Cost Analysis of Delivering Sexual and Reproductive Health Services Among Adolescents and Young People in Zambia: Results from the Yathu Yathu Trial

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ABSTRACT

Background: Adolescents and young people (AYP) in low- and middle-income countries (LMICs), including Zambia, face significant structural and social barriers to accessing essential Sexual and Reproductive Health (SRH) services. This challenge contributes to high rates of negative health outcomes, including early pregnancies, sexually transmitted infections (STIs), and HIV incidence. Evidence on the affordability and value-for-money of youth-tailored SRH interventions in Zambia is urgently needed to inform resource allocation. This study contributes to the literature on the cost of the SRH service delivery in Zambia.

Methods: Following a provider perspective, we prospectively conducted an economic evaluation. An ingredient-based costing approach was used to calculate the total and unit costs of the SRH intervention compared to routine care. Effectiveness was measured as changes in the knowledge of HIV status among AYP. The primary outcomes were the unit costs by services for the trial arms and the standard of care (Youth-friendly corner model). Deterministic sensitivity analysis was conducted to assess changes in the Youth-friendly platform when key cost inputs were varied.

Results: The YFC platform had a total cost of US$31,185.33 and a cost per person reached of US$4.66, while the iYFC platform cost US$27,084.90 with a cost per person of US$14.82, and the iCYFH platform cost US$217,411.91 with a cost per person of US$19.41. Integrated SRH service delivery ($371,235.98) in the iCYFH model was significantly more cost-efficient than parallel provision ($1,131,410.18), resulting in a potential saving of $760,174.20. Sensitivity analysis indicated that discount rate and project life years are key cost drivers, with personnel costs also significantly influencing unit costs. The incentivized community model, despite higher platform costs, offers substantial efficiency gains through integrated service delivery.

Conclusion: The findings provide critical economic evidence necessary for decision-making regarding the scale-up of targeted SRH interventions for AYP in Zambia. This analysis supports policy efforts to prioritize and efficiently allocate resources toward effective SRH delivery models, ultimately improving health equity and outcomes for this population.

BACKGROUND

Adolescents and young people (AYP) in low- and middle-income countries face significant barriers to accessing sexual and reproductive health (SRH) services [1-8]. This vulnerability places them at a high risk of experiencing poor health outcomes that can lead to increased morbidity and mortality rates [9, 10]. In sub-Saharan Africa, AYP continue to face challenges such as early and unwanted pregnancies, unsafe abortions, and sexually transmitted infections (STIs), including HIV [1, 11-19]. In Zambia, the median age at first sex is 16.6 years for women and 18.5 years for men, with high fertility rates and low contraceptive prevalence rates among young people [20]. The country is also faced with high fertility rates among young women, with 88 and 144 births per 1000 women aged 15-19 and 20-24 years, respectively [20]. Despite high knowledge of family planning, the contraceptive prevalence rate (CPR) remains low, at 12% and 35% for 15-19 and 20-24-year-olds, respectively [20]. Furthermore, the unmet need for contraceptives is substantial, with 13% of 15-19-year-old and 16% of 20-24-year-old women lacking access, despite a total demand of 25% and 52%, respectively [20]. Additionally,

HIV prevalence among young people aged 15-24 years in Zambia is disproportionately estimated at 1.90% and 3.8% for men and women, respectively [21, 22].

Investing in the health of AYP is critical for future global health and development [23]. The World Health Organisation (WHO) recommends incentivised SRH programming as an effective strategy for improving SRH service uptake among AYP [24], which has shown promise in increasing SRH service utilisation among AYP in similar contexts [25-27]. However, information on the cost of SRH service delivery for young people in Southern Africa is limited. This study aims to address this research gap by calculating the cost and exploring the economies of scope (EOS) of incentivised SRH service delivery for adolescents and young people in Zambia. The findings of this study provide valuable insights for policymakers, program implementers, and stakeholders to inform resource allocation and decision making.
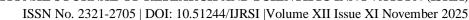
METHODOLOGY

Study setting

This study was nested within a cluster-randomized trial called the Yathu Yathu ("For us by us") trial, which aims to assess the impact of comprehensive community-based and peer-led SRH service delivery on knowledge of HIV status and coverage of SRH among adolescents and young people in Zambia. The trial was undertaken in two highly populated urban communities in Lusaka. The trial design has been described elsewhere[28]. Each community was divided into ten (10) geographical areas, consisting of five intervention and five control clusters. Each cluster consisted of approximately 2,350 young people aged 15–24 years, including approximately 500 adolescent boys (15–19 years), 500 young men (20–24 years), 600 adolescent girls (15–19 years), and 700 young women (20–24 years). These estimates were based on unpublished data from a preceding study conducted in the two communities[29].

