Title: Increasing access to reproductive health services through maternity waiting homes for women living farthest from a health facility in rural Zambia: a quasi-experimental study

Author List: Jody R. Lori[1], Michelle L. Munro-Kramer[1], Haiyin Liu[1], Kathleen L. McGlasson[2], Xingyu Zhang[1], HaEun Lee[1], Thandiwe Ngoma[3], Jeanette L. Kaiser[2], Misheck Bwalya[3], Gertrude Musonda[4], Isaac Sakala[4], Joseph E. Perosky[1], Rachel M. Fong[2], Carol J. Boyd[1], Parker Chastain[2], Peter C. Rockers[2], Davidson H. Hamer[2], Godfrey Biemba[5], Taryn Vian[2], Rachael Bonawitz[2], Nancy Lockhart[1], Nancy A. Scott[2].

Affiliations and addresses:

[1] University of Michigan School of Nursing
400 N Ingalls St, Ann Arbor, MI, USA 48109

[2] Boston University School of Public Health
801 Massachusetts Avenue, Crosstown Center 3rd Floor, Boston, MA, USA, 02118

[3] Zambia Center for Applied Health Research and Development
Plot 4186 Addis Ababa Drive, Long Acres, PO Box 30910, Lusaka, Zambia

[4] Africare/Zambia
Flat A, Plot 2407/10 MBX Off Twin Palm Road, Ibex Hill, PO Box 33921, Lusaka, Zambia

[5] National Health Research Authority, Pediatric Centre of Excellence
Plot 4186 Addis Ababa Drive, Long Acres, PO Box 30910, Lusaka, Zambia

Corresponding Author:
Dr. Jody R. Lori
Professor & Associate Dean for Global Affairs
University of Michigan School of Nursing
400 N Ingalls St, Ann Arbor, MI, USA 48109
jrlori@med.umich.edu
(734) 763-0097

Running title: Maternity waiting homes

ABSTRACT

Objective: To report on the effectiveness of a standardized core Maternity Waiting Home (MWH) model to increase facility deliveries and access to reproductive health services among women living farthest from a health facility (>10km) using facility-based data.

Design: Quasi-experimental design.

Setting: Seven rural districts in Zambia.

Population: Women delivering at 40 health facilities between June 2016 to August 2018.

Methods: 20 intervention sites and 20 comparison sites were used to test if MWHs increased access to reproductive health services for women living in rural Zambia. The difference-in-differences (DID) methodology was used to examine the effectiveness of the core MWH model on our primary outcomes.

Main Outcome Measures: Differences in the change from baseline to endline in the percentage of women who: 1) traveled greater than 10 km for delivery, (2) attended a postnatal visit at 6 days postpartum, and (3) were referred to a higher-level health facility between intervention and comparison group.

Results: We detected a significant difference for the percentage of deliveries at intervention facilities with the core MWH model for all women living >10km away (p=0.03), adolescent women (<18 years) living >10km away (p=0.002), and primigravida women living >10km away (p=0.01). There were no significant differences for women attending a postnatal care visit at 6 days postpartum (p=0.07) or for women referred to the next level of care (p=0.29).

Conclusion: The core MWH model was successful in reaching women with historically low rates of facility delivery, those living >10km from a healthcare facility, including adolescent women and primigravidas.

INTRODUCTION

The social and economic implications of maternal morbidity and mortality reach beyond a woman to her family, community, and even country.[1,2] Since 1990, significant improvements were achieved with the maternal mortality ratio decreasing by 45% worldwide.[3] However, too many women, especially in low income countries, still suffer from preventable complications and deaths related to pregnancy and childbirth.[3] Studies show that reproductive health service utilization, especially facility-based delivery under the supervision of skilled health care providers, is effective in preventing and managing pregnancy and childbirth related complications.[4]

