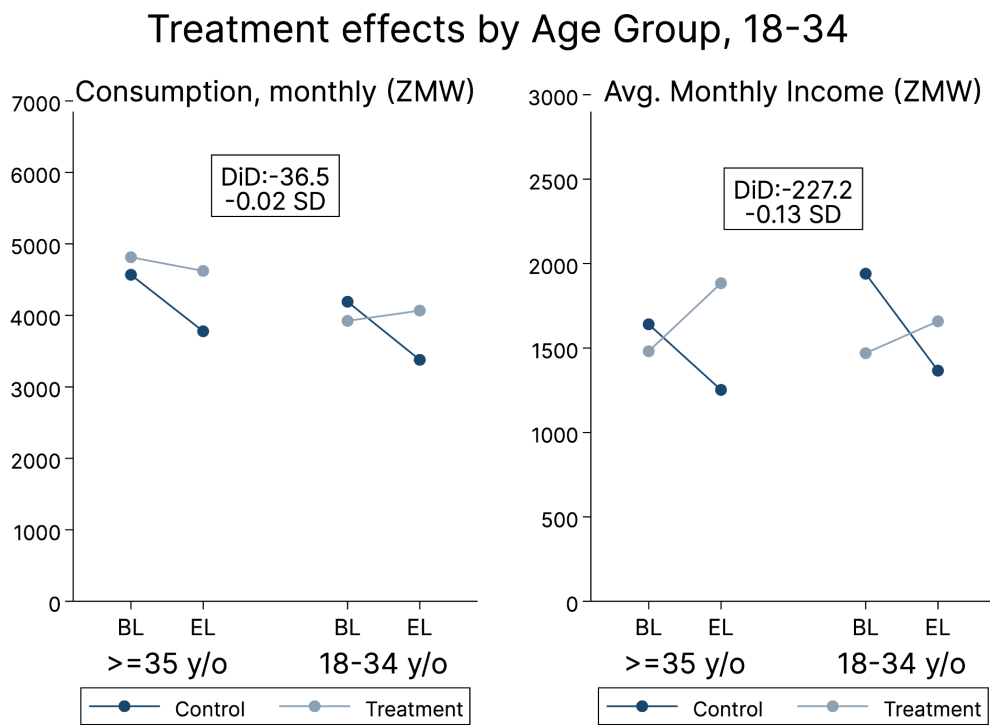
Household baseline socioeconomic level (PPI scores)

We assessed the program's impact on households across various socioeconomic strata as defined by baseline Poverty Probability Index (PPI) scores. At baseline, the likelihood of falling below the National Poverty Line ranged from 1% to 97% in our sample, with the majority of households falling between 43% (25th percentile) and 82% (75th percentile). Households were segmented into poverty quintiles based on these scores, and the treatment effects on consumption and net asset value were evaluated for each respective quintile. These effects are visually presented in **Figure 16**.

We found no statistically significant differences between treatment and control groups across the poverty quintiles. Our analysis suggests that bicycles had a similar effect across the spectrum of baseline wealth.

Figure 16: Treatment effects by baseline wealth level

Treatment effects by Poverty Likelihood (PPI) Quintile
Quintile 1 = most poor

The dotted lines show the full-sample ITTs for reference.
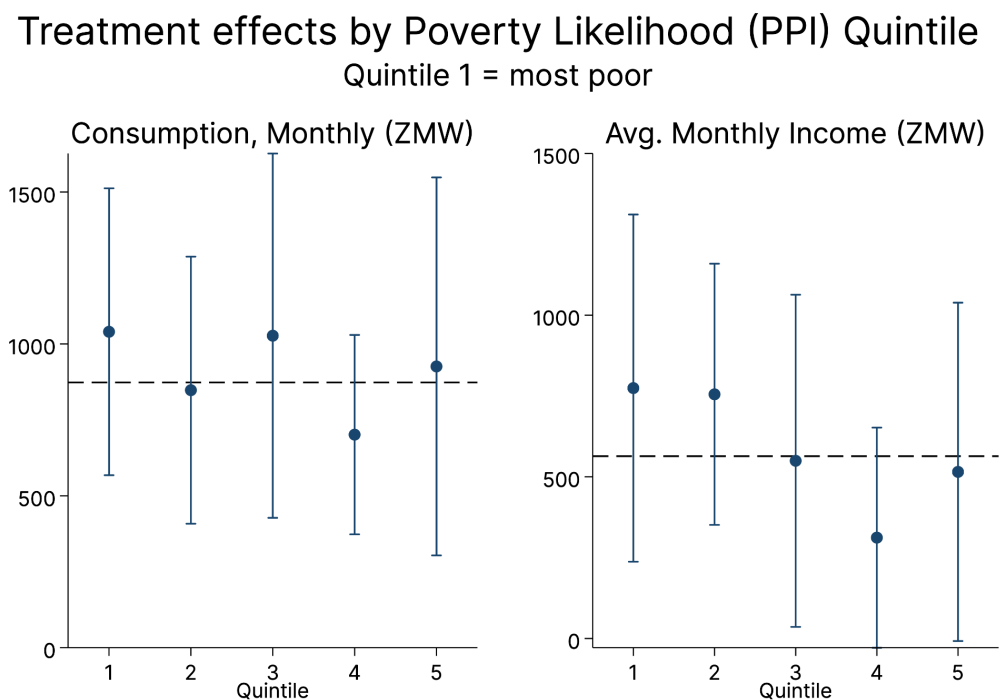
3.4 Impact by Treatment Intensity

In **Table 7**, we compare ITT effects and TOT effects. The ITT analysis compares households randomized into the treatment group and those in the control group, while the TOT analysis considers actual bicycle usage within treatment

households and contamination (i.e., spillover effects) in control households. Our TOT indicator holds a value of 1 if the recipient received a Buffalo Bike, regardless of treatment assignment. If they did not receive a Buffalo Bike, we divided the number of times they used a Buffalo Bicycle in the previous year by the average usage for those who received a bicycle.

