The Cost and Cost-Effectiveness of Vitamin A Supplementation: An Assessment of a Vitamin A Days-Plus Event in Burkina Faso

Stephen A. Vosti[1, 2], Mira Korb[1], Melissa Baker[3], Rolf Klemm[4], Romance Dissieka[3], David Doledec[3], Regina Khassanova[3]

[1] Department of Agricultural and Resource Economics, UC Davis, Davis, California, USA

[2] Institute for Global Nutrition, UC Davis, Davis, California, USA

[3] Helen Keller International, Nairobi, Kenya

[4] Helen Keller International, New York, New York, USA

Corresponding author: Stephen A. Vosti, 660 Deer Park Road, St. Helena, CA 94574, USA savosti@ucdavis.edu, Phone: 530-752-097, Fax: 530-752-5614

Short title: The Cost and Cost-effectiveness of a Hybrid Platform for Vitamin A Supplementation in Burkina Faso

Declarations:

Funding The work was supported by GiveWell via a donation to Helen Keller International.

Conflicts of Interest All authors declare no conflict of interest.

Ethical Standards Disclosure This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Comité d'éthique de la Recherche en Santé, Burkina Faso. Verbal informed consent was obtained from all subjects/patients. Verbal consent was witnessed and formally recorded in a tablet application for data collection.

Consent to Participate The objectives and methods of the study were explained to all interviewees, who were given an opportunity to consent to be interviewed and also were informed that they could curtail interviews at any time.

Consent for Publication N/A

Availability of Data and Material N/A

Code Availability N/A

Authors' Contributions SAV, RD, DD and RK conceptualized the study. SAV, MK, MB, DD, RD and RK developed data collection strategies. MB, RD, DD and RK oversaw field data collection. MK prepared the data and performed all the statistical analyses. SAV and MK developed a first draft of the paper. MB, DD, RK, and RK reviewed and edited the first draft. All authors reviewed the final draft.

Acknowledgements We acknowledge the contributions to this study made by the Ministère de la Santé et de L'hygiène Publique, Burkina Faso, and by UNICEF, Burkina Faso. We also acknowledge the very substantial contributions of the Directorate of the Society for Studies and Research in Public Health (SERSAP) that undertook much of the field-based data collection, and especially the survey teams (supervisors, surveyors, guides and drivers) for the time and effort they dedicated, sometimes under challenging circumstances. We are grateful to the chief medical officers, nurses, and staff members of the Yako and Kombissiri health districts for their support for this project. Finally, sincere thanks go to the individuals who provided data used in this analysis, including but not limited to, mothers and caregivers, health workers, community-based health workers and community distributors.

Abstract

Objectives This study examines coverage, costs, cost-effectiveness, and cost burdens of a hybrid vitamin A supplementation (VAS) event in Burkina Faso.

Methods The study focuses on the Yako and Kombissiri health districts in central Burkina Faso. Data were collected from randomly chosen populations within two health districts. Post-event coverage surveys measured impact; spatially scaled primary data provided estimates of costs. Costs of caregiver participation were measured. We include data provided by and on all the national, regional, district, and local actors involved in the design and implementation of the VAS event.

Results Overall, ~103k children (88% of the target age group) were covered. Coverage did not differ across health districts but was lower in urban areas. Children 6-11 months of age had lower coverage, especially in urban areas. The VAS event cost ~137k USD. National costs, with international support, covered VA capsules and community health worker salaries. Community stakeholders incurred administrative and transportation/communication costs; regional and district-level stakeholders made minimal contributions. Caregivers in rural areas contributed significant amounts of time (~20% of total program costs). The average total cost per child reached was 1.34 USD, ranging from 1.19 USD to 1.62 USD.

Conclusions for Practice Campaign-based Vitamin A supplementation (VAS) programs persist but are expensive and reliant on international assistance, and hence are unsustainable. The study revealed differences in coverage, costs, and cost-effectiveness within and across districts, signaling potential efficiency gains from tailored approaches in Burkina Faso. Changing funding opportunities and trends in VA-attributable deaths support the need for tailored interventions.

Significance

Micronutrient deficiencies, particularly vitamin A (VA) deficiency, are significant public health concerns globally. Alternative strategies for increasing VA intake, such as dietary changes and food fortification, face challenges in low- and middle-income countries. The World Health Organization has recommended twice-annual VA supplementation (VAS) through campaign-based delivery platforms, but high costs and the dependence on international funding have led to the phasing out of VAS campaigns in many countries. Organizations are exploring ways to integrate VAS with existing healthcare delivery service platforms, but little is known about the effectiveness or cost-effectiveness of these alternatives. This paper reports on a study that measured the impacts, costs, and cost-effectiveness of a recently implemented hybrid VAS delivery system in Burkina Faso that combined health facility-based VAS and periodic VAS events. The hybrid program was expensive to design and implement, and the effectiveness and cost-effectiveness varied across districts and across rural-urban populations. In terms of cost-effectiveness, for the overall sample, cost per child reached was 1.34 USD, and ranged from 1.45 USD in rural Kombissiri to 0.93 USD in urban Kombissiri. Options for improving cost-effectiveness are discussed.

Keywords: Vitamin A supplementation, hybrid platform, costs, cost-effectiveness, Burkina Faso

Introduction:

Micronutrient deficiencies, particularly vitamin A (VA) deficiency, are significant public health concerns globally, with implications for early-childhood mortality (Stevens et al. 2022, Laillou et al 2021). Although various strategies, such as dietary changes, food fortification, biofortification can address inadequate VA intake, they all face challenges, especially in low- and middle-income countries (Caswell et al. 2018, Mannar and Hurrell 2018, Pachon 2018, Bouis 2018, Heidkamp et al. 2021). For instance, improvements in diet patterns can be difficult for income-constrained families, and large-scale food fortification programs may have limited and inequitable reach, and industries face compliance issues vis-à-vis established national fortification standards (Muhammad et al 2017, Mkambula et al 2020). Biofortification and agronomic biofortification may have potentially large and equitable reach, but producer and consumer adoption issues can constrain uptake (Bhardwaj et al. 2022). Additionally, the amounts of VA that these programs deliver is limited by fortification standards and plant biology (biofortification and agronomic biofortification), and by the small portions of foods consumed by young children, hence, even programs with large and equitable reach may not deliver amounts sufficient to achieve dietary adequacy (Engle-Stone et al. 2017). Finally, while these alternative programs, individually or combinations, have the potential to reduce inadequate intake of VA in at-risk populations, aside from the challenges noted above, all of these programs take time to design and implement, in some cases many years, e.g., biofortification programs (Bouis 2018, Vosti et al. 2019, Vosti et al. 2022)

As policymakers consider various programs to address inadequate VA intake and child mortality, the World Health Organization, with operational guidance from the Global Alliance for Vitamin A, have recommended twice-annual VA supplementation (VAS) through campaign-based delivery platforms (WHO 2011, GAVA 2017, Imdad et al. 2017). However, the high costs and the dependence on international funding have led to the phasing out of VAS campaigns in many countries. To make VAS programs more cost-effective, organizations are exploring ways to integrate them with existing healthcare delivery service platforms and identify cost-sharing options among local, national, and international stakeholders. In Burkina Faso, the Ministry of Health (MoH) has experimented with a hybrid system called Vitamin A Days-Plus (JVA+)[1] which combines health facility-based VAS and periodic VAS events aimed at children less likely to be covered by health facilities.

This paper reports on a study of a recent JVA+ event in Burkina Faso that measured the impacts, costs, and cost-effectiveness of the VAS event, and uses these results to identify options for reducing and possibly shifting the burden of JVA+ costs without compromising VAS coverage[2].

[1] While the primary objective of the JVA+ events was to administer VAS capsules to young children, other products (e.g., Albendazole) and services (e.g., information on nutrition, etc.) were also provided. Our data and cost analyses focused on activities specifically related to VAS. That said, small portions of (e.g.) planning and management time might have been dedicated to activities unrelated to VAS; we do not adjust for these costs in our analysis.

[2] We use the term 'coverage' to identify the number of young children, or the percentage of that population, who received a VA capsule during a given VAS campaign period, regardless of whether or not those covered were VA deficient or had inadequate dietary intake of VA.

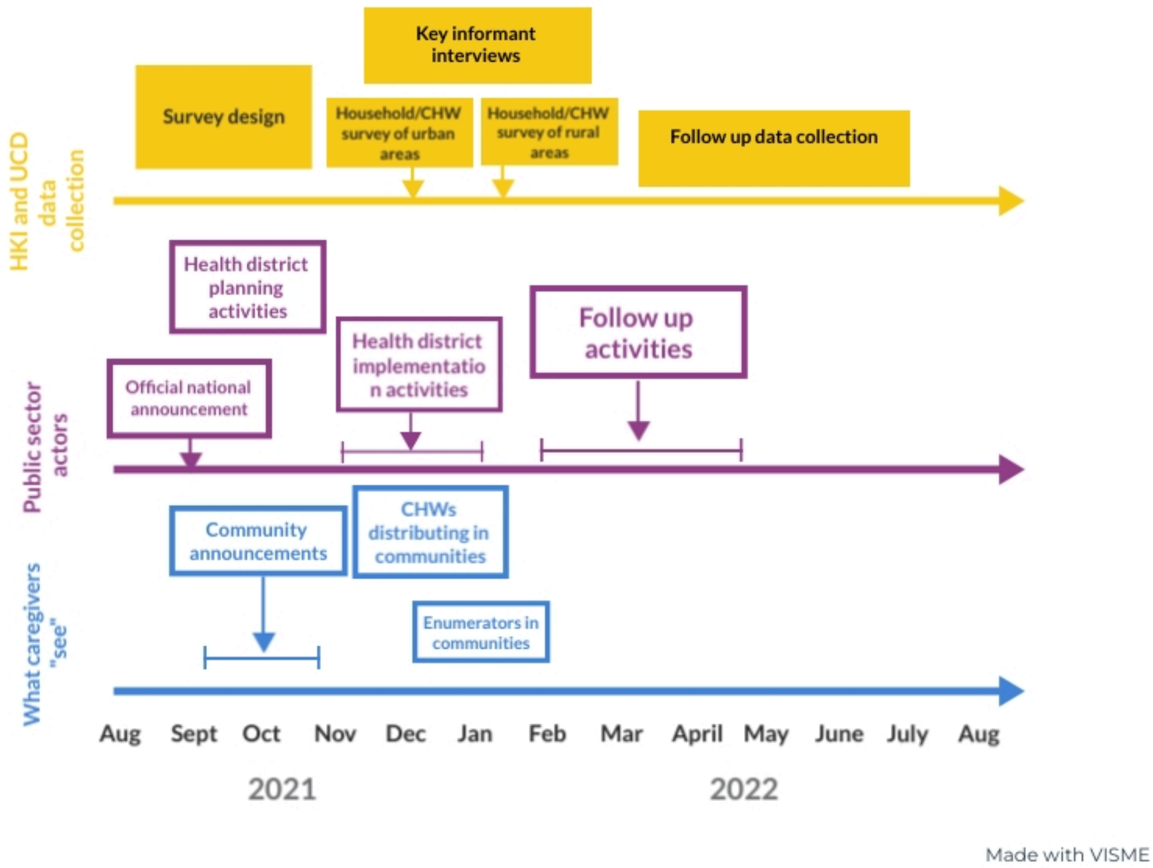
Methods

Overview

To estimate the cost-effectiveness of the JVA+ event, which took place from December 2021 to January 2022, three types of data were needed: VAS coverage, the budgetary costs of the JVA+ event (regardless of who paid them), and the opportunity costs of unpaid participants in VAS distribution and the unpaid caregivers of VAS recipients. The study focused on two health districts, Yako and Kombissiri, out of the 70 in Burkina Faso where the event was held. These districts were chosen based on accessibility and security for data collection teams, as well as existing collaborations with key health actors and authorities.