The inability to access necessary delivery services is one reason low-income countries disproportionately suffer from preventable maternal deaths and illnesses with 99% of all maternal deaths occurring in low income countries and 66% in sub-Saharan Africa.[5] Zambia, a landlocked country in sub-Saharan Africa, has a maternal mortality ratio of 224 per 100,000 live births, which can be attributed to the inequity in access of important reproductive health services.[6,7]

The long distances women must travel to reach health facilities present one of the biggest barriers in accessing crucial services.[4] Maternity waiting homes (MWHs), accommodation located near a health facility where women can stay during pregnancy and/or after birth to enable timely access to reproductive health care, have been identified as an intervention to bridge this inequity in access caused by distance.[8-11] However, the effectiveness of MWHs for improving maternal outcomes is inconclusive.[1,9] While a Cochrane review[8] concluded there is insufficient evidence to determine whether MWHs improve maternal and neonatal outcomes, a recent meta-analysis suggests that in low-income countries MWH users were 80% less likely to die than non-users.[12]

Two chief reasons contribute to the inconsistent results regarding the effectiveness of MWHs: the limited number of studies with strong methodologic designs and varying operationalized models of MWHs.[9, 11] Insufficient randomized control, quasi-randomized, and cluster-randomized trials produce limited reliable evidence regarding the benefits of MWHs.[9] Furthermore, operational models of MWHs are highly

inconsistent in the materials, infrastructure, and service availability between and within countries which further impacts drawing generalizable implications.[11, 13-16]

The present study addresses an important research gap by using a quasi-experimental study design to test the impact of a standardized core MWH model in rural Zambia. The purpose of the paper is to determine the effectiveness of a core MWH model to increase facility deliveries and access to reproductive health services among women living farthest from a health facility (>10km) using facility-based data.

METHODS

The core MWH model was developed by the Maternity Home Alliance (MHA) and is described in detail elsewhere.[17] As part of a quasi-experimental study design, 20 sites received the core MWH model and 20 comparison sites provided the standard of care for waiting mothers. All sites were basic emergency obstetric and newborn care (BEmONC) facilities. Two implementing partners used different methods to assign health facility sites to study arms—one used matched-pair randomization (10 intervention and 10 comparison) and the other used a matched-pair approach without random assignment (10 intervention and 10 comparison).[17] Additionally, geographic information system (GIS) techniques were used to geo-locate and map the distance between rural villages and health facility sites in each of the catchment areas. Distances from mothers' home villages to health facilities were calculated using ArcGIS® Online (ESRI, Redlands, CA, USA). Recorded distances were determined as the most direct route along roads/paths between each village and their associated health facility.

Ethical approvals were obtained from the each implementing partner's institution (University of Michigan and Boston University Institutional Review Boards) as well as ERES Converge (Where Research, Ethics, and Science Converge) IRB, a private research ethics board in Zambia governed by the National Health Research Ethics Committee. We also obtained approval to proceed with the study from the Zambia National Health Research Authority, responsible for oversight of all research conducted in the country.

Study setting and sample

Seven districts (Chembe, Choma, Kalomo, Lundazi, Mansa, Nyimba, and Pemba) in three provinces (Eastern, Luapula, and Southern) were included in the study with a total estimated population of 369,234 within catchment communities at all study sites. Baseline characteristics of study sites were primarily rural with estimates of rural populations as follows: Lundazi (95%), Kalomo (93%), Nyimba (91%), Choma/Pemba (76%), and Mansa/Chembe (67%).[18] Choma/Pemba and Mansa/Chembe were administratively combined in the 2010 census. Except for Chembe, each district has one or more district hospital providing comprehensive emergency obstetric and neonatal care (CEmONC).

Data collection

The MHA partners harmonized instruments for data collection prior to the commencement of the study. Working with their local partners, the University of Michigan collected data on the MWH sites from Chembe, Lundazi, and Mansa while Boston University collected data on the MWH sites from Choma, Kalomo, Nyimba, and Pemba. Data were extracted from Ministry of Health (MOH) registers at each of the 40 health facility sites in the study for admission, delivery, postnatal care (PNC), and referrals. Additionally, data were collected through a MWH register and experience survey (both designed and implemented by the study partners) for women utilizing MWHs to capture demographic data. Data were entered by project MWH research assistants, managers, or caretakers.