Our findings indicate that the treatment effects are slightly larger when assessed with the TOT approach as compared to the ITT. This difference illustrates an amplified impact of the program, as the TOT analysis accounts for varying levels of compliance with the treatment protocol and any indirect effects experienced by the control group.

Table 9: Comparison of ITT and TOT estimates

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW
Est. Total Monthly Consumption, ZMW	1488	3646.7	866.7 ***	875.4 ***	782.8 ***	912.5 ***	919.4 ***	835.4 ***
Est. Total Value of HH Assets, ZMW	1488	42504.5	13533.0 ***	14217.4 ***	9607.4 *	14247.2 ***	14933.2 ***	10252.1 *
Est. Monthly Earnings from Work Nature	1482	1006.2	384.3 ***	420.3 ***	198.4	404.6 ***	441.6 ***	211.8
Est. Average Monthly Household Income, ZMW	1474	1289.6	552.7 ***	625.4 ***	180.3	582.0 ***	657.1 ***	192.6
Total # of Income Sources	1488	1.7	0.0	0.1	0.0	0.0	0.1	-0.1
Household Per Capita Monthly Income, ZMW	1474	219.6	69.5 ***	80.4 ***	15.3	73.2 ***	84.5 ***	16.3
Poverty Likelihood % (From PPI)	1488	0.6	-0.1 ***	-0.1 ***	0.0	-0.1 ***	-0.1 ***	0.0
HH Saved Income in Past 30 days	1485	0.7	0.1 ***	0.1 ***	0.0	0.1 ***	0.1 ***	0.0
HH Savings Past 30 Days, ZMW	1483	513.5	454.9 ***	511.2 ***	209	478.3 ***	536.2 ***	223.0
Total Monthly Loan Payment Expenditures, ZMW	1487	75.3	3.3	-7.7	61.2 *	3.4	-8.1	65.3 *
Est. HH Transport Expenditure in Past 30 Days	1483	234.8	18.9	8.6	49.3	19.9	9	52.7
Weekly Time (Min) Spent Traveling	1488	1146.8	-250.9 ***	-247.7 ***	-250.4 **	-264.1 ***	-260.1 ***	-267.2 **
Weekly Total Distance (KM) Traveled	1488	124.8	-3.3	-1.3	-10.6	-3.5	-1.3	-11.3
Unable to Visit Health Center in Past 30 Days	1484	0.5	-0.4 ***	-0.4 ***	-0.3 ***	-0.4 ***	-0.4 ***	-0.4 ***
Had to cancel plans to travel outside of community in last 30 days	1488	0.8	-0.6 ***	-0.6 ***	-0.5 ***	-0.6 ***	-0.6 ***	-0.5 ***
Number of businesses 0-2	1488	1.1	0.0	0.0	0.1	0.0	0.0	0.1
Total Monthly Business Revenue, ZMW	1488	728.4	382.6 **	518.5 **	-167.4	402.8 **	544.7 **	-178.5
Total Business Transport Costs in Typical Month, ZMW	1488	145.5	-47.7 **	-47.4 *	-27.8	-50.3 **	-49.8 *	-29.6
Intra-HH Index	1482	0.0	0.1	0.0	0.2	0.1	0.0	0.2
Decisions Index	1488	0.0	0.0	0.0	-0.2 **	0.0	0.0	-0.2 **

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.

4. Discussion

One year after the provision of bicycles to the target communities, evaluation findings indicate a beneficial effect of the Buffalo Bicycle on mobility and economic outcomes of participants. The program positively influenced household consumption, income, savings, productivity, and various measures of empowerment. Effects were similarly positive across subgroups - including men and women, younger and older participants, and across all levels of baseline household wealth.

These findings add to evidence from other evaluations of bicycle interventions, which have shown positive effects of bicycles on educational outcomes. An RCT by Innovations for Poverty Action (IPA) in 2017 of WBR's education program in Zambia found that girl students offered bicycles were 19% less likely to drop out of school, scored higher on a mathematics assessment test, were 28% less likely to be absent, and were 66% more likely to arrive at school on time (Fiala et al 2022). A quasi-experimental evaluation of a similar bicycles program in India found similar effects (Muralidharan and Prakash, 2017).

To our knowledge, our study is the first RCT to document the positive impacts of bicycles on livelihoods. Our findings are similar to recent internal evaluations that WBR conducted of the MC program. Similar to our RCT, WBR internal assessments from 2021 in the Mumbwa MC and 2022 in the Petauke MC found high bicycle usage and increase in income and welfare levels after one year of bicycle use. Notably, 80% of Mumbwa participants and 97% of those in Petauke reported increased household incomes owing to expanded business travel. Petauke saw a 33% rise in average income and a shift in travel modes, with walking trips dropping by 57%, motorized transport by 64%, and bicycle trips increasing 5-fold. In Mumbwa, walking trips fell by 86% while bicycle trips increased 8-fold post distribution (WBR, 2024). For comparison, in our RCT treatment participants reported 43% higher income and 57% fewer walking trips than the control group.

WBR is implementing the MC program to provide Buffalo Bicycles and supportive programming to households in the Mumbwa District of Zambia to help communities increase access to education, healthcare, and livelihoods sustainably. The program engages participants through a social contract and requires them to make a contribution towards spare parts. It aims to build a local bicycle ecosystem such that the community can manage the program, monitor program recipients, and provide bicycle spares and repair services by trained people. Our empirical evidence indicates that the program's impact is consistent with the program's TOC. The provision of bicycles has tangibly improved livelihoods, access to healthcare, and enhanced overall productivity. These

findings substantiate the program's efficacy and provide critical data to guide the future shaping and expansion of the program.

Household welfare and wellbeing

The MC program had statistically significant positive impacts on household welfare and wellbeing across multiple dimensions, notably in consumption, income, savings, asset ownership and wealth levels. On average, participants who received a bicycle experienced a statistically significant increase in all the aforementioned household welfare and wellbeing measures.