Description of the trial implementation activities

The Yathu Yathu trial was a cluster-randomized study designed to evaluate a comprehensive, community-based, and peer-led approach to improving SRH outcomes among AYP in Zambia. The main objective was to assess the impact of the trial intervention on knowledge of HIV status and the overall coverage of SRH services. The core of the intervention was the fixed community hubs staffed by Peer Support Workers (PSWs), lay counsellors, and rotating nurses, and situated away from, but linked to, government health facilities through a referral system. The hubs offered a range of comprehensive SRH services such as HIV services, sexually transmitted infections (STIs) treatment, and contraceptives. Additionally, they provided other health services, as well as non-health services (e.g. substance abuse screening)[28]. The second component was the Prevention Point Card (PPC) program, which worked like a retail loyalty card. The PPC allows AYP to accrue points every time they access pre-determined SRH services at the hubs or local clinics. The number of points awarded varied based on the service's importance (e.g., an HIV test earned more points than collecting condoms), and additional incentives ("nudges") such as 'bring a friend' encourage peer mobilisation and referrals. Once sufficient points were accumulated, AYP could redeem them for rewards of their choice, which range from health/hygiene products (like sanitary pads and soap) to non-health services (like hair salon visits). The PPC program was implemented in both the intervention and control arms of the trial to collect service utilisation data and other trial data[28]. The trial control arm formed a combination of the Standard of Care System and the PPC program, designed to provide the current standard of care for AYP at the local government health facility[28]. The standard of care structures for SHR service delivery are designed around the Youth-Friendly Corner model, which acts as the initial, low-barrier entry point for AYP [30, 31]. In this study, the Yathu Yathu hub and facility Youth-Friendly corner will both be synonymously referred to as youth-friendly platforms. The hub will be referred to as incentivised Community-based Youth-Friendly (iCYFH) platform, while the facility-based Youth-Friendly model and Yathu Yathu control arm shall be referred to as the 'Facility-based Youth-Friendly corner (YFC) platform, and incentivised YFC (iCYFC) platforms

Data collection

Cost data collection

Costing information was collected using a mixed research method by combining top-down (through expenditure reviews) and bottom-up (by reviewing field records and observations) approaches. Trial cost data were collected through the expenditure review to establish financial costs, coupled with field observations to account for opportunity costs and identify shared/overhead allocation factors[32-34]. During field observation, we first developed client pathways (process maps) to identify services accessed by AYPs and activities conducted for each service delivery. On the other hand, the cost data for routine SRH services at local government health facilities were collated through a facility costing survey[35], which involved process mapping and cost-tracking activities using informal discussions with key facility staff, observations, and record reviews. Following the development of process maps, we identified and quantified all resources associated with service delivery for each activity within the client or patient pathways. The SRH services for AYP were categorized into two main components: the "Youth-friendly platform," which included community engagement, rewards, training, and safe space coordination, and SRH-specific services, which comprised HIV testing, antenatal care, contraceptive services (both short-term and long-term), voluntary medical male circumcision, sanitary towel distribution, substance abuse screening, TB screening, active referrals, condom distribution, STI and syphilis screening, lab testing, and treatment.

Study Sample Selection

The study included all the ten Yathu Yathu hubs for the trial intervention activities, and two local public health facilities (one in each trial community) for the control arm and routine service delivery activities. Staff time is a crucial component in calculating personnel costs and should be measured accurately, particularly for personnel who are involved in multiple activities. In this study, a purposive sample of 1-3 key SRH service providers from relevant departments in each health facility was selected and observed while delivering services over two consecutive days. All project field staff members were included in both the trial and control arms. The sample size and sampling strategy for the trial service utilisation and outcome data are beyond the scope of this study, as the data were compiled from the PPC system (secondary outcomes) and the cross-sectional survey (primary outcome) [36-38].