Figure 1 (top row) shows the planning and data collection activities associated with the JVA+ event. Post-event coverage surveys (PECS) were conducted immediately after the event to gather information on whether targeted children received VAS (coverage) and the opportunity costs of caregivers. To obtain data on the budgetary costs of JVA+, surveys were administered among community health workers in rural areas and community distributers in urban areas, and semi-structured key informant interviews were conducted among primary actors involved in the JVA+ event. Although the JVA+ event took place in 70 health districts of the country, the budgetary costs and PECS data were only collected for two health districts, Yako and Kombissiri, that were the focus of this study. These health districts were purposively selected based on accessibility by and security of data collection teams, and the ability to leverage existing collaborations between key health actors, organizations, and the health district authorities. Public-sector activities associated with the JVA+ event are presented in the middle row of Figure 1. The final row shows what the caregivers and other participants witnessed during the event, including VAS distribution by community health workers (CHWs) and the collection of PEC and other data by field enumerators.

Figure 1: Temporal Flows of Information and Research Activities

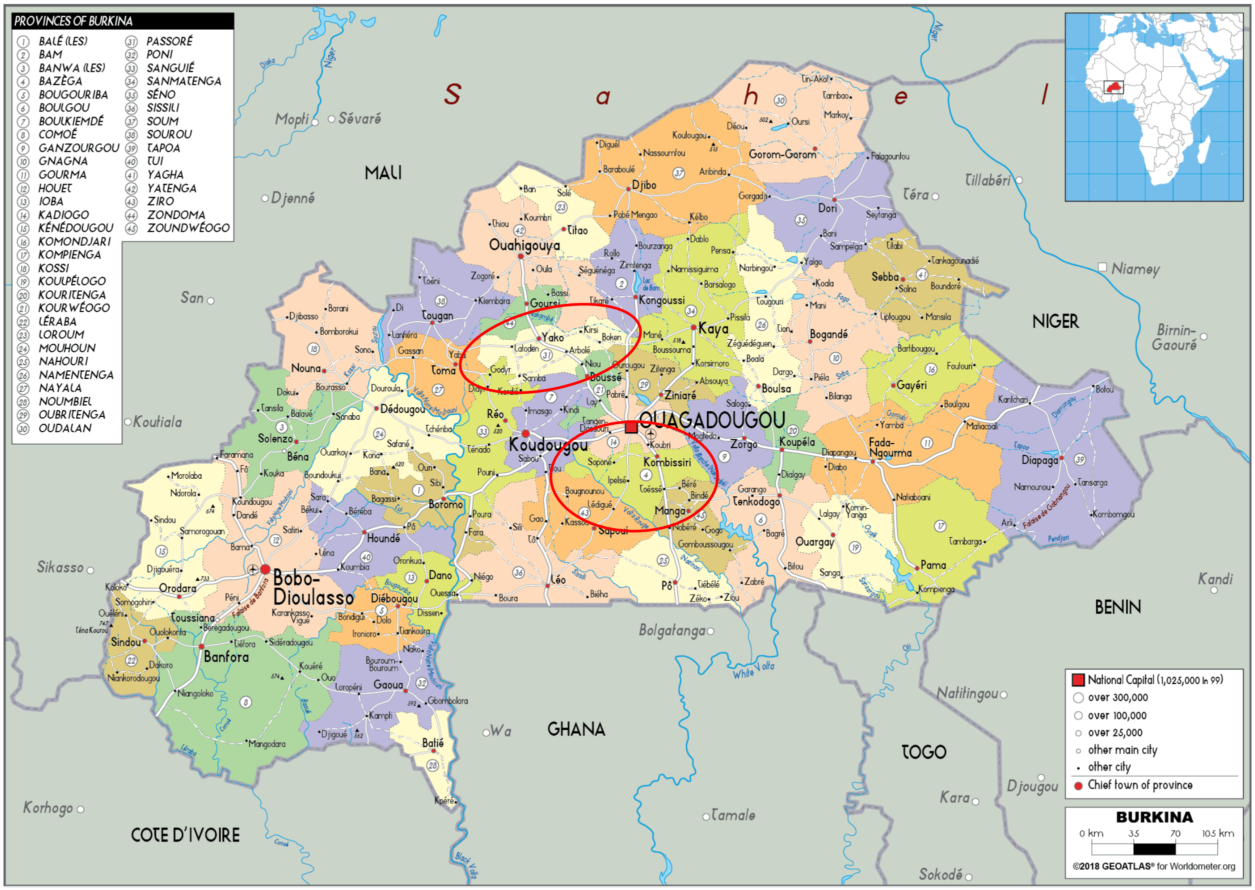


Sampling

The post-event coverage surveys (PECS) used a two-stage, stratified cluster random sampling methodology to select sampled households within selected geographic areas following the 2018 World Health Organization protocol for vaccination coverage (WHO 2018). The primary sampling unit (PSU) was enumeration areas, as defined by the Burkina Faso National Institute of Statistics and Demography, and households were the secondary sampling unit (SSU). The sample was stratified by the two purposively selected health districts, Yako and Kombissiri (as shown in Figure 2), and a probability-proportional-to-size (PPS) method was used to ensure equal chances of sampling for each enumeration area based on its population size. The sample was also implicitly stratified by rural and urban areas to ensure that the ratio of urban-to-rural respondents in the survey matched the ratio of urban-to-rural respondents in each stratum.[3]

[3] In this context, this meant that in each health district 26.3% of enumeration areas sampled were urban and 73.7% were rural.

Figure 2: Map of Burkina Faso, with Yako and Kombissiri Districts Identified



We implemented the two-stage cluster sampling method first, by randomly selecting 77 enumeration areas from each of the two health districts, Yako and Kombissiri, which were classified as either rural or urban areas (Figures 3-6) (Traore et al. 2022). Then, enumerators conducted censuses to identify eligible households in each selected enumeration area. Eligibility was based on whether the household had at least one child between the ages of 6 to 59 months[4]. Finally, we randomly selected 11 households from the set of eligible households in each enumeration area. In total, the survey included 1,696 households across two health districts: 845 in Yako and 851 in Kombissiri. Of these 845 households in Yako, 219 were in urban areas and 626 were in rural areas. Of the 851 households in Kombissiri, 222 were in urban areas and 629 were in rural areas.

[4] In households with multiple children in the target age range, all received VAS.

Figure 3: Yako Health District and Rural Enumeration Areas

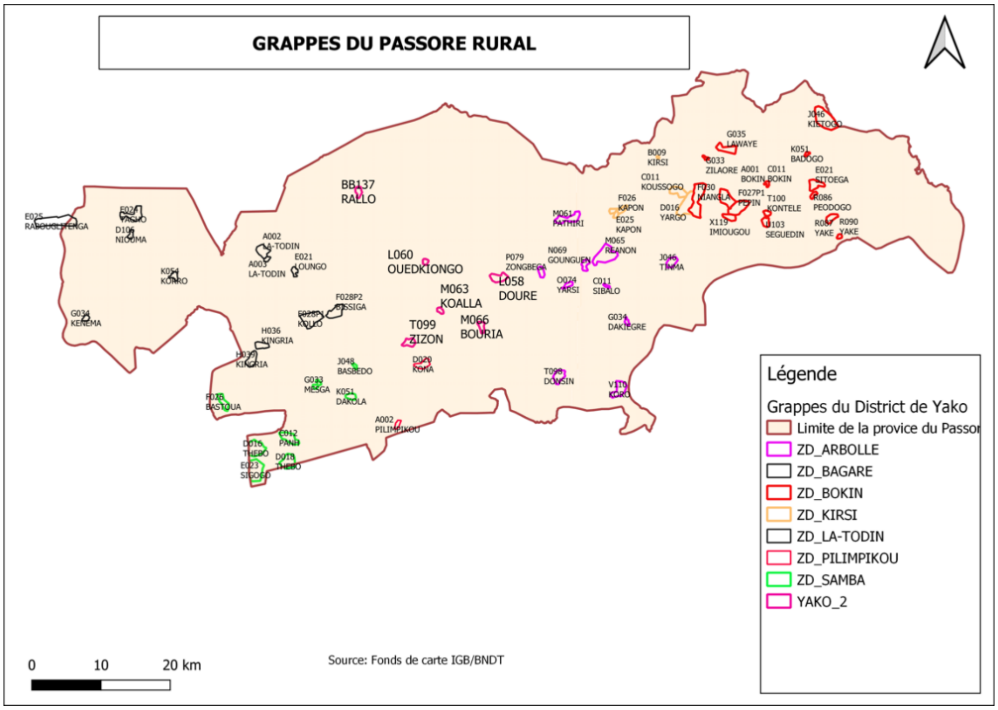
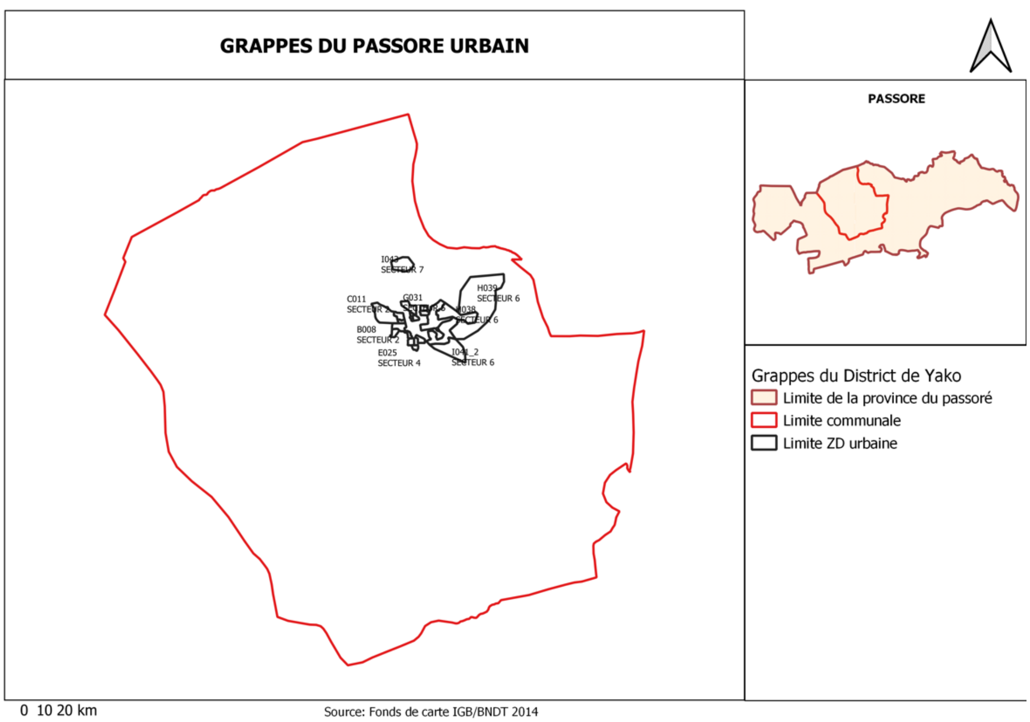


Figure 4: Yako District and Urban Enumeration Areas



The figures above depict the sampling framework used for Yako and Kombissiri health districts. Figure 3 shows the boundary of the Yako health district, and the clusters used for household selection in rural areas, while Figure 4 shows the urban area of the Yako health district and the clusters used for household selection in urban areas.