The control group exhibited a notable decline in consumption levels from baseline to endline as the country is reported to be facing its worst drought in over four decades. This pattern echoes national trends identified in the wake of this extreme climatic event. A joint rapid assessment commissioned by the Zambia Food Security Cluster (FSC)[16] in 27 significantly affected districts, including Mumbwa, highlighted a severe humanitarian crisis, with critical shortages in local market food supplies evident. Notably, a mere 11.4% availability of maize and 31.1% of maize meal was reported. The modelled Minimum Expenditure Basket (MEB) suggested that an overwhelming 70.6% of these households face challenges in meeting basic food requirements.

Although it is too early to know the full effects of the current drought, data from the severe drought in 2015/16 showed that household income fell by 37%[17], which is consistent with our finding that nominal household income in the control group fell by 20% between baseline and endline while real household income (accounting for inflation over the previous year) fell by 30%.

In light of these systemic shocks, the fact that the treatment group maintained consumption and income levels over the previous year underscores the pivotal role that bicycles played in enabling participants to sustain their living standards amidst these widespread difficulties.

Community members reported significant benefits from the bicycle program, particularly as a mitigation measure against the economic impacts of drought. One bicycle recipient stated that: "The bicycles have been instrumental in cushioning the effects of drought for many in the community. We used the bicycles for business purposes, transporting goods purchased in Mumbwa town to sell within our communities, which has been conducive to revenue generation."

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[16] Relief Web International. (2024). Food Security Cluster Joint Rapid Assessment
[17] ACAPS. (2024). Briefing note: Drought in Zambia. 15 March 2024

Productivity

On average, participants who received a bicycle experienced a reduction in travel time, compared to those who did not receive a bicycle. Notably, the time saved was reallocated to productive activities, with many participants indicating an increase in time spent on farm work, business or work, as well as on household chores such as washing, cleaning, and shopping. This is further supported by increases in the number of trips and distance traveled to markets as well as business revenue.

Health Services

CSW bicycle recipients within the health sector reported an increase in the number of service recipients served monthly in comparison to their counterparts who did not receive a bicycle. This data suggests an improvement in health service delivery amongst the community beneficiaries, attributable to the mobility provided by the bicycles. Health volunteers also reported using their Buffalo Bicycles to transport sick patients to health facilities in cases of emergencies.

Our findings reveal that participants who received bicycles were less likely to report an inability to access health care facilities when needed. Among those who did encounter such difficulties, a significant majority—approximately 82%—cited transportation challenges as the primary barrier, underscoring the vital role that transport plays in access in healthcare. This conclusion aligns with a study by Mphande (2016), which showed that there was poor uptake of health and agricultural services among rural communities due to long distances to their nearest access points. Another study by Kaiser and Barstow (2022) also mentioned time spent traveling the long distances to the nearest health service provider as a major factor causing people to abstain from seeing healthcare specialists. Together, these studies corroborate our findings, highlighting transportation as a key determinant in the ability to access health and agricultural services.

Social norms and Empowerment

Our analysis revealed that the provision of bicycles had a positive effect on general life satisfaction and self-esteem related to their perceived ability to provide for and meet their family's needs. Analyses indicate a statistically significant increase in self-esteem and general life satisfaction among those who received bicycles compared to those who did not. In addition, female

participants who received bicycles reported that they were more likely to decide on their own how to spend a sizable amount of money, than their female counterparts who did not receive bicycles.

Limitations of the study

Non-compliance and spillovers

The vast majority of participants in the treatment group received a bicycle from WBR, whereas the vast majority of the control group did not. However, bicycle recipients (including treatment group recipients and BSCs) frequently shared bicycles with non-recipients, including with members of the control group: 54% of control group members reported borrowing a Buffalo Bicycle, though usage was relatively low, with the median control group member reporting using a Buffalo Bicycle for only one day in the previous year. We attempted to account for these spillovers in our TOT analysis. However, it is possible that our assumptions in the TOT analysis - specifically that the effect of bicycles scales linearly with use - or that errors in respondents' recall of reported usage, may lead us to overestimate or underestimate spillover effects.

Missing values

Missing values in the baseline and endline dataset occurred when the respondent said that their household did not know the value to a question relating to cost or quantity, or just was not able to answer the question. Although enumerators probed respondents to give their best estimate when the respondent was not certain of a value, some respondents could not provide a reasonable guess for some survey items and the value was coded as missing. As specified in our PAP, for missing costs or prices, we used the median of reported cost or price for the same item in the consumption and asset modules. We note that since missingness is relatively rare, imputation has a small effect on outcome estimates: imputed values comprise less than 1% of quantities for consumption and asset items, and less than 3% of costs for consumption and asset items.

External Shock

Zambia faced its driest agricultural season in more than forty years overlapping the end of 2023 and beginning of 2024. While bicycles appeared to make recipients more resilient to the effects of the drought - including enabling them to maintain similar consumption and income levels, while their peers in the control group experienced declining living standards - it may be that bicycles would have a different impact in a more 'normal' year. It is difficult to predict whether the impact of bicycles would be larger or smaller in a year when the entire community is experiencing fewer external shocks.

Social Desirability Bias

Finally, as in any study that relies on survey data, it is possible that study participants may have altered their answers based on what they thought the enumerator wanted to hear. In particular, treatment participants may have given overly positive answers if they wanted to show appreciation for receiving the bicycle or if they were worried that the bicycle could be taken from them if they were not using it properly. Similarly, control participants may have understated their living conditions if they felt that would lead them to receiving a bicycle in the future. We attempted to mitigate these effects by training enumerators to introduce themselves as members of a research organization that was independent of WBR and that had no authority over bicycle distribution, and by assisting WBR in drafting standard messaging for BSCs about how bicycle distribution decisions were unrelated to the study. The fact that the positive effects are consistent across intermediate and final outcomes in the MC Theory of Change, similar to WBR's recent internal assessments of the MC program, and that the decline in the living standards in the control group is consistent with external reports about the effects of the drought, give us some confidence in the accuracy of survey responses.