Data analysis

Costing

Cost data were analysed using Microsoft Excel (MS Excel 2013). The costing framework is presented in Supplementary Material S1. We calculated the total and unit costs for each SRH activity by service delivery modality. Our base case analysis included all costs associated with the Yathu Yathu trial setup and implementation, excluding the costs of research activities. Set-up costs for routine service delivery were not calculated due to feasibility constraints. The Set-up costs included all resources used to establish the trial, identified through activities conducted before the commencement of implementation. Implementation/service delivery costs accounted for all resources used for trial execution and routine service delivery. Total costs were calculated as the summation of the costs of all the youth-friendly activities and SRH services. As depicted in Equation i, both direct and indirect costs were accounted for.

$$TC = \sum_{i=0}^{n}(DC_i)+\sum_{i=0}^{n}(IC_i) \quad (i); \text{ Where TC=total, DC=direct cost and IC =indirect cost, taking values of } i=0\text{-}n$$

Costs were categorised into capital (start-up, training, building, and equipment resources) and recurrent costs (personnel, non-medical, operations, and drugs). Capital costs were annualised over their economic life years using a 3% discount rate [39, 40]. Overhead and shared costs were allocated to service delivery activities based on predetermined allocation factors [35], verified with the service providers and project team as outlined in sections H and I of Supplementary Material S1, for the trial activities and routine services, respectively . Costs were further allocated to services based on the average time required to provide each service. Unit costs were

calculated by dividing the total costs by the intermediate outcomes for trial costing and service utilisation data for routine service costing (equation ii).

$$AC = (\sum_{i=0}^{n} \quad (TC_i))/N \qquad \text{(ii)};$$

Where AC=direct cost and TC=total, taking values of i=0-n, and N=number of recipients for each service

All costs were adjusted for inflation and converted to 2020 United States dollars (US$) using the Consumer Price Index deflator for Zambia and the US$/Zambia Kwacha exchange rate [41]. The year 2020 was chosen as the base year for costing because most trial expenditures occurred in that year. The costing framework is presented in Supplementary S2.

Cost analysis

The total unit cost of SRH services was calculated by adding the unit cost of the youth-friendly platform to the SRH service-specific unit costs. The unit cost of the incentivised youth-friendly platform in the control arm was calculated by summing the unit costs of the routine youth-friendly corner and those of the trial activities.

Finally, we descriptively explored the economies of scope (ES) to understand the cost efficiency, in terms of cost saving, of delivering SRH through the Yathu Yathu hub. ES arises when cost savings can be achieved by providing two or more services together compared to when they are provided separately [42]. The cost efficiency was measured in terms of the degree of economies of scope (DES), calculated as the quotient of the total cost of the Yathu Yathu intervention and the summation of the cost of parallel SRH service delivery using the same youth-friendly platform. The following formulas were used to calculate the ES and DES:

$ES = (TC(all\ SRH\ services) < (TC(TB) + TC(COVID - 19)$ *(iii); Where EOS is economies of scope and TC is total cost.*

$$DES = \frac{"TC\ (TB\ diagnosis) + TC(COVID - 19\ diagnosis)"}{"TC(TB, COVID - 19\ diagnosis)} \qquad \text{(iv); where TC=Total Economic Costs, DSC=}$$
Degree of economies of scope; technical efficiency= DSC>1

Sensitivity analysis

Deterministic sensitivity analysis (DSA) was performed to investigate the responsiveness of the cost per person for the youth-friendly platform to changes in the key cost inputs, exchange rate, and discount rate [46]. We varied the unit cost of different cost inputs by minus or plus 20 percent (-/+20%) [47]. The discount rate was varied between 0% and 9.75%. Economic life years of the capital costs were varied as follows: buildings (25 and 50 years), office equipment (2 and 4 years), fabricated office facilities (15 and 25 years), vehicles (5 and 10 years), and other capital assets (4 and 7 years). The project lifespan was considered at 1 year and 5 years as lower value and higher value, respectively. The results are presented on a 'tornado diagram, ordering varied inputs according to the extent of variation of the resulting 'cost per person', with the widest variation at the top [32, 35].