Time parameters for baseline data collection were set at 3 months prior to the opening of each individual MWH. Because MWHs were established using a stepwise approach, time parameters for the evaluation data included the first full month after the opening of the MWH (first MWHs opened in June 2016) to 1 August 2018 (one full year following the opening of the last MWH).

Research assistants (RAs) extracted admission, discharge, and transfer data from all health facility delivery logbooks at all 40 sites. They also extracted data on PNC attendance and referrals from facility logbooks. Admission data were collected from each woman using a MWH survey. Women also completed an experience survey if they stayed a minimum of three nights at the MWH. Women were informed they could refuse to answer any question or stop the survey at any time and participation would

not affect their care. After obtaining informed consent, the survey was administered verbally by a Zambian RA in the local language due to low literacy levels within communities.

Data analysis

Process and outcome indicators from the two implementing partners were agreed upon by partners *a priori* and data were combined. Descriptive analyses were performed comparing demographics across baseline and study period using Chi-square tests for categorical variables and t-tests for continuous variables.

We used the difference-in-differences (DID) methodology to examine the effectiveness of the core MWH model on our primary outcome; of all facility-based deliveries, the proportion of women living >10km away and delivering at the health facility. This approach adjusted for potential biases from underlying time trends and other unmeasured confounders between BEmONC facilities with MWHs (the intervention group) and BEmONC facilities without MWHs or unimproved MWHs (the comparison group).[19] Based on data from the Saving Mothers Giving Life (SMGL) initiative Phase I and district level MOH, intervention facilities experienced a common trend in attendance to comparison facilities until the opening of MWHs.[20] For both groups, we calculated the proportions of women who: (1) came for deliveries at a BEmONC facility from greater than 10 km, (2) attended a PNC visit at 6 days postpartum, and (3) were referred to a higher-level health facility in baseline and the evaluation period. We compared the differences in the changes of percentages at intervention group vs. comparison group during the evaluation period relative to baseline (3 months prior to MWH opening) to identify association between MWHs and outcomes.

A logistic regression model was fit to test the association between women who delivered at a BEmONC facility and lived >10 km away from the facility. Linear regression models were employed to estimate the association between monthly referral rates and the monthly PNC rates. We estimated robust standard errors with a cluster effect on BEmONC facilities. In each model, we included two dummy variables: (1) equal to 1 for the intervention group and 0 for the comparison group and (2) equal to 1 for observations

from the evaluation period and 0 for those from baseline. We used an interaction term between these two dummy variables to perform a statistical test of the DID estimator. All hypothesis tests were two-sided with the level of statistical significance set to 0.05. Statistical analyses were conducted in Stata version 15·0.

Results

A total of 18,544 women delivered at an intervention or comparison health facility during our study timeframe. Overall, the intervention and comparison groups were similar. Delivery records from MOH registers indicated women were on average 24 years of age, having their 3rd child, with 24-27% primigravidas. However, there was a greater number of women under age 18 years in the intervention communities than in the comparison communities at baseline (p=0.01). During the course of the study period (June 2016 to 1 August 2018), 63.3% (n=6622) of all women delivering at an intervention health facility used a MWH. Complete demographics are listed in Table 1.

Table 2 presents the absolute DID for women living >10km away and delivering at the health facility, women with a PNC visit at six days postpartum, and women referred for complications to a CEmONC facility. The absolute DID compares facilities with the core MWH model to comparison sites. We detected a significant difference for the percentage of women delivering at a health facility living >10km away (p=0.03), with a higher percentage of women living >10km delivering at a health facility in the intervention sites after the core MWH model was introduced. The difference in women attending a PNC visit at 6 days postpartum approached significance (p=0.07), with a higher percentage of change in the number of women at the intervention sites attending their day 6 PNC visit after the core MWH model was introduced. There was not a significant difference for referrals.