Recommendations for WBR on the MC program

The positive results of this study provide a strong justification for continuing and expanding the MC program in Zambia. Specifically, we recommend the following:

- **Targeting the most vulnerable:** The evidence suggests that the treatment group experienced similar impacts of bicycle provision. Future program designs should continue prioritizing the vulnerable to maximize the social return on investment.
- **Expansion of the program:** With the positive impacts on livelihoods, healthcare access, and productivity, scaling up the MC program could yield significant benefits for more communities.
- **Empowerment programs:** Further interventions could be designed specifically to enhance empowerment outcomes, especially among women, given the positive trends observed in financial decision-making autonomy.
- **Monitoring and evaluation:** Continue to rigorously monitor and use feedback mechanisms to adapt the program based on ongoing findings and to facilitate additional research on long-term outcomes.
- **Further research on the MC program:** We recommend that WBR conduct a follow-up round of data collection next year, in order to measure the medium-term effects of the MC program, as well as to estimate the impacts of bicycles in what will hopefully be a year with less extreme drought or other external shocks.

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6. Appendices

Appendix A: Regression Results for all Outcomes

Table A1: Demographics

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Respondent Age	1488	43.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.5
Household Size	1488	7.1	0.1	0.0	0.7 **	0.1	0	0.7 **	-0.1
No. School-going Children 6-17 yrs	1488	2.9	-0.1	-0.2 **	0.3 *	-0.1	-0.2 **	0.3 *	0
Own account worker (self-employed/business)	1488	0.7	0	0.0	0.0	0.0	0.0	0.0	0.0
Unemployed: Both looking or not looking for work	1488	0.2	0	0.0	0.1	0	0.0	0.1	0
Crop farmer	1488	0.6	0	0.0	0.1 **	0	0.0	0.1 **	0.1 *
Livestock farmer	1488	0.2	0	0.0	0.1 *	0	0.0	0.1 *	0
Petty trading	1488	0.3	0	0.0	0.0	0.0	0.0	0.0	0.1
Gardening	1488	0.5	-0.1	-0.1 *	0.0	-0.1	-0.1 *	0	0
Main income source: Subsistence farming	1488	0.6	0	0.0	0.1	0	0.0	0.1	0
Main income source: Petty Trading	1488	0.2	0	0.0	0.0	0.0	0.0	0.0	0.1

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Est. Monthly Earnings from Work Nature	1482	1006.2	384.3 ***	420.3 ***	198.4	404.6 ***	441.6 ***	211.8	90
Est. Average Monthly Household Income, ZMW	1474	1289.6	552.7 ***	625.4 ***	180.3	582.0 ***	657.1 ***	192.6	279.9
Household Per Capita Monthly Income, ZMW	1474	219.6	69.5 ***	80.4 ***	15.3	73.2 ***	84.5 ***	16.3	9.6
HH Saved Income in Past 30 days	1485	0.7	0.1 ***	0.1 ***	.	0.1 ***	0.1 ***	0	-0.1 *
HH Savings Past 30 Days, ZMW	1483	513.5	454.9 ***	511.2 ***	209.0	478.3 ***	536.2 ***	223.0	37.3
Has Formal Fin. Services	1400	0.1	0	.	0.0	0.0	0	0	0

Table A2: Livelihoods Group Members

Variable	# Obs	Control Mean	ITT, LGM	TOT, LGM	DiD Female
Livelihoods Group Size	1201	20.2	0.1	0.1	0.8
Members of VSLAs	1218	0.4	0.0	0.0	0.2 ***
Co-operative members	1218	0.4	0.0	0.0	-0.1 *
Women's clubs	1218	0.3	0.0	0.0	0.0
Youth Clubs	1218	0.1	0.0	0.0	0.0
Tot. Value of LG Monetary Contribution	1204	61.4	58.2 *	61.1 *	65.4 **
LG Transport Costs Last 30 Days	1216	50.8	-6.7	-7.0	-6.1
Receives Dividends	1218	0.5	0.0	0.0	0.1
Avg. Value of Dividend	1216	821.5	353.7 **	371.8 **	308.7
Better Transport Access Would Impact LG Activity	1224	1	-0.1 ***	-0.1 ***	0.0
Impact: Can be able to attend meetings frequently	1188	0.5	0.0	0.0	0.0
Impact: Ease movements (including business related activities)	1188	0.8	0.0	0.0	0.1

Variable	# Obs	Control Mean	ITT, LGM	TOT, LGM	DiD Female
Impact: Ease costs (including the cost of doing business)	1188	0.4	0.0	0.0	0.0
Impact: General livelihood improvement	1188	0.4	0.0	0.0	0.0
Impact: Ease mobilization	1188	0.5	0.0	0.0	0.1
Impact: More efficiency in carrying out different tasks	1188	0.3	0.0	0.0	0.1