RESULTS

Healthcare utilisation data

Table 1 presents the detailed annual outcome data related to SRH service provision. Outcome data for the Routine service delivery model were not AYP-specific. The number of AYP enrolled in the trial was 20,092 for the control arm and 20,772 for the intervention arm. 10966 accessed services in the intervention arm, whereas the control arm only reached 1,614. The facility-based Youth Friendly model reached 4,950. Reward redemption points were significantly higher in the community hub at 8,803 than in the control arm, 494. The total number of individuals testing for HIV in the routine model was estimated at 32,352. but the community hub identified 133 HIV-positive cases, which was proportionally similar to the other models. The community hub also had higher numbers of women receiving short-term hormonal contraceptives (859), antenatal care visits (84), and men undergoing circumcision (32). For sexually transmitted infections, the community hub screened 7,310

individuals, tested 678 for STIs, and identified 57 positive cases, with similar trends observed in syphilis testing and treatment.

Table 1: Health Care Utilisation data

Outcome[&]	Routine Service delivery*	Incentivised Routine Service delivery[&]	Incentivised fixed community hub[&]
Youth-friendly platform			
Number of AYP enrolled	-	20092	20772
Number of AYP consented	-	14498	14872
Number of AYP reached	4,950	1614	10966
Number of AYP redeeming reward points	-	494	8803
SRH service			
IV testing services			
Number of persons tested for HIV*	32352	568	8841
Number of persons who tested positive for HIV*	3012	4	133
Number of women who received short-term hormonal contraceptives	15180	50	859
Antenatal care visits	24691	36	84
Number of AYP who got circumcised using Voluntary Medical male circumcision	5190	14	32
Syphilis screening, testing & treatment			
Number of persons screened for STIs	2342	393	7310
Number of persons tested for STIs	2342	129	678
Number of persons who tested positive for syphilis	231	32	57
Number of persons treated for syphilis	231	32	57
Throughputs for the Routine service delivery model were not AYP-specific; [&]Outcome data for incentivised routine and community hub are reported as annual average by dividing data collated for a period of 2 years by project life years			

Costing results

Standard Facility-Based Youth-Friendly Model

Table 2 represents the cost of delivering services through a Facility-based Youth-friendly platform (Youth-friendly Corner), a standard of care for delivering youth-friendly SRH services to young people. The total cost of the youth-friendly platform was calculated at US$31,185.33, with capital costs accounting for (6.13%) and recurrent costs forming the larger proportion at 93.87%. Capital costs constitute buildings and facilities and equipment at US$1,289.82 and US$621.49, respectively. There were no start-up costs reported in this model, as the model had been in existence for many years before the study. Recurrent costs (US$29,274.02) were dominated by personnel at 95%. The costs of non-medical supplies and operations were calculated at US$935.46, US$295.04, and US$953.76, respectively, whereas the cost of medical supplies was US$124. The cost per person reached was calculated at US$4.66; US$0.54 for community engagement, and US$4.12 for Youth-friendly Corner coordination.

The total cost of HIV testing was US$97,791.32 at a cost per person tested of US$2.91 and a cost per person tested positive of US$31.23. The total costs of ANC, short-term contraceptives, long-term contraceptives, and VMMC were US$123,290.94, US$94,063.01, US$4,228.69, and US$133,327.65, resulting in the cost per person of US$19.97, US$6.20, US$13.47 and US$250.69, respectively. The total cost of syphilis management was US$9,73013, comprising of STI screening (US$663.63), Rapid Plasma Reagin (RPR) testing (US$5,731.51) and treatment (US$3,331.99) costs, with a cost per person treated of US$39.52; US$0.28 for STI screening, US$2.45 for RPR testing, US$24.81 syphilis case identified, and 14.42 for case treated.

Incentivised Facility-Based Youth-Friendly Model

This model introduces incentives (rewards) to facility-based youth-friendly services to encourage service uptake (Table 3). The total cost of youth-friendly platform was US$27,084.90, with capital costs of US$1,1340.38 and recurrent costs of US$25,950.52. The capital costs comprised building and facilities (63%), equipment (31%), and modest safe space start-up activities (6%). Similar to the facility-based youth-friendly model, recurrent costs were driven by personnel at US$22,9270.28. The total cost of non-medical supplies was US$2,412.36, and medical supplies were US$600.7. The operational costs were US$100.18. The cost per person was calculated as US14.82: US$0.54, US$6.02, and US$8.26 for community engagement, rewards, and safe space coordination, respectively.

The total costs of SRH-specific services were US$626.95, US$688.14, US$1,066.61, US$825.77, and US$1,162.95, at cost per person of US$29.98, US$6.04, US$2.80, US$2.13 and US$2.96 for active referral to different service points within a local government health facility, alcohol and drug screening, TB screening, condom distribution, and STI Screening, respectively.