We also examined the absolute DID for characteristics of women living >10km away and delivering at a health facility, specifically focusing on adolescent women (<18 years old), primigravida, and grand multipara women (Table 3). We detected a significant difference for the percentage of adolescent women

living >10km away delivering at a health facility (p=0.002), with a higher percentage of adolescent women delivering at health facilities in the intervention group after introduction of the core MWH model. We also detected a significant difference for the percentage of primigravida women living >10km away delivering at a health facility (p=0.01), with a higher percentage of primigravida women delivering at health facilities in the intervention communities after the core MWH model was introduced.

Using the GIS data, we calculated the travel distance for 98% of the women utilizing a MWH during the study period. Mean distance traveled for all women utilizing a MWH was 8.3km (SD=11.3km). We calculated the mean length of stay and standard deviation for antepartum care 10.9 days (SD=13.8 days), those awaiting delivery 15.2 days (SD=17.7 days), and those using the MWH to receive postnatal care 2.5 days (SD=13.0 days) as well as the distance women traveled for each type of stay. As noted in Table 4, overall, 38.6% of women traveled from >10km away representing the largest group of women using the MWH for any reason. The mean distances for each type of care received included 7.1km (SD=6.5km) for antenatal care, 8.5km (SD=12.0km) for those awaiting delivery, and 7.4km (SD=6.1km) for those receiving postnatal care.

Additionally, transportation data were calculated for 97% of the women using a MWH (Figure 1 S1). The majority of participants (82.5%) used non-motorized means to get to the health facility including walking, bicycle, carried in hammock/wheelbarrow, or an ox cart. A smaller percentage (17.5%) used motorized transportation such as a motorcycle, taxi, car, or ambulance. Of those who used motorized transportation, 79% were located within a two-hour distance to the health facility, while among those who reported using non-motorized transportation only 54% were within a two-hour distance to the health facility.

DISCUSSION

Main findings

In the present study, we examined how the core MWH model can increase health facility delivery, PNC visit at six days postpartum, and referral for complications to a CEmONC facility for women living >10km away from a HF. This study found the core MWH model was successful in reaching women with low rates of facility delivery, especially those living >10km from a healthcare facility. The difference for the percentage of women attending a PNC visit at 6 days postpartum >10km away was approaching significance and there was no difference for referrals. The core MWH model also increased the percentage of women less than 18 years old and primigravida women living >10km away accessing health facilities for deliveries.

Strength and limitations

This study has several strengths including a large sample size of women living in rural, remote areas of Zambia, and the use of selection criteria to match comparison and intervention sites.[17] Additionally, the harmonization of indicators prior to the start of data collection ensured that partners used the same definitions and measured similar outcomes.

There are several limitations that constrain interpretation of the findings. First, implementing partners used different methods to select and assign health facility sites to study arms. In four districts, one partner randomly assigned health facilities to receive the MWH intervention while in three districts, the second partner used input from district health teams and purposively sampled from eligible rural health facilities.[17] Second, the study was conducted in districts where the SMGL initiative had implemented evidence based interventions to reduce maternal and newborn mortality including improving the quality of BEmONC services while improving access and demand.[20] However, these SMGL districts were purposively chosen to ensure adequate quality of care if the intervention increased access and demand. Finally, MOH facility registers were used for collection of various data. Data were entered into these various registers by the nurse or midwife on duty. While each health facility was issued standard data collection registers with definitions for each cell, there was the chance of varying interpretation by the

recorder. To address this, we conducted trainings at each site with nurses and midwives; also field staff worked with nurses and midwives to ensure accuracy of the data.

Interpretation

This study found the core MWH model was successful in reaching women with historically low rates of facility delivery, those living >10km from a healthcare facility. Data on utilization of maternal and newborn care from five East African countries suggests that greater geographic inaccessibility (often defined as >10km from a health facility) contributes to lower rates of receiving recommended antenatal care, delivering at a facility with a skilled birth attendant, and obtaining PNC.[21] The core MWH model provided access to this population regardless of how they initially reached the MWH, via motorized or non-motorized transportation.