Similarly, Figure 5 and Figure 6 show the rural and urban areas of the Kombissiri health district, respectively, and the clusters used for household selection in each area.

Figure 5: Kombissiri Health District and Rural Enumeration Areas

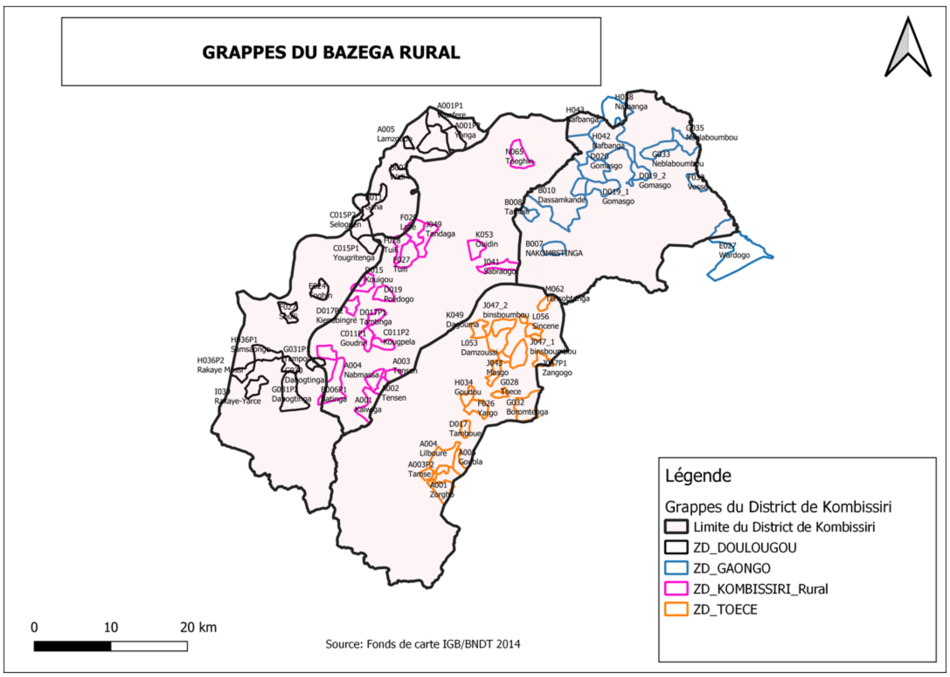
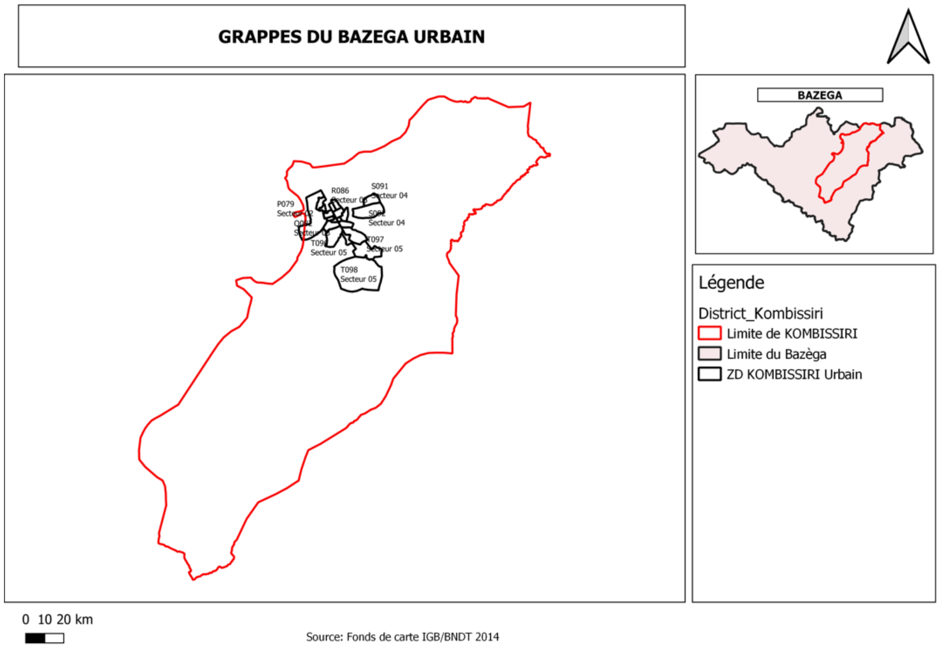


Figure 6: Kombissiri Health District and Urban Enumeration Areas



For the community health worker (CHW) survey, once enumeration areas were chosen using the procedure above, rural health clinics (CSPS) that served the chosen enumeration areas were selected to be sampled. From each CSPS, 1-2 CHWs were randomly selected from a complete list of CHWs to be surveyed. For key informant interviews, purposive sampling techniques identified individuals with direct involvement in the JVA+. To minimize recall bias, all data collection activities began at the end of January 2022, immediately following the conclusion of JVA+.

VAS Coverage

In this study, VAS coverage refers to the proportion of children 6–59 months of age who received VAS during the JVA+ event conducted from December 2021–January 2022, out of all targeted children 6–59 months of aged in the Yako and Kombissiri health districts. Structured household surveys were conducted among a representative sample of caregivers of the targeted children. The enumerators showed samples (or pictures) of both dosages of vitamin A capsules (100,000 and 200,000 International Units, with the former administered to children aged 6-11 months) to the caregivers and asked if each child recorded in the household register had received either type of capsule during the most recent JVA+, regardless of *where* the child received it.[5]

[5] Capsules could have been received in the home, at a clinic, or at pre-identified meeting points for VAS distribution.

VAS Program Costs

Costs associated with the JVA+ event were incurred at the national, regional, district and local levels. We collected data on all costs related to the planning, management of the JVA+ event and the final administration of VAS using (a) structured surveys administered to caregivers, community distributers (CD, urban areas) and community health workers (CHW, rural areas), and (b) structured key informant interviews with health facility staff at CSPSs, health management teams at the health district and regional levels, as well as staff from Helen Keller International and UNICEF who planned for, partially financed, and oversaw VAS activities at the national level.

The caregiver surveys collected information on the time that caregivers spent waiting for their child/children to receive VAS. This included the time spent waiting for the CHW to arrive at their house, and the time spent waiting for the CHW to complete the VAS administration once they had arrived. Fewer than 1% of caregivers reported taking their child to receive VAS at a location away from the homes (e.g., school, neighbor's house), however, to account for these additional costs, the surveys collected data on time spent and transportation costs associated with travelling to these locations. Since most caregivers did not report earning a wage, to value caregivers' time spent on VAS-related activities, essentially the opportunity cost of their time, we used the average wage earned by individuals with no formal education, as reported in the Enquête Régionale Intégrée sur l'Emploi et le Secteur Informel (2018).[6]

The CD/CHW surveys collected data on the time dedicated to, and on the out-of-pocket cash spent during, the JVA+ event. To estimate the financial costs borne by CDs/CHWs during JVA+, we multiplied the average expenditure on transportation and communication per health worker by the total number of health workers for each health district, separately for rural and urban areas. Expenditures on transportation were calculated as the sum of transportation costs paid by CDs/CWHs to travel to households to administer VAS, and to health facilities for JVA+-related activities. Transportation costs associated with attending planning and organizational meetings were reimbursed, and therefore were excluded from this sum. Expenditures on communication were given by the total cost of cellphone airtime for communications relating to JVA+, as reported by CDs/CHWs. We also collected data on the total number of working days dedicated by CDs/CHWs to the JVA+ event. CWHs working in rural areas were paid 20,000 CFA for the entire 4-week period VAS distribution; CDs working in urban areas were paid 3,000 CFA per day for the four-day period of urban VAS distribution. Based on these payment rates, we estimated the daily salaries of CDs/CHWs. Thus, for the purposes of cost accounting for CDs/CHWs, there are two relevant types of costs: (1) financial costs borne by CDs/CHWs through their *own* expenditures on transportation and communication during JVA+, and (2) salaries paid to CDs/CHWs for their involvement in the JVA+ event. All of these costs were included in estimating the total cost of the JVA+ event.

To collect data on the cost of supplies used to distribute VAS during JVA+, structured key informant interviews were conducted among staff from Helen Keller International and UNICEF, as well as regional and health district nutrition coordinators. Supplies included vitamin A capsules (100,000 IU and 200,000 IU), T-shirts, banners, masks, scissors, pens, posters, soap,

[6] Over 80% of caregivers surveyed had no formal education, although this number is driven by the large number of caregivers in rural areas, where almost 85% of caregivers have no formal education vs. 46% in urban areas.

and alcohol cleaning gel. In addition to data on the unit costs and the number of units purchased or acquired, we also collected information on the cost of storing and transporting supplies.

Operational costs associated with the JVA+ event were collected via structured key informant interviews with staff from Helen Keller International, and regional and health district nutrition officers, as well as nutritionists, head nurses, or administrators at each health facility included in the study. In these surveys, respondents were asked to identify all administrative personnel in their respective offices or facilities who were involved in the planning, management and implementation of the JVA+ event that took place from December 2021-January 2022. We requested lists of job titles[7], the number of personnel in each job, days spent working on JVA+, and the average hours per day spent working on JVA+. Information was also collected on overhead costs per month, including rent, warehouse payments, utilities, maintenance, water, and office supplies. Finally, these surveys collected data on vehicle insurance, maintenance, and rental rates for three vehicle types: bikes, motorbikes and cars/trucks. We inquired about the numbers of each vehicle, monthly and annual costs of maintenance and insurance, as well as the days or fractions of days that each vehicle type was used during the JVA+ event.