Incentivised fixed Community-Based Youth-Friendly Model

Table 4 presents the detailed costs of the incentivised fixed community youth-friendly platform. The total cost of youth-friendliness services was calculated at US$217,411.91, with capital and recurrent costs 13.94% and 86.06%, respectively. Capital investments were driven by start-up costs (US$29,78195). The equipment costs were calculated at US$518.06. Like for the other two models, personnel cost formed (US$85,788.93), followed by non-medical supplies (US$85,261.33). Operations were the third driver at US$14,727.72, with medical supplies (US$1,332.91) being the lowest. The cost per person was calculated at US$19.41, comprising community engagement (US$2.40), reward programme (US$8.73) and safe space coordination (US$8.28).

The total costs, with cost per person presented in parentheses, of SRH-specific services were US$106,633.22 (US$129.57) for active referral, US$81,314.49 for HIV testing (US$9.20 per person tested and US$611.39 per person tested positive), US$27,393.88 (US$326.12) for ANC services, US$61,306.56 (US$US$71.37) for short-term contraceptives, US$7,204.44 (US$1.15) for sanitary pad distribution, US$6,087.53 (US$0.57 for alcohol and drug screening, US$10,957.56 (US$1.39) for TB screening, US$10,348.80 (US$2.07) for condom distribution, and US$15,117.37 (US$2.07) for STI screening.

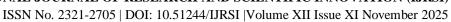*Sensitivity analysis of Unit Cost for Youth-friendly platform*

The sensitivity analysis results showed that the unit cost estimates for the three youth-friendly platforms were influenced to varying degrees by different costing inputs (Figure 1). The discount rate was one of the most influential inputs, with unit costs increasing substantially from US$4.66 to US$7.61, US$14.81 to US$17.83, and US$19.41 to US$23.33, when the discount rate was set at Zambia's economic policy rate of 9.25%, for the facility-based youth-friendly platform, incentivised facility-based youth-friendly platform, and incentivised fixed community-based youth-friendly platform, respectively. Project life year assumptions were another key cost driver, especially for the community model, where shorter project life years resulted in higher unit costs as capital costs are spread over fewer years than longer project life years. Unit costs were also responsive to the changes in the personnel costs; a -/+20% change in personnel costs leads to a substantial change in the unit cost. In contrast, changes in the economic life of buildings, vehicles, equipment, and other assets, as well as changes in building and facility costs, have a minimal effect on unit cost outcomes. Similarly, -/+20% variations in medical supplies and operational costs had only a small impact.

Economies of scope for service delivery at a fixed incentivised community hub

Table 5 presents the economics of the scope of providing SRH services at a fixed incentivised community Youth-friendly platform, comparing parallel and integrated service delivery models. The table presents the costs of HIV testing, antenatal care, short-term contraceptives, sanitary towels, alcohol and drug screening, TB screening, condom distribution, and STI Screening services. We estimated a total cost of $371,235.98 for service integration and $1,131,410.18 for parallel service delivery, with a degree of economies of scope (DSC) of 3.05, indicating that integrated service delivery is three times more cost-efficient, resulting in a potential cost saving of $760,174.20, underscoring the approach's financial gains.

Table 2: Costs of delivering SRH services through a standard Facility-based Youth-friendly platform (Youth-friendly Corner)

Cost line	Youth-friendly platform			SRH-specific costs								
									Syphilis			
	Community engagement	Safe space	Total	HIV testing	ANC	Short-term contraceptives	Long-term contraceptives	VMMC	STI Screening	Lab testing	Treatment costs	Total
Capital												
Buildings & facilities	437.48	852.34	1,289.82	1,161.13	2,140.42	1,193.92	19.53	847.88	9.72	68.11	1.95	6,732.47
Equipment	216.96	404.52	621.49	691.11	1,576.67	1,246.38	794.26	4,835.18	11.42	74.22	53.82	9,904.54
Start-up	-	-	-	-	-	-	-	-	-	-	-	-
Total capital	*654.44*	*1,256.86*	*1,911.31*	*1,852.24*	*3,717.09*	*2,440.31*	*813.79*	*5,683.06*	*21.13*	*142.33*	*55.76*	*16,637.02*