In addition to increasing access for all women at geographic risk, the core MWH model also increased the percentage of adolescent women (<18 years old) and primigravida women living >10km away accessing health facilities for deliveries. Adolescents are known to have greater risk for maternal morbidity and mortality due to biological and sociocultural factors.[22] The government of Zambia specifically recommends that all adolescent pregnancies, primigravidas, and grand multiparas should deliver at a health facility due to increased risk for maternal morbidity and mortality related to age and pregnancy status.[23] This finding therefore helps support the national strategy to improve the maternal health of those most at risk.

Past research has noted there are numerous barriers to MWH use once they are constructed and some studies have seen minimal use and sustainability.[24-26] The core MWH model incorporated many of the facilitators identified in past research including no cost to stay, community involvement, awareness raising, and integrating culturally-appropriate practices to ensure uptake and sustainability.[27] The core MWH model was therefore responsive to women's needs and attracted women during the antepartum, intrapartum, and postpartum timeframes.

Early harmonization of indicators ensured that MHA partners used the same definitions and measured similar outcomes. This allowed for comparisons using all partner data and is essential to ensure that large-scale data obtained using a quasi-experimental design is comparable across sites. This methodology addresses many of the critiques in the literature that have led to mixed and inconclusive results regarding the outcomes and effectiveness of MWHs.[11,12]

CONCLUSION

This study is one of the first to examine the impact of a MWH intervention to increase access to reproductive health services for women living farther than 10 km from a rural health facility. Results of this study indicate that a community-driven, entrepreneurial core MWH model is effective at increasing facility delivery for women living farthest from the health facility (>10 km) especially primigravidas and those less than 18 years old. Maternity waiting homes are one strategy to improve access to facility delivery for women living the greatest distance from a health care facility.

Acknowledgements

Elizabeth G. Henry, Kat James, Data Collection Teams Right to Care and Africare.

Funding for Online Open publication supported by Chronos Support through the Bill & Melinda Gates Foundation.

Disclosure of interests

All authors have no disclosures of interest to declare. Completed disclosure of interest forms are available to view online as supporting information.

Contribution to authorship

JRL, CJB, DHH, NAS designed the study and data collection instruments; TN, JLK, MB, GM, JEP collected data; JRL, MLMK, HL, KLM, XZ, PK, PCR, NL, NAS managed and conducted data analysis; JRL, MLMK, HL, KLM, XZ, HL, TN, JLK, MB, GM, IS, JEP, RMF, CJB, PC, PCR, DHH, GB, TV,

RB, NL, NAS contributed to the development of the manuscript; all authors reviewed and approved the final version of the manuscript.

Ethical approval

Ethical approvals were obtained from the University of Michigan (Ref No. HUM00110404, Date of Approval 01-18-2016) and Boston University Institutional Review Boards (Ref No. H-34526, Date of Approval 01-12-2016) as well as ERES Converge (Where Research, Ethics, and Science Converge) IRB (Ref No. 00005948, Date of Approval 12-14-2015) a private research ethics board in Zambia governed by the National Health Research Ethics Committee. We also obtained approval to proceed with the study from the Zambia National Health Research Authority, responsible for oversight of all research conducted in the country.

Funding

This program was developed and is being implemented in collaboration with *Merck for Mothers*, Merck's 10-year, $500 million initiative to help create a world where no woman dies giving life. *Merck for Mothers* is known as *MSD for Mothers* outside the United States and Canada (MRK 1846-06500.COL). The development of this article was additionally supported in part by the Bill & Melinda Gates Foundation (OPP1130334) https://www.gatesfoundation.org/How-We-Work/Quick-Links/Grants-Database/Grants/2015/06/OPP1130334 and The ELMA Foundation (ELMA-15-F0010) http://www.elmaphilanthropies.org/the-elma-foundation/ The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The content is solely the responsibility of the authors and does not necessarily reflect positions or policies of Merck, the Bill & Melinda Gates Foundation, or The ELMA Foundation.