Table A3: Mobility Patterns

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Daily Total Distance Traveled	1488	17.8	-0.5	-0.2	-1.5	-0.5	-0.2	-1.6	-3.4
Weekly Total Distance Traveled	1488	124.8	-3.3	-1.3	-10.6	-3.5	-1.3	-11.3	-23.9
Total Distance to Places of Interest	1488	42.2	-0.8	-0.8	0	-0.8	-0.8	0.1	-7.2 *
Daily Time Spent Traveling	1488	163.8	-35.8 ***	-35.4 ***	-35.8 **	-37.7 ***	-37.2 ***	-38.2 **	-11.9
Weekly Time Spent Traveling	1488	1146.8	-250.9 ***	-247.7 ***	-250.4 **	-264.1 ***	-260.1 ***	-267.2 **	-83.3
Monthly Total Visits to Places of Interest	1488	69.6	-8.2 ***	-7.5 ***	-11.2 **	-8.6 ***	-7.9 ***	-11.9 **	-12.5 **
Weekly time spent traveling in minutes to Local Market	967	274.8	-76.8 ***	-76.0 ***	-81.9 **	-81.3 ***	-80.4 ***	-87.0 **	8
Weekly time spent traveling in minutes to Main Market	669	331.3	8.4	14.7	-12.6	8.8	15.4	-13.6	-19.7
Weekly time spent traveling in minutes to Farm	880	229.6	-66.0 ***	-70.8 ***	-41	-69.5 ***	-74.3 ***	-43.8	17.4
Monthly number of visits to Health Center	1488	1.1	-0.1	0.1	-0.7 *	-0.1	0.1	-0.7 *	-0.1
Monthly number of visits to Water Source	1488	24.2	-8.9 ***	-9.1 ***	-7.4 *	-9.4 ***	-9.6 ***	-7.9 *	-13.4 ***
Monthly number of visits to Fuel Source	1488	3.8	-1.4 ***	-1.4 ***	-1.4	-1.5 ***	-1.4 ***	-1.5	-1.5 **

Table A4: Transportation

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Able to ride a bicycle	1487	1	.00	.00	0.0	0.0	0.0	0.0	0.0
HH Owns Bicycle	1488	0.2	0.8 ***	0.8 ***	0.7 ***	0.9 ***	0.9 ***	0.7 ***	0.0
HH Number of bikes	1488	0.2	1.1 ***	1.0 ***	1.1 ***	1.1 ***	1.1 ***	1.2 ***	0.0
HH Access to Bike When Needed	817	0.9	0.0	0.0	0.1	0.0	0.0	0.1	0.1
Bike use is weekly to daily	1485	0.3	0.6 ***	0.6 ***	0.5 ***	0.6 ***	0.6 ***	0.6 ***	0.1
Bike use is several times a month to monthly	1485	0.3	-0.2 ***	-0.2 ***	-0.3 ***	-0.2 ***	-0.2 ***	-0.3 ***	0.0
Bike use is rare or never	1485	0.5	-0.5 ***	-0.5 ***	-0.4 ***	-0.5 ***	-0.5 ***	-0.4 ***	-0.1 ***
Bike Shared Outside Household	819	0.8	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
More bike access for males	818	0.5	0.0	0.0	-0.2	0.0	0.0	-0.2	-0.3 *
More bike access for females	818	0.2	0.0	0.0	0.1	0.0	0.0	0.1	0.1
Equal bike access for males/females	818	0.2	0.0	0.0	0.1	0.0	0.0	0.1	0.2
Other Transport Owned: None	1488	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Owns vehicle or cart	1488	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Had to cancel plans to travel outside of community in last 30 days	1488	0.8	-0.6 ***	-0.6 ***	-0.5 ***	-0.6 ***	-0.6 ***	-0.5 ***	0

Table A5: Business Activity

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Number of businesses 0-2	1488	1.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
HH Business Agriculture	1258	0.8	0.0	0.0	0.1	0.0	0.0	0.1	0.0

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
HH Business Trade	1258	0.3	0.1	0.1 *	0	0.1	0.1	0	0.1 *
HH Business Skills/All Other	1258	0.1	0.0	0.0	0	0.0	0.0	-0.1	0.0
HH Business is Stationary	1258	0.6	-0.1 *	0.0	-0.1	-0.1 *	-0.1	-0.1	0.2 ***
HH Business is Mobile	1258	0.4	0.1 *	0.0	0.1	0.1 *	0.1	0.1	-0.2 ***
HH Business Sources Supplies Elsewhere	1258	0.5	0.0	0.0	0.1	0.1	0	0.1	0.1 *
HH Distance (KM) to Business	658	10	10.7	7.6	22.4	11.4	8.1	22.5	-6.9
HH Time (Min) to Travel to Business	503	96.2	6	0.1	-7.8	6.4	0.1	-7.4	-32.8
HH Mob. Business Distance (KM) Traveled	548	24.5	-1.6	-1	-4.4	-1.6	-1.1	-4.8	22.1
HH Business Distance (KM) to Supply Source	627	30.7	-3.8	-4.6	4.5	-4	-4.8	5.1	-7.7
HH Business Time (Min) to Supply Source	638	129.8	-12.7	-17.6	45.9	-13.3	-18.4	50.1	-25
Total Business Revenue Last 3 Months, ZMW	1488	728.4	382.6 **	518.5 **	-167.4	402.8 **	544.7 **	-178.5	601.3
Group Business Agriculture	386	0.8	0.0	0.0	1.8 ***	0.0	0.0	2.2 ***	0.0
Group Business Trade	386	0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0
Group Business Skill/All Other	386	0.1	0.0	0.0	-1.6 ***	0.0	0.0	-1.9 ***	0.0
Belongs to a Group	1487	0.8	0.0	0.0	0	0.0	0.0	0	0.1
# of Group Meetings Per Year	1192	56.6	-6.7 **	-5.9 *	-9.2	-7.1 **	-6.2 *	-9.9	4.9
Group Meetings Attend Last 3 Months	1191	8.6	-1.1 **	-1	-1.5	-1.2 **	-1	-1.6	-0.6

Table A6: Household Welfare

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Est. Total Monthly Consumption, ZMW	1488	3646.7	866.7 ***	875.4 ***	782.8 ***	912.5 ***	919.4 ***	835.4 ***	389.5 *
Weekly Food Consumption ZMW Value - Winsorized	1488	538.1	120.6 ***	126.6 ***	88.7 **	126.9 ***	133.0 ***	94.6 **	68.0 *