Recurrent												-
Personnel	9,639.65	18,261.25	27,900.90	35,362.68	39,324.06	27,837.15	518.97	65,606.73	169.87	1,989.25	26.8	198,736.41
General supplies	102.13	192.91	295.04	2,351.17	1,438.52	822.06	15.76	2,286.42	141.68	113.49	1.29	7,465.43
Operations	6.25	12.04	18.29	7,558.86	3,421.55	3,455.97	87.48	2,700.01	286.11	201.92	192.22	17,922.41
Medical supplies	334.54	600.93	935.46	50,666.37	2,521.63	1,176.39	253.07	48,582.57	47.83	3,284.52	126.51	107,594.36
Drugs	44.05	80.28	124.33	-	72,868.09	58,331.14	2,539.61	8,468.86	-	-	2,929.41	145,261.44
Total recurrent	*10,126.62*	*19,147.41*	*29,274.03*	*95,939.08*	*119,573.85*	*91,622.71*	*3,414.90*	*127,644.59*	*645.49*	*5,589.18*	*3,276.23*	*476,980.05*
Total	**10,781.06**	**20,404.27**	**31,185.33**	**97,791.32**	**123,290.94**	**94,063.01**	**4,228.69**	**133,327.65**	**666.63**	**5,731.51**	**3,331.99**	**493,617.07**
Denominator (positive results)	*20092*	*4950*	*-*	*32352 (3012)*	*6173*	*15180*	*314*	*5190*	*2342*	*2342 (231)*	*231*	*-*
Cost per person (person tested positive)	*0.54*	*4.12*	*4.66*	*2.91 (31.23)*	*19.97*	*6.20*	*13.47*	*25.69*	*0.28*	*2.45 (24.81)*	*14.42*	*39.52*

Table 3: Costs of delivering SRH services through an Incentivised standard Facility-based Youth-friendly platform

Cost input	Youth-friendly platform				SRH - specific costs				
	Community engagement	Rewards	Safe space	Total	Active referral	Alcohol & drug screening	TB screening	Condom distribution	STI Screening

Capital									
Buildings & facilities	437.48	-	277.91	715.39	-	-	-	-	-
Equipment	216.96	-	131.90	348.86	-	-	-	-	-
Start-up	-	-	70.13	70.13	-	-	-	-	-
Total capital	*654.44*	*0*	*479.94*	*1,134.38*	*0*	*-*	*-*	*-*	*-*
Recurrent									
Personnel	9,639.65	1,008.09	12,279.55	22,927.28	5,770.71	658.88	1,021.27	790.66	1,113.51
General supplies	102.13	1,966.46	343.76	2,412.36	256.23	29.26	45.35	35.11	49.44
Operations	6.25	-	3.93	10.18	-	-	-	-	-
Medical supplies	378.59	-	222.12	600.70	-	-	-	-	-
Total recurrent	*10,126.62*	*2,974.56*	*12,849.35*	*25,950.52*	*6,026.95*	*688.14*	*1,066.61*	*825.77*	*1,162.95*
Total	**10,781.06**	**2,974.56**	**13,329.29**	**27,084.90**	**6,026.95**	**688.14**	**1,066.61**	**825.77**	**1,162.95**
Denominator	*20092*	*494*	*1614*		*201*	*114*	*381*	*387*	*393*
Cost per person	*0.54*	*6.02*	*8.26*	*14.82*	*29.98*	*6.04*	*2.80*	*2.13*	*2.96*

Table 4: Costs of delivering SRH services through an Incentivised fixed Community-Based Youth-Friendly Model (Community Hub)

Cost line	Youth-friendly platform				SRH - specific costs								
	Community engage	Rewards	Safe space	Total	Active referral	HIV testing	ANC	Short-term contraceptives	Hygiene service	Alcohol & drug	TB screening	Condom distribution	STI Screening