Finally, key informants were interviewed about the costs of meetings related to the planning and management of the JVA+ event. The interviews focused on three main types of activities: meetings, transportation, and social mobilization. First, data collection focused on the costs associated with hosting and attending meetings or trainings for the JVA+, including materials, meals, and snacks/tea/coffee. Any per diems or allowances associated with the meetings/trainings were included in the salary and allowance data described above. Second, data were collected on transportation costs associated with trips taken during JVA+ event. These transportation costs covered fuel expenditures, but not the vehicle rental, insurance, or maintenance costs described above. Third, respondents were asked about expenditures on social mobilization activities associated with JVA+, such as paying for posters or banners, TV or radio ads, public announcements via town criers, entertainers, distributing letters or pamphlets or making phone calls.

Cost-Effectiveness of the JVA+ Event

Cost-effectiveness was defined as the cost per child who received[8] VAS during the JVA+ event. Cost-effectiveness was estimated for each health district (Yako and Kombissiri) and for rural and urban areas. More specifically, cost-effectiveness for a given district and area type was calculated as the ratio of the total cost of the JVA+ event in that health district and area type to the number of children 6 - 59 months of age who received VAS in that health district and area type.

---

[7] Ranges of salaries for specific job titles/categories were obtained from the ministry of health salary + compensation grid; we used the upper bound of these job title/category-specific salary ranges in our cost calculations.

[8] JVA+ event planners aim to cover *all* children in the targeted age bracket (6-59 months of age), and purchase VA capsules, etc. with that goal in mind. However, VAS coverage is never 100%, so the cost/child targeted will be lower than the cost/child reached.

Coverage

VAS coverage rates (the denominator of the cost-effectiveness measure) by health district and area type were estimated by multiplying the proportion of surveyed children 6 - 59 months of age that received VAS by the total number of children 6 - 59 months of age in each health district and area type. More specifically, let *d* represent the index for the health district (either Kombissiri or Yako) and a index the area type (either rural or urban). If we define P_{da} as the proportion of surveyed children 6 to 59 months of age that received VAS and N_{da} as the total number of children 6 to59 months of age in health district, then the VAS coverage for health district *d* and area a is given by $Coverage_{da} = P_{da} \times N_{da}$.

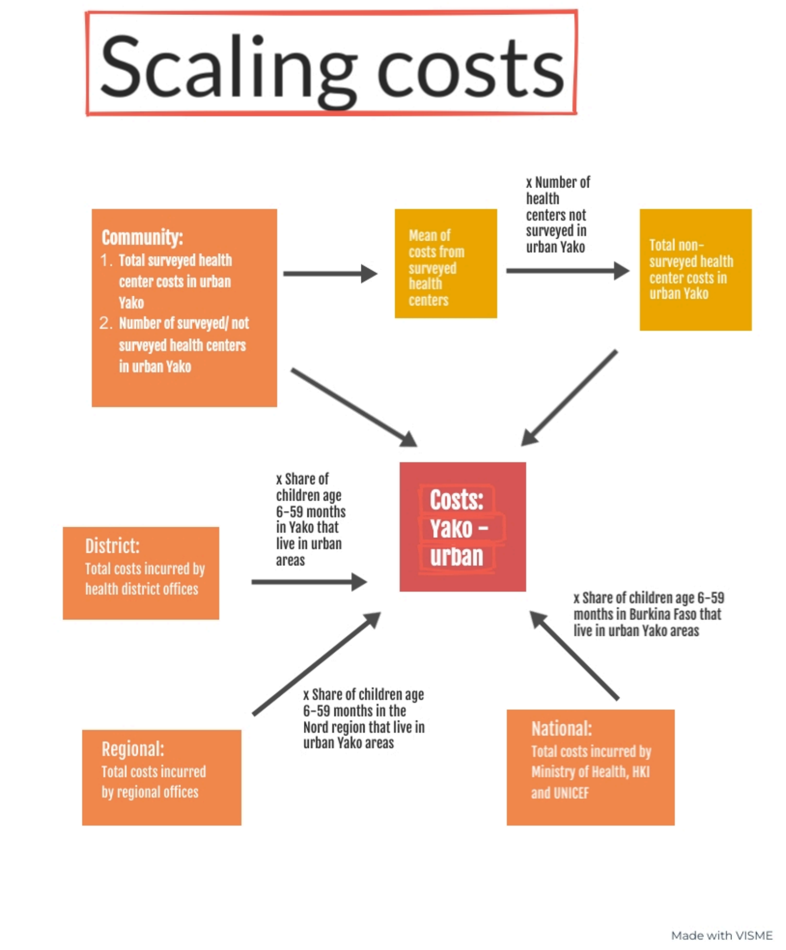
Spatial and Temporal Scaling of JVA+ Event Costs

Some JVA+ event costs were incurred and collected at the health district level, but other costs were incurred and collected at the national, regional, or CSPS levels. Therefore, obtaining estimates of the total costs of the JVA+ event by health district and by area type (the numerator of the cost-effectiveness measure) required additional assumptions regarding the spatial allocation of costs. To do so, a set of scaling factors were developed and applied to adjust costs to the appropriate health district and area type spatial units. To estimate health district and area type costs from *national or regional costs*, we scaled costs *down* by the number of children 6 - 59 months of age in a given health district and area as a fraction of the total number of children 6 to 59 months of age in Burkina Faso (for national costs) or in the relevant region (Nord region for Yako health district, Centre Sud region for Kombissiri health district). To estimate costs for area type from health district-level costs, we scaled costs *down* by the number of children 6-59 months of age living in a particular area type (rural or urban) in a given health district as a fraction of the total number of children 6-59 months of age living in that health district.

To estimate health district and area type costs from data collected from the *subset* of health facilities, we first calculated the average cost per surveyed health facility, by health district and by area type. We then estimated the costs for health facilities within a given health district that were *not* surveyed by multiplying the average cost per surveyed health facility by the number of *non*-surveyed health facilities, for each health district and area type. Summing the actual costs across surveyed health facilities and the estimated costs across non-surveyed health facilities yielded total costs, by health district and area type.

For the case of urban areas in the Yako district, Figure 7 summarizes the methods used to downscale and upscale costs so that estimates could be reported at the health district level, for rural and urban areas.

Figure 7: Scaling Factors to Address Spatial Differences in Data Sources



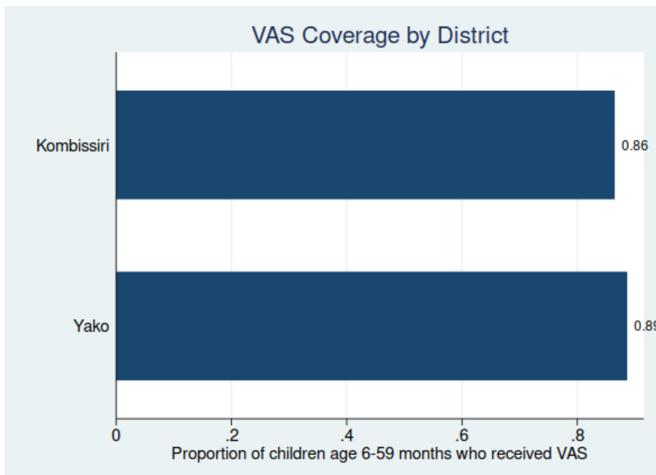
Finally, there were also temporal differences in the reporting of costs associated with the JVA+ event. Most of the data on costs were based on the number of hours, days or other time units of participants in the JVA+ event. For example, data were gathered on the number of hours and days participants spent on JVA+ event. For instance, the data collected included the number of hours and days participants worked on JVA+, the number of days that vehicles were used for JVA+ activities, and the number of hours that caregivers spent waiting for health workers. We scaled this information to report costs that were appropriate to the JVA+ event timeframe. Data on administrative expenses, such as rent and utilities, were collected on monthly and annual timesteps. In these cases, we made a simplifying assumption that one month of administrative expenses, excluding salary and allowance costs of administrative personnel (which were included in other cost categories), were associated with the JVA+ event.

Results

VAS Coverage

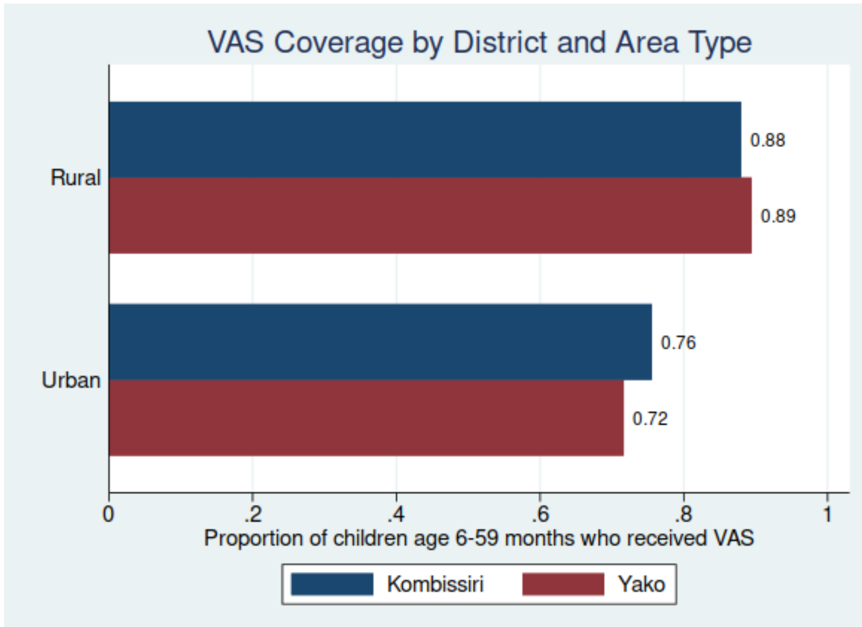
The vast majority of children 6 - 59 months of age in the health districts of Kombissiri (86.8% [CI 84.6%, 88.7%] and Yako (88.6% [CI 86.5%, 90.4%]) received VAS during JVA+ event that took place from December 2021-January 2022, Figure 8) (Ministry of Health 2022). Selected, more detailed results are reported in Table 1 of the Technical Appendix.