References

1. Bekele B, Dadi T, Tesfaye T. The significant association between maternity waiting homes utilization and perinatal mortality in Africa: systematic review and meta-analysis. BMC Research Notes. 2019;12(1).
2. Onarheim K, Iversen J, Bloom D. Economic Benefits of Investing in Women's Health: A Systematic Review. PLOS ONE. 2016;11(3):e0150120.
3. United Nations (UN). The Millennium Development goals report 2015. [Available from: http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf]
4. Dimbuene Z, Amo-Adjei J, Amugsi D, Mumah J, Izugbara C, Beguy D. Women's education and utilization of maternal health services in Africa: a multi-country and socioeconomic status analysis. J Biosoc Sci 2015; 50(06), 725-748.
5. Alkema L et al. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. Lancet 2015; 387(10017), 462-74.
6. World Health Organization, United Nations International Children's Emergency Fund, United Nations Population Fund, World Bank Group, & United Nations Population Division Maternal Mortality Estimation Inter-Agency Group. Maternal mortality in 1990-2015. Retrieved from: https://www.who.int/gho/maternal_health/countries/zmb.pdf
7. Center Statistical Office (CSO) Zambia, Ministry of Health (MOH) Zambia, & ICF International. Zambia Demographic and Health Survey 2013-14. Retrieved from: https://www.dhsprogram.com/pubs/pdf/fr304/fr304.pdf
8. Lonkhuijzen L, Stekelenburg J, Roosmalen J. Maternity waiting facilities for improving maternal and neonatal outcome in low-resource countries. Cochrane Db Syst Rev 2014; doi:10·1002/14651858.CD006759

9. World Health Organization. Maternity Waiting Homes: A review of experiences. Geneva: World Health Organization, Maternal and Newborn Health Safe Motherhood Unit. Division of Reproductive Health; 1996.
10. Lori J, Munro-Kramer M, Mdluli E, Musonda G, Boyd C. Developing a community driven sustainable model of maternity waiting homes for rural Zambia. Midwifery 201641, 89-95. doi:10.1016/j.midw.2016.08.005
11. Penn-Kekana L, Pereira S, Hussein J, Bontogon H, Chersich M, Munjanja S, Portela A. Understanding the implementation of maternity waiting homes in low- and middle-income countries: A qualitative thematic synthesis. BMC Pregnancy and Childb 2017;17(1). doi:10.1186/s12884-017-1444-z
12. Dadi T, Bekele B, Kasaye H, Nigussie T. Role of maternity waiting homes in the reduction of maternal death and stillbirth in developing countries and its contribution for maternal death reduction in Ethiopia: A systematic review and meta-analysis. BMC Health Serv Res 2018;18(1). doi:10.1186/s12913-018-3559-y
13. Bergen N et al. Maternity waiting areas – serving all women? Barriers and enablers of an equity-oriented maternal health intervention in Jimma Zone, Ethiopia. Glob Public Health 2019; doi: 10.1080/17441692.2019.1597142
14. Gaym A, Pearson L, Soe K. Maternity waiting homes in Ethiopia–three decades experience. Ethiop Med J 2012;50(3):209–19.
15. Chandramohan D, Cutts F, Chandra R. Effects of a maternity waiting home on adverse maternal outcomes and the validity of antenatal risk screening. Int J Gynaecol Obstet 1994;46(3):279–84.
16. Kelly J et al. The role of a maternity waiting area (MWA) in reducing maternal mortality and stillbirths in high-risk women in rural Ethiopia. BJOG 2010;117(11):1377–83.