	men t									ce s	scr ee nin g		
Capital													
Equipment	181.73	47.51	288.82	518.06	543.99	182.97	139.75	74.53	24.84	31.06	55.9	52.79	77.12
Start-up	531.36	69.15	29,182.44	29,782.95	791.73	266.3	203.39	108.48	36.16	45.2	81.36	76.84	112.24
Total capital	*713.09*	*116.66*	*29,471.26*	*30,301.02*	*1,335.72*	*449.27*	*343.14*	*183.01*	*61*	*76.25*	*137.26*	*129.63*	*189.37*
Recurrent													
Personnel	36,845.23	6,914.48	42,029.22	85,788.93	79,162.56	26,626.04	20,336.72	53,564.72	3,615.42	4,519.27	8,134.69	7,682.76	11,222.86
General supplies	6,518.01	68,393.05	10,350.27	85,261.33	9,358.11	4,029.22	2,404.08	1,282.18	2,761.81	534.24	961.63	908.21	1,326.70
Operations	5,269.94	1,336.14	8,121.64	14,727.72	15,297.21	5,145.16	3,929.83	2,095.91	698.64	873.29	1,571.93	1,484.60	2,168.68
Medical supplies	418.11	129.24	785.56	1,332.91	1,479.62	45,064.80	380.11	235.3	67.58	84.47	152.04	143.6	209.77
Drugs	-	-	-	-	-	-	-	3,945.44	-	-	-	-	-
Total recurrent	*49,051.29*	*76,772.91*	*61,286.69*	*187,110.89*	*105,297.50*	*80,865.22*	*27,050.74*	*61,123.55*	*7,143.44*	*6,011.28*	*10,820.30*	*10,219.17*	*14,928.00*
Total	**49,764.38**	**76,889.57**	**90,757.95**	**217,411.91**	**106,633.22**	**81,314.49**	**27,393.88**	**61,306.56**	**7,204.44**	**6,087.53**	**10,957.56**	**10,348.80**	**15,117.37**

Denominator (positive results)	207 72	88 03	10 96 6		823	884 1 (13 3)	84	859	62 49	10 76 9	787 7	498 9	731 0
Cost per person (person tested positive)	2.40	8.7 3	8.2 8	19. 41	129 .57	9.20 (61 1.39)	32 6.1 2	71.37	1.1 5	0.5 7	1.3 9	2.07	2.0 7

Figure 1: Sensitivity analysis of Unit Cost for Youth-friendly platform

Table 6: Economies of Scope Analysis Results

Activity	Parallel service delivery										Integrated service delivery
	HIV testing	Antenatal care	Short-term contraceptives	Hygiene services	Alcohol & drug	TB screening	Condom distribution	STI Screening	Total		

					scree ning						
Youth-friendly platform	171,573.06	1,630.15	16,670.20	121,271.35	208,988.82	152,865.16	96,819.13	141,861.67	911,679.55		*212,811.91*
SRH service-specific	81,314.49	27,393.88	61,306.56	7,204.44	6,087.53	10,957.56	10,348.80	15,117.37	219,730.63		158,424.07
Total cost (TC)	**252,887.55**	**29,024.03**	**77,976.76**	**128,475.79**	**215,076.35**	**163,822.72**	**107,167.93**	**156,979.04**	**1,131,410.18**		**371,235.98**
Degree of Economies of Scope (DSC)											**3.05**
Cost saved											**760,174.20**

DISCUSSION

To the best of our knowledge, this study is the first to explore the costs of SRH for young people in Zambia, filling a critical evidence gap in the country's health policy and planning landscape. The report presents a comprehensive analysis of the costs of three different alternatives for delivering sexual and reproductive health (SRH) services to young people in Zambia: the standard facility-based, youth-friendly, incentivized facility-based youth-friendly, and incentivised fixed Community-Based Youth-Friendly Models. The results show that the cost per person of the youth-friendly platform varies significantly across the three models, with the incentivised fixed Community-Based Model being the most expensive, followed by the incentivised Standard Facility-Based Modality. Recurrent costs, primarily driven by personnel expenses, constituted the largest proportion of costs in all three models. The study also provides detailed costs for specific SRH services, such as HIV testing, ANC, and contraceptives, highlighting the variations in costs across the models.

Furthermore, the sensitivity analysis revealed that the key cost drivers were the discount rate, personnel costs, and project life years. For example, increasing the discount rate to Zambia's economic policy rate significantly raised unit costs across all models. This demonstrates the importance of considering economic conditions when projecting the costs. A 20% change in personnel costs led to substantial fluctuations in the cost per person across all three models. This indicates that careful management of human resource costs is critical for maintaining the cost efficiency of these models. In contrast, capital costs and assumptions about the economic life of assets had minimal effects on unit costs, suggesting that recurrent costs, such as personnel and operational inputs, are the primary concern in these service delivery models.