Figure 8: VAS coverage, Kombissiri and Yako Health Districts



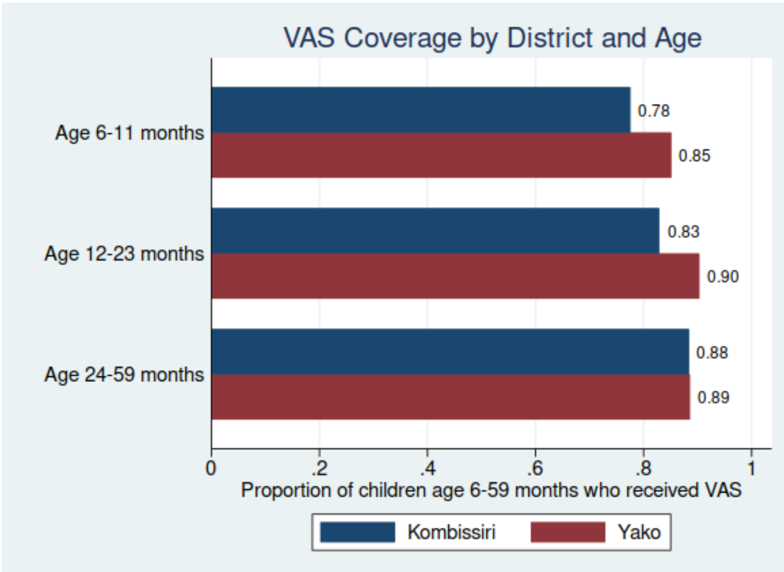
However, these health district-level measures mask heterogeneity in coverage in rural versus urban areas. Overall, coverage was higher in rural areas (89.2% [CI 87.5%, 90.6%]) than in urban areas (73.5% [CI 69.5%, 77.1%]) in both health districts. Coverage of rural areas was higher in Yako (89%) than in Kombissiri (88%), whereas coverage of urban areas was lower in Yako (72%) than in Kombissiri (76%) (Figure 9). Nevertheless, coverage was lower in urban areas than in rural areas in both health districts.

Figure 9: VAS coverage, Kombissiri and Yako Health Districts, by rural and urban areas



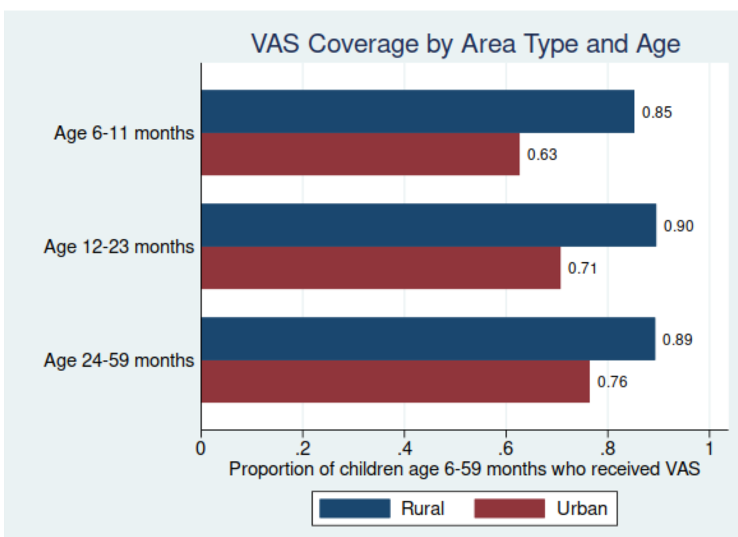
The impact of the JVA+ event also varied across different age groups within the 6-59-month target age range. In both health districts, VAS coverage was lowest for the youngest children 6-11 months of age (78-85%) and highest for the oldest children in the targeted group 24-59 months of age (88-90%) (Figure 10). Although there were some differences in coverage between the two health districts across all age groups, these differences tended to be small.

Figure 10: VAS coverage, Kombissiri and Yako Health Districts, by child age cohort



When comparing coverage between rural and urban areas (Figure 11), it was found that coverage was substantially lower in urban areas for all age groups. This difference in coverage between rural and urban areas ranges from a 12-percentage point difference for children 24-59 months of age to a 22-percentage point difference for children 6-59 months of age.

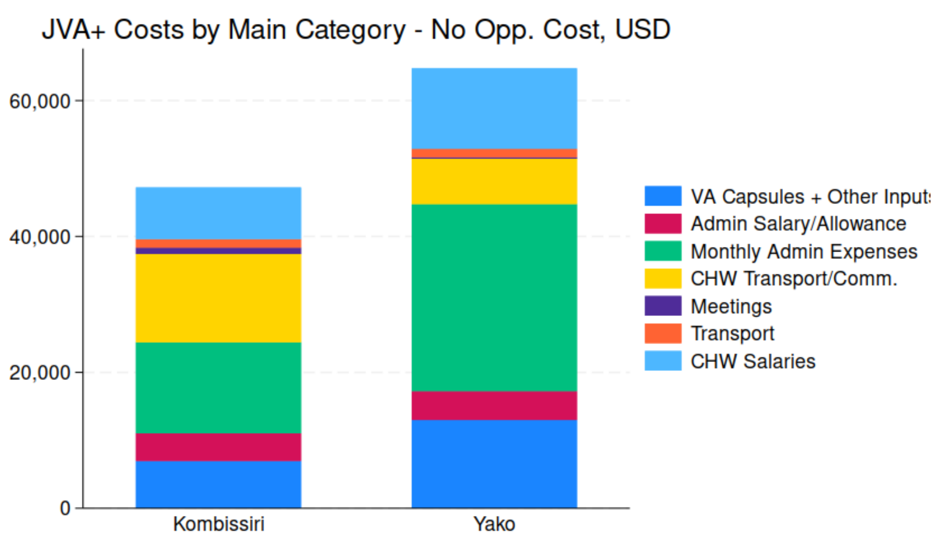
Figure 11: VAS coverage, by age cohort, and by urban and rural area



JVA+ Event Costs and Cost Drivers

The total cost of the JVA+ event was 64,919 USD for Yako and 47,600 USD for Kombissiri.[9] The composition of costs associated with the JVA+ event varied across different locations and activities. In our data collection and analysis, we grouped JVA+ expenditures into several cost categories:[10] VAS capsules and other supplies, administrative expenses (such as rent, utilities, vehicles), salaries and allowances of administrative personnel, financial costs borne by health workers (such as transportation/communication), meeting and training costs, social mobilization costs, personnel transportation costs (including fuel), and salaries of CDs/CHWs. Figure 12 presents the total costs and cost composition for each health district, and detailed cost estimates are available in Table 2 of the Technical Appendix. The composition of costs also differed between the two health districts, with higher monthly administrative expenses and VA capsule costs in Yako, and higher CHW transportation and communication costs in Kombissiri. Monthly administrative expenses accounted for approximately 20-40% of JVA+ costs in both districts, including expenditures on rent, storage, bills, building maintenance, office expenses and other administrative expenses including vehicle rental, maintenance and insurance for vehicles used during the JVA+ event. High vehicle-related expenses were a key driver of the total monthly administrative expenses, particularly vehicle rental costs, which accounted for a larger share of vehicle-related JVA+ expenses, compared to vehicle insurance and maintenance costs. Similar patterns emerged for bicycles and cars, but motorbikes were the most prominent contributors to costs, as they were used more frequently and for longer periods than other vehicle types.

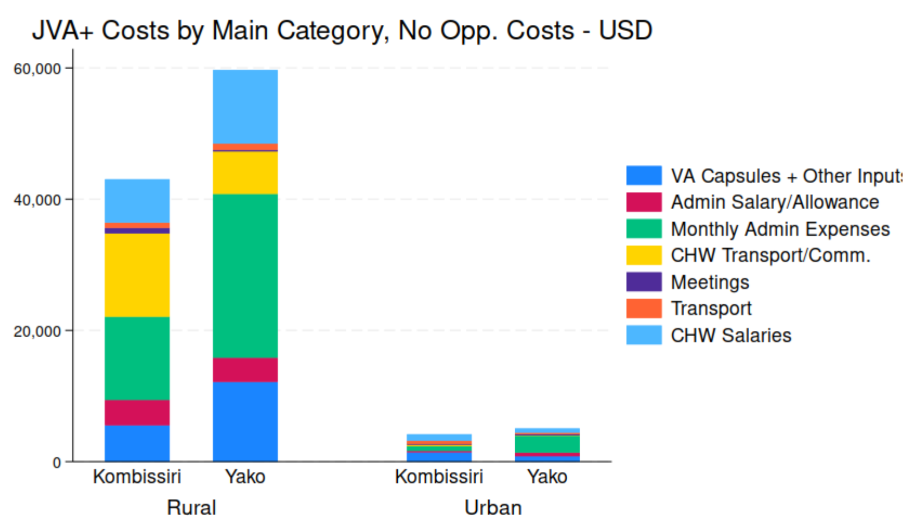
Figure 12: Total JVA+ program costs, by main cost categories, by Health District



[9] All costs and cost-effectiveness results are reported in 2022 USD; total JVA+ event costs reported here are net of the opportunity costs of caregivers' time.
[10] The selection of cost categories and the specific costs included in each of them were chosen, in part, to assist in the search for JVA+ event design and management changes that could enhance cost-effectiveness.

Total costs were substantially higher in rural areas (103,179 USD) than in urban areas (9,340 USD); this difference was mainly attributable to the location of the target population of children. When examining costs by rural and urban areas within districts (Figure 13), the cost composition becomes more diverse. Total costs across all categories were higher in rural areas than in urban areas, mainly due to the larger populations served in rural areas. In rural areas, monthly administrative expenses comprised the largest share of costs (~ 20-35%). However, in urban areas, monthly administrative expenses, while relatively small compared to those in rural areas, accounted for the largest share of costs only in Yako (40%) but only a minimal share in Kombissiri (10%). Across both health districts and area types, supply costs represented a significant share of the total costs, ranging from approximately 15% in urban Yako to 30% in urban Kombissiri. These supply costs were driven by the costs of purchasing VA capsules, which was directly linked to the size of the target child population. In all cases, except for rural Kombissiri, the financial costs borne by health workers (out-of-pocket expenses for transportation and cell phone communication) represented a relatively small share of total costs (5-10%). However, in rural Kombissiri, this share exceeded 20%. CD/CHW salaries accounted for a similar share across all health district areas, ranging from 15-20%. Interestingly, while transportation costs seemed almost negligible in rural areas, their share in urban areas is larger (5-10%).

Figure 13: Total JVA+ program costs, by main cost categories, by Health District, and by rural and urban area



When discussing policies related to the JVA+ event, the issue of the allocation of costs across stakeholder groups often arises. The costs are distributed across different levels, from the community to the national level, with various stakeholders being responsible for different expenses. Figure 14 provides an overview of the spatial distribution of JVA+ event costs, categorized by cost type. The results reveal two important findings. First, national and community stakeholders bore the majority of total JVA+ event costs. Costs incurred by district- and regional-level stakeholders were relatively modest. Secondly, as shown in Figure 15, the composition of cost covered by different stakeholders varied significantly. For instance, as expected, national stakeholders (with support from international agencies) were primarily responsible for VA capsule costs. On the other hand, communities were responsible for most of the monthly administrative expenses and CHW transportation/communication costs. The salaries of CHW, however, were the responsibility of national stakeholders (in the case of this JVA+ event, with support from the international community).