Est. Total Value of HH Assets, ZMW	1488	42504.5	13533.0 ***	14217.4 ***	9607.4 *	14247.2 ***	14933.2 ***	10252.1 *	4625.1
Durable Assets - Winsorized Total ZMW Value	1488	8706.4	3167.4 ***	3221.0 ***	2708.1 **	3334.4 ***	3383.0 ***	2891.3 **	359.9
Agricultural Assets - Winsorized Total ZMW Value	1461	33518.4	9926.5 ***	10469.6 ***	6585.1	10461.7 ***	11008.8 ***	7032.9	3913.3

Table A7: Community Service Workers

Variable	# Obs	Control Mean	ITT, CSW	TOT, CSW	DiD, Female
Service Nature = Health	257	0.8	0.0	0.0	0.0
Service Nature = Agriculture	257	0.1	0.0	0.0	0.0
Service Nature = Environment	257	0.1	0.0	0.0	0.1
CSW: Number of times a Buffalo Bicycle was used to transport someone	216	2.0	15.0 ***	15.9 ***	2.9
Service from Home	257	0.0	0.0	0.0	0.0
Service from Stationary Place	257	0.3	0.0	0.0	-0.2 *
Service from Moving	257	0.7	-0.1	-0.1	0.2 *
Total Service Days Per Month	261	7.5	-0.4	-0.4	1.9
Mobile CSW - Required recipients to reach monthly	170	242.6	101.7	108.0	-159.5
Total Customers Served Per Month	261	184.3	79.6 *	84.8 *	23.4
Time Spent Traveling for Service Weekly	198	1674.8	-261.3	-274.9	358.0
Distance Spent Traveling for Service Weekly	194	113.3	-7.3	-7.7	6.2
Total Service Days Per Month, Health Only	217	7.2	-0.3	-0.4	1.9
Mobile CSW - Required recipients to reach monthly, Health Only	135	265.1	106.1	113.1	-232.1
Total Customers Served Per Month, Health Only	217	183.8	115.4 **	122.1 **	16.2
Time Spent Traveling for Service Weekly, Health Only	159	1573.2	-110.5	-116.3	288.1

Variable	# Obs	Control Mean	ITT, CSW	TOT, CSW	DiD, Female
Distance Spent Traveling for Service Weekly, Health Only	156	108.5	-1.9	-2.0	47.8
Service main transport = Walking	261	0.7	-0.7 ***	-0.7 ***	-0.2 **
Service main transport = Own Bike (not WBR)	261	0.0	-0.0 *	-0.0 *	0.0
Service main transport = Paid Bike (not WBR)	261	0.0	-0.0 **	-0.0 **	0.0
Service main transport = Buffalo Bicycle	261	0.1	0.8 ***	0.9 ***	0.1
Service main transport = All Others	261	0.1	-0.1	-0.1	0.2 *
Challenges = Long distance	171	0.5	-0.3 ***	-0.4 ***	0.0
Challenges = Lack of transportation	171	0.8	-0.7 ***	-0.8 ***	-0.1
Challenges = Cost of transportation	171	0.2	-0.1 **	-0.1 **	-0.2
Challenges = Physical fatigue	171	0.2	-0.2 ***	-0.2 ***	-0.1
Challenges = Lack of compensation	171	0.2	0.0	0.0	-0.1
Solution = Money	139	0.2	0.1	0.1	-0.4 *
Solution = Transportation	139	0.9	-0.7 ***	-0.8 ***	0.1
Solution = Incentives	139	0.1	0.1	0.1	-0.3 *

Table A8: Social Norms

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Have you attended any community meetings in the past 12 months?	1487	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Voice Opinion in Community Meetings: Never	1446	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Voice Opinion in Community Meetings: Sometimes	1446	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Voice Opinion in Community Meetings:	1446	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
Often									
Voice Opinion in Community Meetings: Always	1446	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Can Spend Sizable Amount, Female	997	0.8	0.05 **	0.05 *	0.1	0.05 **	0.05 *	0.1	0.0
Can Make Finance Decisions, Female	997	0.7	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0
Can Decide on Assets, Female	997	0.7	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0
Partner Consults You, Female	1024	0.8	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Voices Opinion in Community Meetings, Female	961	0.4	0.0	0.0	0.1	0.0	0.0	0.1	0.0
I think I am satisfied with my life in general	1488	3.0	0.47 ***	0.52 ***	0.2	0.49 ***	0.55 ***	0.2	0.1
I feel I have control over the direction my life is taking	1488	3.6	0.13 *	0.18 **	-0.1	0.14 *	0.18 **	-0.1	-0.1
I feel there is always a solution to any problem when you make effort	1488	4.3	0.1	0.10 *	-0.1	0.1	0.11 *	-0.1	0.0
Whatever happens to me is because of my own doing	1488	3.1	0.0	0.1	-0.34 *	0.0	0.1	-0.4 *	0.3
I feel that I have a number of good qualities	1488	4.2	0.0	0.1	-0.1	0.0	0.1	-0.1	-0.1
I am able to do things as well as most other people	1488	4.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
I feel that my life will improve in the future	1488	4.5	0.0	0.1	-0.1	0.0	0.1	-0.1	0.1
I expect good things to happen to me in the future.	1488	4.6	0.06 *	0.09 **	-0.1	0.07 *	0.09 **	-0.1	0.0
I feel I can provide for my family and meet my family's needs.	1488	4.0	0.12 **	0.18 ***	-0.2	0.13 **	0.19 ***	-0.2	0.1
Boys should be allowed to get more opportunities for education than girls	1488	2.3	0.17 *	0.24 **	-0.2	0.18 *	0.26 **	-0.2	-0.2
It is better to be a man than to be a woman	1488	2.6	0.1	0.17 **	-0.2	0.1	0.18 **	-0.2	0.0
A wife should obey her husband, even if she	1488	3.3	0.1	0.17 *	-0.1	0.1	0.18 *	-0.1	-0.3 *