17. Scott NA, Kaiser JL, Vian T, Bonawitz R, Fong RM, Ngoma T, Biemba G, et al. Impact of maternity waiting homes on facility delivery among remote households in Zambia: Protocol for a quasiexperimental, mixed-methods study. BMJ Open 2018;8:e022224. doi: 10.1136/bmjopen-2018-022224.
18. Central Statistical Office Zambia. 2010 Census of Population and Housing - Southern Province Analytical Report. Retrieved from: https://www.zamstats.gov.zm/phocadownload/2010_Census/2010_Census_Analytical_Reports/Southern%20Province%20Analytical%20Report%20-%202010%20Census.pdf
19. Dimick JB, Ryan AM. Methods for evaluating changes in health care policy: The difference-in-differences approach. JAMA 2014;312(22):2401-2402.
20. Centers for Disease Control and Prevention. Saving Mothers, Giving Life: Monitoring and Evaluation Overview, Phase 1 Report. Atlanta, GA: Centers for Disease Control and Prevention, US Dept of Health and Human Services; 2014. Retrieved from: https://www.cdc.gov/reproductivehealth/global/publications/pdfs/MonitoringandEvaluationOverview.pdf
21. Ruktanonchai CW, Ruktanonchai NW, Nove A, Lopes S, Pezzulo C, Bosco C, Alegana VA, Burgert CR, Ayiko R, Charles AS, Lambert N. Equality in maternal and newborn health: modelling geographic disparities in utilisation of care in five East African countries. PLoS One 2016;11(8):e0162006.
22. Ganchimeg T, Ota E, Morisaki N, Laopaiboon M, Lumbiganon P, Zhang J, Yamdamsuren B, Temmerman M, Say L, Tunçalp Ö, Vogel JP. Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. BJOG 2014;121:40-8.
23. Republic of Zambia, Ministry of Health, Reproductive, Maternal, Newborn, Child and Adolescent Health and Nutrition Communication and Advocacy Strategy 2018-2021. Retrieved from: https://www.moh.gov.zm/?wpfb_dl=111

24. Eckermann E, Deodato G. Maternity waiting homes in Southern Lao PDR: the unique ‘silk home’. J Obstet and Gynaecol Re 2008;34(5):767-75.
25. García Prado A, Cortez R. Maternity waiting homes and institutional birth in Nicaragua: policy options and strategic implications. Int J Health Plan M 2012;27(2):150-66.
26. Ruiz MJ, van Dijk MG, Berdichevsky K, Munguía A, Burks C, García SG. Barriers to the use of maternity waiting homes in indigenous regions of Guatemala: a study of users' and community members' perceptions. Culture, health & sexuality 2013;15(2):205-18.
27. Penn-Kekana L, Pereira S, Hussein J, Bontogon H, Chersich M, Munjanja S, Portela A. Understanding the implementation of maternity waiting homes in low-and middle-income countries: a qualitative thematic synthesis. BMC Pregnancy Childb 2017;17(1):269.

Table and Figures Caption List

Table 1. Characteristics of women delivering at health facilities at baseline and following opening of maternity waiting home (MWH) core model.

Table 2. Absolute difference-in-differences for women living >10km away and delivering at a health facility, attending postnatal care (PNC) visit at 6 days postpartum, and referred to comprehensive emergency obstetric and neonatal care (CEmONC) facility.

Table 3. Absolute difference-in-differences between intervention and comparison sites for women who live >10km, N(%).

Table 4. Length of maternity waiting home (MWH) stay by type and distance.

Supplementary Figure 1. Comparison of non-motorized versus motorized transportation by time in hours.

Table 1. Characteristics of women delivering at health facilities at baseline and following opening of maternity waiting home (MWH) core model.