Figure 14: Total JVA+ program costs, by geographic areas and associated stakeholder groups

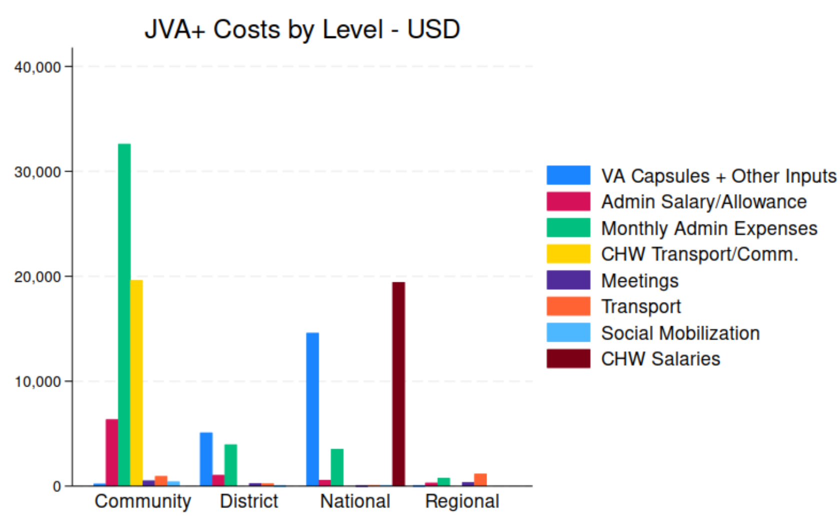
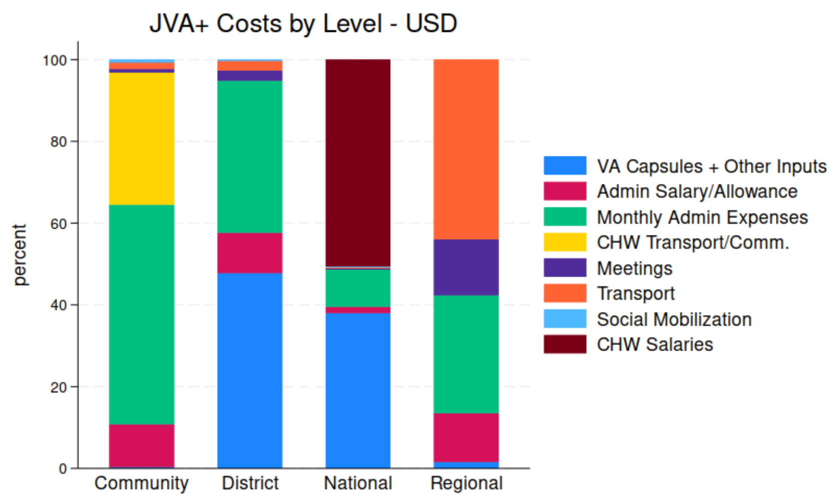


Figure 14: Percent of total JVA+ program costs, by geographic areas and associated stakeholder groups



In addition to stakeholders previously discussed, caregivers of the children who received VA capsules during the JVA+ events and individuals who participated in social mobilization events also incurred costs. [11] These groups are often forgotten stakeholder groups in policy discussions. The study collected data on the waiting and travel times of caregivers who left their homes to receive VAS and estimated the value of their time on the wage paid to workers without any formal education. Figure 15 provides an overview of the total opportunity costs borne by caregivers and total social mobilization costs for each health district. While Yako had higher caregiver opportunity costs, both health districts had substantial costs representing 15%) of total JVA+ costs in Yako and 25% in (as reported in Figure 12). In contrast, social mobilization costs were minimal in both health districts. Given the larger targeted populations in rural areas, caregivers in rural areas faced higher opportunity costs compared to those of urban areas (as shown in Figure 16).

[11] We use JVA+ social mobilization costs as a proxy for the costs faced by local populations.

Figure 15: Total caregiver opportunity costs and social mobilization costs, by health district

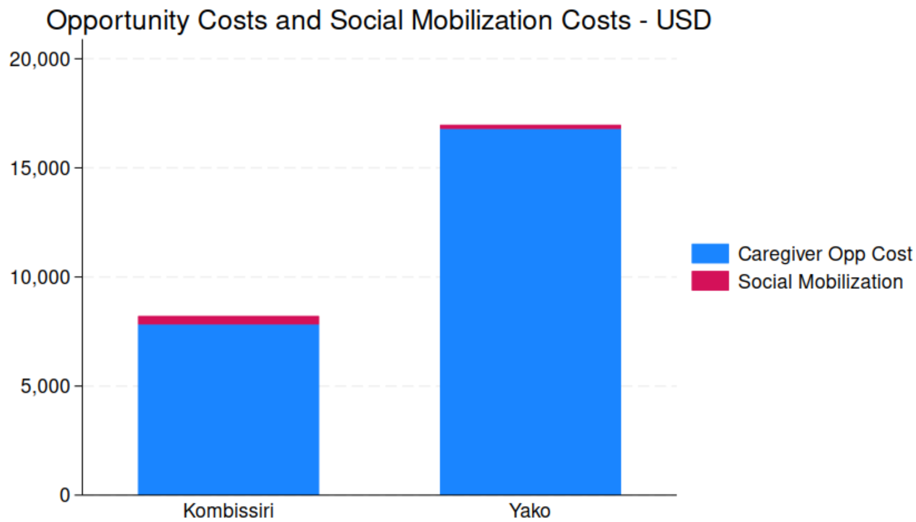


Figure 16: Total caregiver opportunity costs and social mobilization costs, by health district, by rural and urban areas

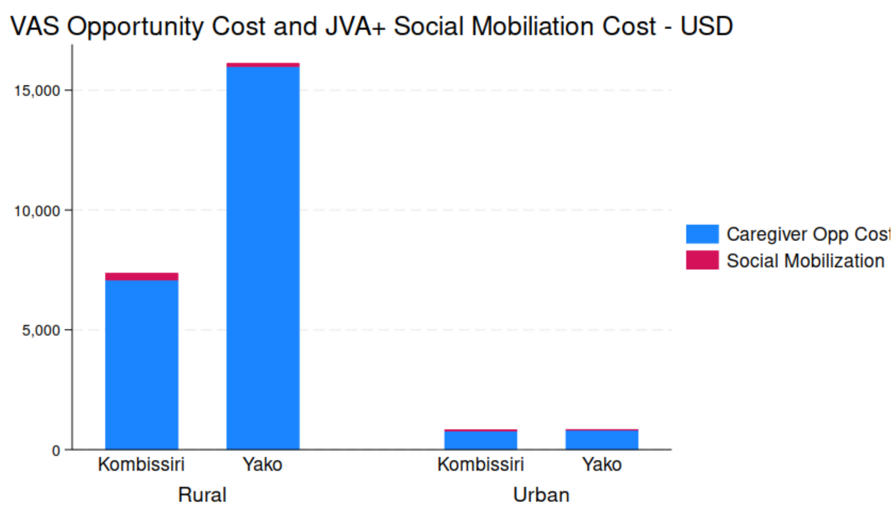
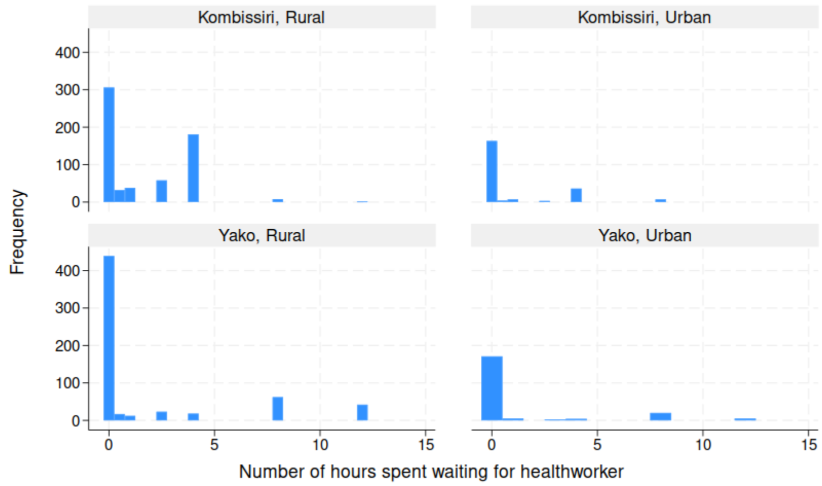


Figure 17 sheds light on the reason behind the higher caregiver opportunity costs in rural Yako. Although most caregivers in all locations had short waiting times for CHWs to administer VAS, a significant number of caregivers in rural areas had to wait for several hours, and in some cases, even longer for the arrival of CHWs. This was particularly prevalent in rural Yako.

Figure 17: Caregiver opportunity costs of time (hours), by Health District, by rural and urban area



Cost-Effectiveness of JVA+ Event

Lastly, we present the cost-effectiveness of the JVA+ event, with results by district and rural and urban areas. For a detailed summary, please refer to Table 3 in the Technical Appendix. Our measures of impact are the number of children targeted (the total population of children 6-59 months of age) or reached (the number of children who received the age-appropriate dose of VA provided by the supplementation capsules). These serve as the denominators of our cost-effectiveness ratios. The numerator is the total costs of the JVA+ event (excluding the opportunity costs of caregivers' time, in some of the figures below). Figure 18 shows that the average cost per child *targeted* ranged from 1.05 USD in Yako to 1.40 USD in Kombissiri. Figure 19 reports the cost per child reached, which are slightly higher in both districts due to incomplete coverage. When viewed from an urban versus rural area perspective and reporting cost per child reached, Figure 20 reveals that the higher cost-per-child-reached in Kombissiri is primarily driven by the cost of reaching children in rural areas (1.44 USD versus 1.05 USD). In contrast, the opposite is true for Yako, where it was more costly to reach urban children than those residing in rural areas (1.44 USD versus 0.92 USD).