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW	DiD Female
disagrees									
It is the job of men to be leaders, not women	1488	2.8	0.1	0.1	-0.1	0.1	0.1	-0.1	-0.2
Decisions Index	1488	0.0	0.0	0.0	-0.21 **	0.0	0.0	-0.2 **	0.0
Intra-HH Index	1482	0.0	0.1	0.0	0.2	0.1	0.0	0.2	0.2 *
Locus of Control Index	1488	0.0	0.20 ***	0.27 ***	-0.1	0.21 ***	0.29 ***	-0.2	0.1
Self-Esteem Index	1488	0.0	0.1	0.13 *	-0.1	0.1	0.14 *	-0.1	0.0
Gender Norms Index	1488	0.0	-0.11 *	-0.17 **	0.2	-0.12 *	-0.17 **	0.2	0.2

Appendix B: Detailed Consumption & Asset Results

Here, we report individual treatment effects on the components in our consumption and asset modules. Table B1 shows that our ITT estimate for **monthly** consumption (ZMW 867) was primarily driven by differences in expenditure for fish, meat, bread, sugar, oil, and petrol. Table B2 shows that our ITT estimate for assets (ZMW 13533) was driven primarily by differences in the value of furniture, kitchen utensils, technology like cellphones and solar panels, and agricultural assets such as cows, chickens, goats, and land.

Table B1: Treatment effect on Consumption Items

Variable	Ctrl Mean (ZMW)	ITT	q-value
Fish	79.89	65.00	0.001
Kapenta	45.86	26.70	0.001
Chicken	153.93	77.20	0.001

Variable	Ctrl Mean (ZMW)	ITT	q-value
Beef	40.33	21.60	0.034
Goat	61.72	66.70	0.001
Breakfast Mealie Meal	275.72	-24.60	0.199
Hammer Mealie Meal	347.38	14.90	0.247
Rice	31.10	29.40	0.001
Wheat	8.50	10.70	0.029
Maize	57.53	14.50	0.012
Beans	32.80	19.20	0.001
Green Maize	18.34	6.90	0.169
Tomatoes	75.83	13.20	0.002
Potatoes	6.76	10.70	0.009
Groundnuts	95.70	15.90	0.074
Pumpkin Leaves	41.11	3.70	0.169
Rapeseed	87.75	-5.10	0.19
Pumpkin	16.01	-0.90	0.36
Onions	17.03	4.00	0.024
Okra	32.87	2.00	0.199
Sweet Potatoes	65.66	4.30	0.222
Eggs	47.18	12.70	0.003
Bread	71.83	35.80	0.001
Sugar	100.75	36.90	0.001
Alcohol Beverage	9.04	2.90	0.222
Milk	58.50	-1.20	0.413
Munkoyo	219.10	50.50	0.065

Variable	Ctrl Mean (ZMW)	ITT	q-value
Maheu	7.81	-1.60	0.222
Oil	175.61	33.10	0.001
Seasonal Fruit	23.41	8.40	0.035
Outside Food	56.32	5.30	0.326
Cosmetics	65.51	5.20	0.071
Detergent	67.83	12.20	0.001
Soap	13.26	3.60	0.003
Charcoal	13.93	7.90	0.005
Petrol	62.25	60.60	0.016
Rent	7.82	2.50	0.213
Electricity	25.21	12.10	0.03
TV	15.78	7.30	0.02
Phone Fees	45.93	10.70	0.001
Public Transport	178.00	6.30	0.326
Vehicle	29.06	45.20	0.169
Motor Bike	21.08	6.10	0.199
Bike Repair	11.61	17.60	0.001
Loan Pay	75.25	3.40	0.36
Remittance	26.27	7.00	0.029
Men's Clothes	24.20	9.70	0.001
Women's Clothes	28.58	11.90	0.001
Children's Clothes	36.91	13.90	0.001
Gifts	42.90	9.00	0.169
Contributions	21.77	7.60	0.001
School Fees	23.60	11.20	0.074

Variable	Ctrl Mean (ZMW)	ITT	q-value
School Expenses	44.03	18.20	0.008

Table B2: Treatment effect on Asset Items

Variable	Ctrl Mean	ITT	q-value
Bed	951.25	182.67	0.002
Mattress	938.71	238.05	0.001
Mosquito Net	113.54	19.39	0.013
Table	219.56	43.48	0.021
Sofa	1100.05	265.75	0.011
Radio	495.07	99.89	0.056
TV	1720.90	516.63	0.036
Satellite TV	575.45	-19.06	0.384
DVD/VCR	326.14	110.08	0.083
Cellphone	736.75	258.44	0.001
Clock	126.36	-42.19	0.194
Brazier	34.35	7.83	0.005
Stove	1092.86	-288.50	0.016
Iron	70.88	14.16	0.014
Axe	92.04	14.00	0.014
Pick	91.78	7.36	0.194
Hoe	157.69	40.47	0.001
Hammer	68.88	2.40	0.322
Shovel	92.85	4.06	0.272
Plough	1299.99	226.89	0.009

Variable	Ctrl Mean	ITT	q-value
Crop Sprayer	514.86	110.46	0.007
Ox Cart	5233.83	296.33	0.219
Solar Panel	764.68	406.08	0.007
Kitchen	866.88	401.36	0.001
Oxen	18164.39	2048.34	0.141
Cows	18248.17	5912.68	0.015
Other Cattle	5873.24	1883.85	0.141
Horses	5720.00	3489.96	N/A
Goats	3391.35	573.46	0.036
Sheep	3075.53	633.09	0.145
Pigs	7068.59	2191.25	0.247
Chickens	933.01	295.37	0.005
Other Animals	248.39	58.88	0.194
Land	19492.08	20340.31	0.116

Appendix C: IPW Regressions

As robustness checks, Table C1 shows our ITT estimates for our main outcomes when using inverse probability weights to account for attrition. These do not meaningfully change any of our findings