	Baseline Deliveries (3 months before MWH's opened)			Deliveries Following Opening of MWH (beginning first complete calendar month open)			Women Utilizing the MWH Core Model
	Intervention N=1570	Comparison N=1162	p-value^	Intervention N=10463	Comparison N=8081	p-value^	Intervention N=6622 (63.3%)
Age, mean (SD)	24.6 (6.8)	24.7 (6.6)	.57	24.6 (6.6)	24.7 (6.5)	0.1	24.3 (6.5)
Age < 18 yrs, N (%)	183 (11.9)	103 (8.9)	.01*	1081 (10.5)	785 (9.8)	0.13	781 (11.9)
Gravida, mean (SD)	3.2 (2.1)	3.2 (2.1)	.64	3.2 (2.0)	3.2 (2.0)	0.95	3.2 (2.1)
Parity, mean (SD)	2.2 (2.0)	2.3 (2.0)	.62	2.2 (2.0)	2.3 (2.0)	0.16	2.1 (2.0)
Primigravida, N (%)	421 (27.1)	276 (24.1)	.08	2479 (24)	1902 (23.8)	0.7	1736 (26.3)
Grand Multipara >6 pregnancies, N (%)	139 (8.9)	88 (7.7)	.24	810 (7.8)	574 (7.2)	0.09	516 (7.8)

^p-value compares intervention and comparison; two sample t-test used to compare means; chi-square test used to compare proportions
*p<0.05

Table 2. Absolute difference-in-differences for women living >10km away and delivering at a health facility, attending postnatal care (PNC) visit at 6 days postpartum, and referred to comprehensive emergency obstetric and neonatal care (CEmONC) facility.

	Intervention Sites			Comparison Sites			Absolute Difference-in-Differences^	
	Baseline N=1570	**Study Period N=10463**	**Study period – Baseline**	**Baseline N=1162**	**Study Period N=8081**	**Study period – Baseline**	**DID**	**p-value**
Women who delivered at a health facility, N(%)	440 (28.3%)	3185 (31.0%)	2.7%	291 (25.1%)	1900 (23.6%)	-1.5%	4.2%	0.03*
Average PNC visit rate at 6 days postpartum	66.3%	72.5%	6.2%	79.9%	78.2%	-1.7%	8.0%	0.07
Average referral rate to CEmONC facility	6.7%	9.5%	2.8%	6.5%	8.4%	1.9%	0.9%	0.29

^The absolute difference in differences compares facilities with the core Maternity Waiting Home (MWH) Model to Comparison Sites
*$p<0.05$

Table 3. Absolute difference-in-differences between intervention and comparison sites for women who live >10km, N(%).

	Intervention Sites			Comparison Sites			Absolute Difference-in-Differences^	
	Baseline	**Study Period**	**Study period – Baseline**	**Baseline**	**Study Period**	**Study period – Baseline**	**DID**	**p-value**
Adolescent Women, <18 years old (N=2152)	43 (23.8)	342 (32.1)	8.3%	34 (33.0)	182 (23.2)	-9.8%	18.1%	0.002*
Primigravida (N=5078)	104 (24.9)	760 (31.0)	6.1%	75 (27.2)	456 (24.0)	-3.2%	9.3%	0.01*
Grand Multipara (N=1611)	45 (32.4)	259 (32.5)	0.1%	23 (26.4)	115 (20.1)	-6.3%	6.4%	0.27

^The absolute difference in differences compares facilities with the MWH Core Model to Comparison Sites
*p<0.05

Table 4. Length of maternity waiting home (MWH) stay by type and distance.

	MWH Length of Stay	Distance (km)			
	Mean (SD)	**Mean (SD)**	**<5km**	**5-10km**	**>10km**
Overall (N=6622)	13.2 (18.3)	8.3 (11.3)	1630 (28.8%)	1852 (32.7%)	2186 (38.6%)
By reason					
Antenatal Care (N=27)	10.9 (13.8)	7.1 (6.5)	10 (43.5%)	4 (17.4%)	9 (39.1%)
Awaiting Delivery (N=5627)	15.2 (17.7)	8.5 (12.0)	1333 (27.7%)	1613 (33.5%)	1867 (38.8%)
Postnatal Care (N=949)	2.5 (13.0)	7.4 (6.1)	281 (34.4%)	229 (28.1%)	306 (37.5%)