Figure 18: Cost per child targeted, by Health District

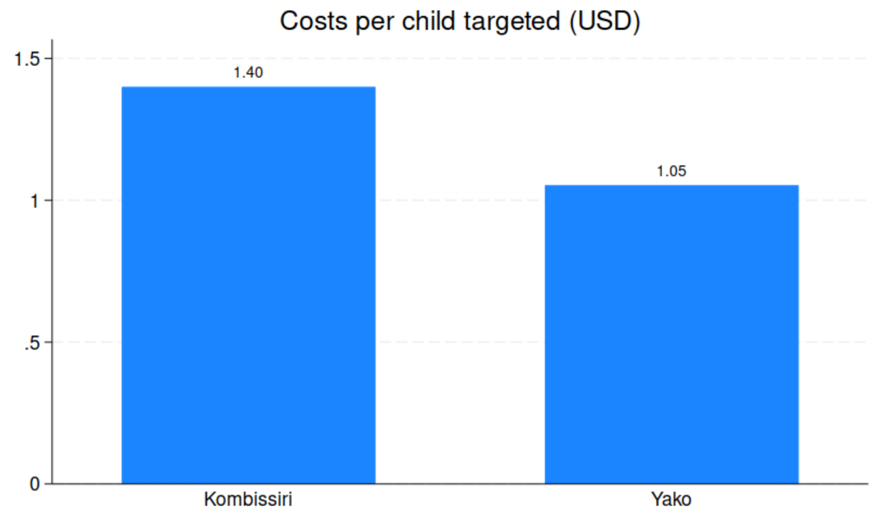


Figure 19: Cost per child reached, by Health District

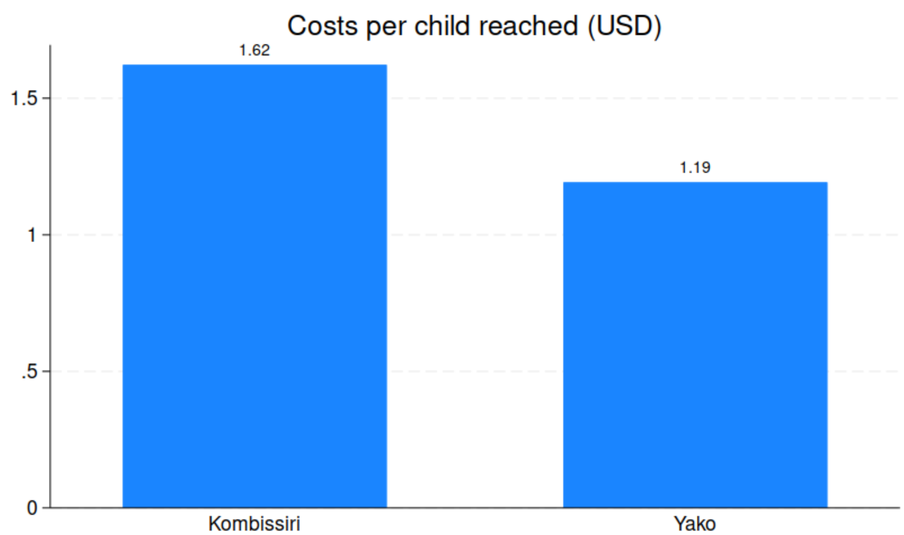
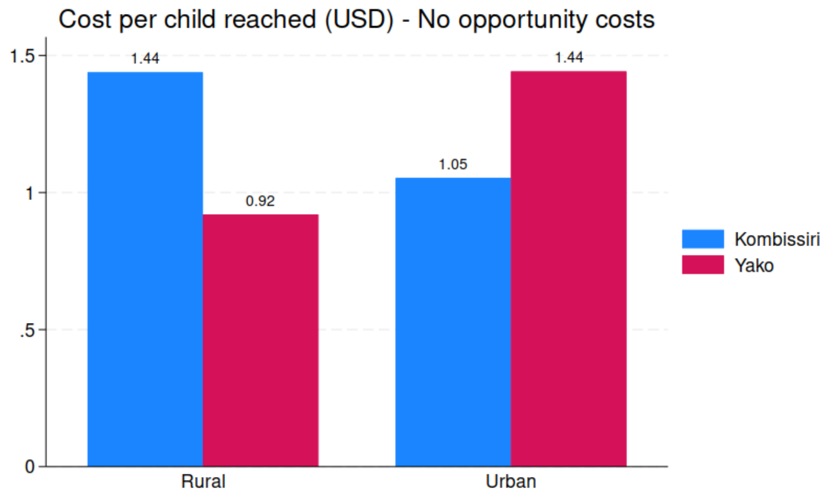


Figure 20: Cost per child reached, rural and urban areas, by Health District



Discussion

For some time now, the effectiveness (e.g., Horton et al. 2018), cost (e.g., Neidecker-Gonzales et al. 2007), and cost-effectiveness (e.g., Kannan et al. 2019) of VAS programs have been concerns, as has the international funding available to support such programs in LMICs (McLean et al. 2020). This study contributes to the evidence base on the cost and cost-effectiveness of hybrid VAS distribution platforms. More specifically, we assessed the effectiveness of the hybrid platform JVA+ event in two health districts in central Burkina Faso in 2021/2022. We measured the costs associated with the JVA+ event, identified the key cost drivers, and determined the stakeholder groups responsible for paying these costs. We estimated cost-effectiveness by linking program effects and costs, which is one measure of program efficiency. We identified differences across health districts (e.g., rural versus urban areas) and sought to understand why these differences might occur. Finally, we used this evidence to suggest ways to improve the effectiveness and cost-effectiveness of future JVA+ programs in Burkina Faso.

Regarding effectiveness, our findings indicate that the JVA+ event covered approximately 88% of children in the targeted age group of 6-59 months, which is at that level of WHO's target of 80% VAS coverage. Although coverage did not differ statistically across health districts (~87% in Kombissiri and ~89% in Yako), urban coverage was lower than rural coverage in both health districts (75% and 72% in Kombissiri and Yako, respectively). Additionally, coverage among those in the lowest target age group (6-11 months of age) was lower than the other age cohorts in both health districts, particularly in urban areas. Therefore, subgroups within the two health districts did not meet the WHO target of 80% coverage, mainly in urban areas and among very young children.

In terms of JVA+ program costs, including caregiver costs, our study found that total costs were highest in Yako (~82,000 USD) compared to Kombissiri (~55,000 USD). The size of the target child population was identified as the primary cost driver. The majority of costs were incurred in rural areas where most children in the target age group resided. The cost composition varied significantly across districts, with Yako spending proportionately more on monthly administrative expenses and relatively less on CHW transportation and communication expenses. These differences were also observed at the rural level. Program costs were allocated differently among stakeholders depending on the location. National costs (with international support) mainly covered VA capsules and CHW salaries. Community-level stakeholders were responsible for monthly administrative expenses and transportation/communications outlays, while regional and district-level stakeholders contributed minimally to the JVA+ event. Caregivers also contributed significantly to the program costs, mostly in terms of their time waiting for CHW to administer VA capsules or traveling to VAS sites. These costs were particularly high in rural areas. The value of caregiver time devoted to the JVA+ event amounted to approximately 20% of total program costs in one area, using the wage rate paid to workers with no formal education. Overall, the costs and cost burdens of the JVA+ event can help identify areas for improvement to enhance program efficiency and effectiveness.

In terms of cost-effectiveness, the cost per child reached varied across different areas within and across the two health districts studies. The cost per child reached ranged from 1.45 USD in rural Kombissiri to 0.93 USD in urban Kombissiri, with health-district-level averages of 1.62 USD and 1.19 USD for Kombissiri and Yako, respectively. The overall sample had a cost per child reached of 1.34 USD. Extrapolating this to the national coverage of 3.16 million children, the cost of a single JVA+ event in Burkina Faso would be approximately 4.2m USD, and the annual cost of twice-annual VAS would be approximately 8.3m USD (IPC 2022).

In terms of cost drivers, the size of child population was a major factor affecting JVA+ program costs. Larger populations required more time and effort, as well as more supplies, such as VA capsules. Additionally, transportation costs borne by CHWs were a significant driver of higher costs per child reached in Kombissiri. Free-form responses from CHW surveys confirmed that transportation costs were a substantial burden. However, the lower effectiveness of JVA+ events in urban areas in both health districts is more difficult to explain. Higher population densities in urban areas may have made it harder for CHWs to locate children in the target age group during the door-to-door event, but further research is needed to better understand this phenomenon. Overall, the study found notable differences in effectiveness, costs, and cost-effectiveness within and across health districts, highlighting the need for tailored approaches to improve the efficiency and effectiveness of future JVA+ programs in Burkina Faso. Trends in VA-attributable deaths and changing funding opportunities support the need for such tailoring (Stevens et al. 2015, McLean et al. 2020).

Finally, this study has several strengths and weaknesses in informing policy discussions around the design and implementation of JVA+ programs. One of the strengths is the importance of understanding the total costs of programs like JVA+ events, including who pays them and any unexpected contributions from stakeholders. Transparent knowledge of cost burdens is crucial for ensuring the sustainability of these programs. Caregiver contributions are often overlooked, but their fundamental role to program success should be acknowledged. The effectiveness of JVA+ events may be reduced if caregiver opportunity costs increase, but program design changes can help reduce these private costs.

However, some key policy questions associated with JVA+ event design and implementation cannot be easily addressed by cost studies. While we all seek to improve the cost-effectiveness of JVA+ events, it is not clear how to apply lessons from more cost-effective to less cost-effective areas. For instance, the circumstances faced in each health district can vary significantly, which can affect program activities and costs, making it challenging to identify cross-health-district lessons. Additionally, this study only offers limited insights into factors influencing productivity among CHWs during the JVA+ event.

Study Limitations

There are several limitations to this study. First, data were only collected on costs and coverage during the JVA+ event period, not for VAS provision through health clinic visits. Therefore, it is not possible to compare cost-effectiveness of campaign-based VAS delivery through JVA+ to clinic-based VAS provision. Future studies should include a framework for collecting data on clinic-based VAS provision.

Second, the two health districts chosen for this study were not randomly selected from all health districts in Burkina Faso. Instead, they were chosen based on accessibility, security and existing partnerships, which may have contributed to higher-performing JVA+ events. This raises concerns about external validity, making it challenging to extrapolate findings to other areas of the country. If understanding JVA+ cost-effectiveness on a national scale is an important research goal, future studies should adopt other sampling frameworks.

Third, estimates of JVA+ coverage for the youngest group of the target population (6-11 months of age) may have been underestimated since these children are still receiving vaccines provided at health clinics. Low-dose VA capsules are often administered during such visits and may not have been captured in our data.

Fourth, while descriptive comparisons of costs, effectiveness, and cost-effectiveness can be made between the two health districts, and other empirical results can be obtained, these results do not allow us to speak to the effects of providing *additional* funding for JVA+ events.

Fifth, the analysis does not deal with the issue of consuming VA above the recommended upper limit (UL), which may be a policy concern (Engle-Stone et al 2019).

Finally, our analysis depends on several assumptions used to scale costs to health districts and area types. Costs at the national and regional level were scaled *down* to the health district and area type, while costs at the health facility level were scaled *up* to account for unsampled health facilities. The population of children 6 to 59 months of age was used as the scaling *down* factor, and the number of CSPS clinics was used as the scaling *up* factor. Other scaling factors could be used.