Table C1: Treatment effect on Main Outcomes with IPW

Variable	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW
Est. Total Monthly Consumption, ZMW	867.7 ***	873.3 ***	797.7 ***	913.5 ***	917.3 ***	850.9 ***
Est. Total Value of HH Assets, ZMW	13669.7 ***	14292.0 ***	10360.5 *	14391.6 ***	15011.6 ***	11051.5 *
Est. Average Monthly Household Income, ZMW	555.7 ***	627.6 ***	194.1	585.3 ***	659.4 ***	207.2
Total # of Income Sources	0	0.1	0	0	0.1	0
Poverty Likelihood % (From PPI)	-0.1 ***	-0.1 ***	0	-0.1 ***	-0.1 ***	0
HH Saved Income in Past 30 days	0.1 ***	0.1 ***	0	0.1 ***	0.1 ***	0
HH Savings Past 30 Days, ZMW	457.3 ***	512.1 ***	219.1	480.8 ***	537.1 ***	233.7
Total Monthly Loan Payment Expenditures, ZMW	2.5	-7.7	59.4 *	2.6	-8.1	63.3 *
Est. HH Transport Expenditure in Past 30 Days	18.7	8.3	48.4	19.7	8.7	51.7
Weekly Time (Min) Spent Traveling	-246.1 ***	-242.7 ***	-248.9 **	-259.1 ***	-254.8 ***	-265.6 **
Weekly Total Distance (KM) Traveled	-2.6	-0.6	-10.3	-2.8	-0.6	-11
Unable to Visit Health Center in Last 30 Days	-0.4 ***	-0.4 ***	-0.3 ***	-0.4 ***	-0.4 ***	-0.4 ***
Number of businesses 0-2	0	0	0.1	0	0	0.1
Total Monthly Business Revenue, ZMW	380.6 **	514.5 **	-168.7	400.7 **	540.5 **	-179.9
Total Business Transport Costs in Typical Month, ZMW	-47.9 **	-47.4 *	-27.6	-50.4 **	-49.8 *	-29.4
Intra-HH Index	0.1	0	0.2	0.1	0	0.2
Decisions Index	0	0	-0.2 **	0	0	-0.2 **
Locus of Control Index	0.2 ***	0.3 ***	-0.2	0.2 ***	0.3 ***	-0.2
Self-Esteem Index	0.1	0.1 *	-0.1	0.1	0.1 *	-0.1
Gender Norms Index	-0.1 **	-0.2 **	0.2	-0.1 **	-0.2 **	0.2

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Appendix D: HDDS Food Classification

Table D1 shows our household dietary diversity score food group classifications for the items in our consumption module, with Zambian-specific items italicized.

Table D1: HDDS Food Group Classification

HDDS food group	Food item
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 E: Female-Only Treatment Effects

Table E1 shows our ITT and TOT estimates for our main outcomes for female households.

Table E1: Female-Only Treatment effects

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW
Est. Total Monthly Consumption, ZMW	996	3353.7	1001.9 ***	1059.4 ***	495.1	1062.0 ***	1116.6 ***	547.4
Est. Total Value of HH Assets, ZMW	996	34160.9	15457.9 ***	15522.9 ***	12476.6 *	16384.9 ***	16361.9 ***	13792.2 *
Est. Monthly Earnings from Work Nature	991	826.7	414.0 ***	430.1 ***	98.8	439.0 ***	453.6 ***	109.2
Est. Average Monthly Household Income, ZMW	985	1140.6	648.0 ***	697.8 ***	81.2	687.2 ***	735.7 ***	89.9
Total # of Income Sources	996	1.8	0.1	0.1	0	0.1	0.1	0.1
Household Per Capita Monthly Income, ZMW	985	206.9	67.8 ***	81.2 ***	-41.8	71.9 ***	85.6 ***	-46
Poverty Likelihood % (From PPI)	996	0.6	-0.1 ***	-0.1 ***	0	-0.1 ***	-0.1 ***	0
HH Saved Income in Past 30 days	994	0.7	0.1 ***	0.1 ***	0	0.1 ***	0.1 ***	0
HH Savings Past 30 Days, ZMW	993	406.6	499.1 ***	519.5 ***	221.2	529.1 ***	547.7 ***	244.5
Total Monthly Loan Payment Expenditures, ZMW	995	75.4	-9.9	-18.1	39.2	-10.5	-19	43.4
Weekly Time (Min) Spent Traveling	996	1131.1	-282.8 ***	-265.2 ***	-421.6 ***	-299.7 ***	-279.5 ***	-465.9 ***
Weekly Total Distance (KM) Traveled	996	114.7	-10.5	-9.5	-16.2	-11.2	-10	-18
Unable to Visit Health Center in Last 30 Days	992	0.5	-0.4 ***	-0.4 ***	-0.4 ***	-0.4 ***	-0.4 ***	-0.4 ***
Had to cancel plans to travel outside of community in last 30 days	996	0.8	-0.6 ***	-0.6 ***	-0.5 ***	-0.6 ***	-0.6 ***	-0.6 ***
Number of businesses 0-2	996	1.1	0	0	0.1	0	0	0.1
Total Monthly Business Revenue, ZMW	996	570.3	590.4 **	658.9 **	58.9	625.8 **	694.7 **	65
Total Business Transport Costs, ZMW	996	117.1	-29	-33.8	-5.5	-30.7	-35.7	-6
Intra-HH Index	991	-0.1	0.1 *	0.1	0.1	0.1 *	0.1	0.1

Variable	# Obs	Control Mean	ITT, Pooled	ITT, LGM	ITT, CSW	TOT, Pooled	TOT, LGM	TOT, CSW
Decisions Index	996	0	0	0	-0.2 *	0	0	-0.3 *
Locus of Control Index	996	0	0.2 ***	0.3 ***	0.1	0.3 ***	0.3 ***	0.1
Self-Esteem Index	996	-0.1	0.1	0.1	0	0.1	0.1	0
Gender Norms Index	996	0.1	-0.1	-0.1	0.2	-0.1	-0.1	0.2