The analysis of economies of scope in delivering sexual and reproductive health services for AYP at a fixed incentivised community hub revealed the significant advantages of adopting an integrated service delivery model over a parallel approach. By combining various services, such as HIV testing, antenatal care, contraceptive provision, and screenings for tuberculosis and sexually transmitted infections, the integrated model demonstrates a higher level of cost-efficiency. This is evidenced by the substantial cost difference between the two models, with integration resulting in considerable savings. The findings suggest that integrating these services not only enhances accessibility and convenience for users but also optimises resource utilisation, leading to a more sustainable financial framework for community health initiatives in the future. Ultimately, this approach highlights the potential for improved health outcomes while simultaneously reducing operational costs, making it a strategic choice for public health planning.

These findings have important implications for policymakers and program managers seeking to scale up youth-friendly SRH services, providing valuable insights into the potential cost savings and cost-efficiency. Our results can inform resource allocation decisions, highlighting the need to balance costs with service quality and accessibility. Furthermore, the variations in costs across the Youth-friendly platforms and services suggest that a one-size-fits-all approach may not be suitable, and context-specific considerations are essential when designing and implementing youth-friendly SRH programs. These findings suggest that no single model is universally optimal; rather, a hybrid approach leveraging facility-based care for complex services and community models for preventive outreach may maximise cost-efficiency and health impact. Importantly, these data provide a foundation for a more detailed cost-effectiveness analysis, budgeting, and resource mobilisation efforts to support scale-up of integrated SRH and HIV services in resource-constrained settings.

Our findings are consistent with prior studies that have highlighted the importance of integrated service delivery in optimising resource utilisation and improving health outcomes [48-51]. A study in Zambia found that integrated services were found to be more efficient and cost-effective than vertical service provision [52]. Like a study in Kenya and Swaziland [53], our study found that personnel costs form the largest proportion of the costs of most services, but HIV testing services of which it was second, following medical consumables. Another study in Kenya found that integrating SRH services with HIV services resulted in cost-efficiency.

This study has several limitations that impact the generalizability and validity of the findings. Firstly, the study's focus on two densely populated urban communities limits the applicability of the results to rural settings or other urban areas with different socio-economic contexts. Secondly, the exclusion of costs associated with AYP's time and productivity loss may also affect the overall cost estimates. Furthermore, the study's short time frame may not capture the long-term sustainability and cost-effectiveness of the interventions. The outcome data were derived from client loyalty cards, health information systems, and cross-sectional surveys, which may not fully capture the impact of the interventions on other important health outcomes. The study did not account for all potential confounding factors, and the cluster-randomised trial design may have been affected by spill-over effects. Moreover, the incentivised reward system may introduce biases in reporting and service utilisation. These limitations should be considered when interpreting the findings, and further research is needed to address these limitations and enhance the understanding of effective SRH service delivery strategies in diverse contexts.

Notwithstanding these limitations, our study presents a comprehensive economic evaluation of sexual and reproductive health (SRH) service delivery models for AYP in Zambia, addressing a critical gap in the existing literature. By employing a robust methodology that includes micro-costing, sensitivity analyses, and the assessment of economies of scope, the research provides detailed insights into the costs of various SRH interventions. The inclusion of diverse service delivery models—standard facility-based, incentivised facility-based, and incentivised community-based—enables a nuanced comparison that is valuable for policymakers. Furthermore, the study's findings contribute to optimising resource allocation and enhancing the efficiency of SRH services in resource-constrained settings, thus supporting the development of evidence-based health policies tailored to the needs of AYP. The ethical rigour, with approval from relevant ethics committees and informed consent from participants, further strengthens the study's credibility and relevance.

CONCLUSION

This study provides the first comprehensive exploration of the costs of sexual and reproductive health (SRH) service delivery for AYP in Zambia, addressing a crucial evidence gap in the country's health policy landscape. The analysis compares three models: the standard facility-based youth-friendly platform, an incentivised facility-based model, and an incentivised community-based hub. Results reveal significant variation in cost per person across these models, with the community-based hub being the most expensive, primarily driven by personnel costs, which form the largest portion of recurrent expenses. The study also demonstrates the potential advantages of integrated service delivery, showing that economies of scope can lead to substantial cost savings while enhancing access and efficiency. Further, the findings provide valuable insights for policymakers and program implementers. They underscore the importance of tailoring SRH delivery approaches to maximise cost efficiency and health in resource-constrained settings.

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