Conclusions and Implications for Policy

It is important to know the total costs of programs such as JVA+ events and who is responsible for paying them. Unpaid costs can compromise program effectiveness and sustainability, making it crucial to have clarity regarding costs and cost burdens when designing and managing such programs. Tools and methods exist for generating estimates of costs and cost-effectiveness. In this study conducted in Burkina Faso, the JVA+ event was generally effective, but experienced some spatial and other variations in child coverage. Changes in program design and implementation could increase coverage, especially in urban areas and among very young children. However, the JVA+ program was expensive to design and implement. Data analyses suggested some pathways for reducing costs. Costs were not distributed uniformly across stakeholder groups, and failure to address these imbalances could undermine the fiscal viability and effectiveness of future JVA+ events. For example, alternative funding sources for CHW salaries and reducing time costs to caregivers could be explored to reduce and/or reallocate costs across stakeholders to help ensure sustainability of programs.

References

Bhardwaj, A. K., S. Chejara, K. Malik, R. Kumar, A. Kumar and R. K. Yadav. 2022. Agronomic Biofortification of Food Crops: An Emerging Opportunity for Global Food and Nutritional Security. *Frontiers in Plant Science* 13:1055278.

Bouis, H. E. 2018. Biofortification: An Agricultural Tool to Address Mineral and Vitamin Deficiencies. Chapter 7, in Mannar, M. G. V. and R. F. Hurrell, editors. Food Fortification in a Globalized World. Academic Press, Elsevier, Inc.

Caswell, B. L., S. A. Talegawkar, W. Siamusantu, K. P. West Jr. and A. Palmer. 2018. A 10-Food Group Dietary Diversity Score Outperforms a 7-Food Group Score in Characterizing Seasonal Variability and Micronutrient Adequacy in Rural Zambian Children. *Journal of Nutrition* 2018, Jan 1: 148(1):131-139.

Engle-Stone, R., A. Perkins, A. Clermont, N. Walker, M. J. Haskell, S. A. Vosti and K. H. Brown. 2017. Estimating Lives Saved by Achieving Dietary Micronutrient Adequacy, with Focus on Vitamin A Intervention Programs in Cameroon. *Journal of Nutrition*, Volume 147, Issue 11, 1 November 2017, Pages 2194S–2203S, https://doi.org/10.3945/jn.116.242271.

Engle-Stone, R., S. A. Vosti, H. Luo, J. Kagin, A. Tarini, K. P. Adams, C. French, and K. H. Brown. 2019. Weighing the Risks of High Intakes of Selected Micronutrients Compared with the Risks of Deficiencies. Special Issue: Risk of Excessive Intake of Vitamins and Minerals *Ann. N.Y. Acad. Sci*., 1446 (1), 81-101.

Enquête Régionale Intégrée sur l'Emploi et le Secteur Informel (2018).

Global Alliance for Vitamin A (GAVA). 2017. Monitoring of Vitamin A Supplementation: A Guide for National Programme Managers. Published by Micronutrient Initiative, 2017

Heidkamp, R. A., E. Piwoz, S. Gillespie, E. C. Keats, M. R. D'Alimonte, P. Menon, J. K. Das, A. Flory, J. W. Clift, M. T. Ruel, S. Vosti, J. K. Akuoku, and Z. A. Bhutta. 2021. Mobilising Evidence, Data, and Resources to Achieve Global Maternal and Child Undernutrition Targets and the Sustainable Development Goals: An Agenda for Action. Maternal and Child Undernutrition Progress 2. *The Lancet* Vol 397, April 10, 2021.

Horton, Susan, Lauren S Blum, Mamadou Diouf, Banda Ndiaye, Fatou Ndoye, Khadim Niang, and Alison Greig. 2018. Delivering Vitamin A Supplements to Children Aged 6–59 Months: Comparing Delivery through Campaigns and through Routine Health Services in Senegal. *Current Developments in Nutrition*, Volume 2, Issue 4, 2018, nzy006, ISSN 2475-2991, https://doi.org/10.1093/cdn/nzy006

Imdad A., Mayo-Wilson E., Herzer K and Bhutta Z. A. 2017. Vitamin A Supplementation for Preventing Morbidity and Mortality in Children from Six Months to Five Years of Age. *Cochrane Database of Systematic Reviews* 2017, Issue 3. Art. No.: CD008524. DOI:10.1002/14651858.CD008524.pub3.

IPC Acute Malnutrition Analysis: Nutrition Situation for 45 Provinces in Burkina Faso, 2021-2022, IPC Report Issued January 2022

Kannan A, Tsoi D, Xie Y, Horst C, Collins J, Flaxman A (2022) Cost-effectiveness of Vitamin A supplementation among children in three sub-Saharan African countries: An individual-based simulation model using estimates from Global Burden of Disease 2019. *PLoS ONE* 17(4)

Laillou A, Baye K, Zelalem M, Chitekwe S. 2021. Vitamin A Supplementation and Estimated Number of Averted Child Deaths in Ethiopia: 15 Years in Practice (2005-2019). *Matern Child Nutr.* 2021 Jul;17(3):e13132. doi: 10.1111/mcn.13132. Epub 2020 Dec 17. PMID: 33336556; PMCID: PMC8189216.

Mannar, M. G. V. and R. F. Hurrell, editors. 2018. Food Fortification in a Globalized World. Academic Press, Elsevier, Inc.

McLean E, Klemm R, Subramaniam H, et al. 2020. Refocusing Vitamin A Supplementation Programmes to Reach the Most Vulnerable. *BMJ Global Health* 2020; doi:10.1136/bmjgh-2019-001997

Ministry of Health, Burkina Faso. 2022. Post National Supplementation Days Coverage Assessment Survey in vitamin A+, second passage 2021, Provisional Report 1, June 2022.

Mkambula, P., M. N. N. Mbuya, L. A. Rowe, M. Sablah, V. M. Friensen, M. Chadha, A. K. Osei, C. Ringholz, F. C. Vasta, and J. Gorstein. 2020. The Unfinished Agenda for Food Fortification in Low and Middle-Income Countries: Quantifying Progress, Gaps and Potential Opportunities. *Nutrients* 2020, 12, 354

Muhammad, A., A. D'Souza, B. Meade, R. Micha and D. Mozaffarian. 2017. The influence of Income and Prices on Global Dietary Patterns by Country, Age, and Gender. *Economic Research Report* Number 225, Economic Research Service, USAID, February 2017

Neidecker-Gonzales O, Nestel P, Bouis H. 2007. Estimating the Global Costs of Vitamin A Capsule Supplementation: A Review of the Literature. *Food and Nutrition Bulletin*. 2007;28(3):307-316. doi:10.1177/156482650702800307

Pachon, E. 2018. Wheat and Maize Flour Fortification. Chapter 12 in Mannar, M. G. V. and R. F. Hurrell, editors. 2018. Food Fortification in a Globalized World. Academic Press, Elsevier, Inc.

Stevens GA, Bennett JE, Hennocq Q, Lu Y, De-Regil LM, Rogers L, Danaei G, Li G, White RA, Flaxman SR, Oehrle SP, Finucane MM, Guerrero R, Bhutta ZA, Then-Paulino A, Fawzi W, Black RE, Ezzati M. 2015. Trends and Mortality Effects of Vitamin A Deficiency in Children in 138 Low-income and Middle-income Countries between 1991 and 2013: A Pooled Analysis of Population-based Surveys. *Lancet Glob Health*. 2015 Sep;3(9):e528-36. doi: 10.1016/S2214-109X(15)00039-X. PMID: 26275329.

Stevens, G. A., T. Beal, M. N. N. Mbuya, H. Luo, L. M. Neufeld, et al. 2022. Micronutrient Deficiencies among Preschool-aged Children and Women of Reproductive Age Worldwide: A Pooled Analysis of Individual-level Data from Population-representative Surveys. *Lancet Global Health* 2022; 10:e1590-99

Traoré, R., Sanoussa, B. C. and Noel, S. P. 2022. Post National Supplementation Days Coverage Assessment Survey in Vitamin A+, Second Passage 2021, Burkina Faso Provisional Report 1, June 2022

Vosti, S. A., J. Kagin, R. Engle-Stone, H. Luo, A. Tarini, A. Clermont, J. G. Assiene, M. Nankap, K. H. Brown. 2019. Strategies to Achieve Adequate Vitamin A Intake for Young Children: Options for Cameroon, *Ann. N.Y. Acad. Sci*., 1465 (2020) 161–1

Vosti, S. A., Adams, K. P., Michuda, A., Ortiz-Becerra, K., Luo, H., Haile, D., Chou, V. B., Clermont, A., Teta, I., Ndjebayi, A., Kagin, J., Guintang, J., & Engle-Stone, R. (2022). Impacts of micronutrient intervention programs on effective coverage and lives saved: Modeled evidence from Cameroon. *Ann NY Acad Sci*., 1–12. https://doi.org/10.1111/nyas.14937

WHO. Guideline: Vitamin A supplementation in infants and children 6–59 months of age. Geneva, World Health Organization, 2011.World Health Organization (WHO).

World Health Organization 2018. Vaccination Coverage Cluster Surveys: Reference Manual. World Health Organization. https://apps.who.int/iris/handle/10665/272820. License: CC BY-NC-SA 3.0 IGO

Technical Appendix

Table 1: Number of children reached by the JVA+ event – overall, by health district, and by rural/urban areas

Number of children reached	**Total**	
	102,722	
	Kombissiri	**Yako**
	34,172	68,550
	Rural	**Urban**
	95,155	7,567

Table 2: JVA+ Event Costs (USD[12]) – overall, by health district, by urban/rural areas

	Total	
Total JVA+ Costs	137,140	
VA Capsules and Other Input Costs	19,974	
Admin Salary and Allowance	8,326	
Monthly Admin Expenses	40,915	
Meetings	1,196	
Transport	2,482	
CHW Salaries	19,440	
CHW Transport/Communication	19,628	
Caregiver Opportunity Costs	24,623	
Social Mobilization	558	
	Kombissiri	**Yako**
Total JVA+ Costs	55,430	81,710
VA Capsules and Other Input Costs	6,977	12,997
Admin Salary and Allowance	4,077	4,249
Monthly Admin Expenses	13,390	27,525
Meetings	946	249
Transport	1,264	1,218
CHW Salaries	7,596	11,844
CHW Transport/Communication	12,968	6,660
Caregiver Opportunity Costs	7,832	16,791
Social Mobilization	381	177
	Rural	**Urban**
Total JVA+ Costs	126,227	10,913
VA Capsules and Other Input Costs	17,727	2,247
Admin Salary and Allowance	7,534	793
Monthly Admin Expenses	37,654	3,261
Meetings	1,073	122
Transport	1,750	732
CHW Salaries	17,820	1,620
CHW Transport/Communication	19,171	457
Caregiver Opportunity Costs	23,055	1,569
Social Mobilization	450	108

[12] All costs are reported in 2022 USD; exchange rate 1 XOF = .0015 USD

Table 3: Cost-effectiveness (USD) of JVA+ event – overall, by health district, by rural/urban areas

Cost per child reached (including opportunity costs of caregivers' time)	**Total**	
	1.34	
	Kombissiri	**Yako**
	1.62	1.19
	Rural	**Urban**
	1.33	1.44