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RESEARCH

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The costs of implementing anaemia reduction interventions among women fish processors in Ghana

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Abstract

Background Anaemia among women of reproductive age (WRA) remains persistently high in Ghana, affecting 41% in 2022. Women in low-income communities in Ghana engaged in fish processing activities are at increased risk of anaemia due to inadequate diets, exposure to infectious pathogens, and pollutants. The Invisible Fishers (IFs) project was implemented among women fish processors in their reproductive age in Central and Volta regions of Ghana to mitigate anaemia. Despite the efficacy, feasibility and scalability of the intervention, the cost of implementing the intervention is unknown. The objective of this study was to estimate the costs of implementing the IFs project in Ghana.

Methods We used micro-costing approach to analyse the costs of implementing the IFs project. Data were collected as part of a pilot randomized control trial with three interventions: Behaviour Change Communication (BCC), Strengthening Market Engagement of fish processors plus Behaviour Change Communication (SME + BCC), and Fish Smoking Technology and Practices plus Behaviour Change Communication (FST + BCC). The interventions were delivered to 60 women fish processors in the Central region and 60 in Volta region. The cost of the intervention was estimated from the societal perspective. Economic costs were categorized as direct costs (i.e. personnel, transportation, meetings, training, and monitoring) and indirect cost (i.e. value of productive time lost due to women and community volunteers' participation in the activities of the IFs project).

Results The FST + BCC had the highest average cost per beneficiary (US$11898.62), followed by the SME + BCC (US8962.93). The least expensive was the BCC (US$4651.93) over the intervention period of 18 months. Recurrent costs constituted the largest component of economic costs (98%). Key drivers of direct costs were personnel (58%), administrative expenses (14%), and transportation (7%).

Conclusion There is a high cost for implementing interventions included in the IFs project. Planning and scaling -up of the interventions across larger populations could bring about economies of scale to reduce the average cost of the interventions.

Keywords Anaemia, Invisible fishers, Economic cost, Financial cost, Women fish processors, Ghana

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Background

Anaemia is considered one of the most prevalent nutritional disorders in the world with far reaching consequences [1]. Anaemia among women and adolescent girls in low-income countries is a major public health concern which needs urgent attention [2]. Despite the implementation of interventions targeted at reducing anaemia over the past decades, it still contributes about 9% to the total global disability [3, 4]. Globally, about one-third of women in their reproductive age are anaemic, which affects 30% of non-pregnant women and 36% of pregnant women [2, 5]. In 2019, anaemia alone was associated with 58.6 million years lived with disability worldwide [6]. Women with anaemia are particularly at increased risk of adverse birth outcomes and lower work capacity, potentially leading to adverse effects on countries'national economic development [7]. Common causes of anaemia are nutritional deficiencies, infections and inflammatory diseases, and genetic haemoglobin disorders [2].

In 2012, the 65th World Health Assembly (WHA) approved global targets for maternal, infant and young child nutrition, with commitment to reduce by half anaemia prevalence in women of reproductive age (WRA) by 2025 [8–10]. Further, both WHO and UNICEF proposed that the target be extended to 2030 to ensure that it aligns with the UN Sustainable Development Goals (SDGs) [11]. Almost 10 years into the SDGs era, and less than a year of the WHA global target to halve anaemia among WRA, progress made by nearly all African countries on this target is insufficient to meet the WHA global nutrition target by 2030. This calls for a holistic understanding of context-specific causes of anaemia and quality implementation of effective multi-sectoral actions to address it [11].

In Ghana, the prevalence of anaemia has remained persistently high over the past two decades. For instance, the prevalence of anaemia was assessed nationally in 2022 as part of a Demographic and Health survey, which revealed that 49% of children aged 6–59 and 41% of women aged 15–49 are anaemic, an indication of severe public health problem according to WHO classification [12]. Evidence suggests that women in low income communities engaged in fish processing activities are at increased risk of anaemia due to inadequate diets, exposure to infectious pathogens, particulate matter and other pollutants through smoke [13]. For example, a comparative study in Ghana involving women engaged in fish smoking and those engaged in other livelihoods revealed that fish smoking women had statistically higher anaemia prevalence and 80% greater risk of being anaemic than those engaged in other livelihoods [13]. So far, the dominant public health response to anaemia in Ghana has been the provision of nutrients, mainly iron to at risk populations through supplementation, fortification of staple foods, and multiple micronutrient powders [14]. Despite the fact these measures are useful in situations where micronutrient intakes are insufficient, particularly when supplementation is administered as part of antenatal care [15, 16], several of these intervention programmes continue to be underutilized [17, 18]. This requires combination of intervention programmes that address the infectious and nutritional determinants of low haemoglobin concentrations [11]. Without such interventions, women fish processors will continue to experience high risk of maternal mortality, reduced work capacity, impaired health and poor quality of life [5].

Against this background, the IFs project was piloted in the Central and Volta regions of Ghana. The interventions were implemented in the regions because of the high prevalence rate and burden of anaemia among women. The incidence of anaemia among women in Central and Volta regions was estimated to be 44.4% and 43.0%, respectively, higher than the national average [12]. In terms of children, the Volta region had a higher prevalence (51.3%) than the Central region (44.7%) indicating the need for prompt public health action. Further, large proportion of women in these regions derive their livelihoods from fish smoking process (about 72%, and 62%) [13, 19].

The interventions led to numerous changes in the expected directions, and in many cases quite large changes, along nearly all the hypothesized impact pathways of the study. For example, despite the study not aimed at assessing the impact of the intervention on anaemia because it was not powered to do so, at endline, the prevalence of anaemia had declined by 4.9% across participants. Further, the intervention led to an increase in knowledge of behaviour change, decline in the prevalence of malaria infection (8.5% at baseline and 5.9% at endline), whilst increasing the earnings of women fish processors from the sale of smoked fish, most notably in Central region (72% increase).

However, deciding on the type of intervention to implement requires consideration of not only its benefits but also what resources it requires; hence both costs and benefits of the intervention need to be appropriately considered and captured to inform evidence-based decision-making [20]. A growing number of interventions have explored the implementation costs of nutrition related interventions to reduce anaemia, but many continue to estimate only the financial costs of the intervention, which may greatly underestimate the actual economic costs of the interventions [21]. For example, Levin et al. estimated the average financial costs of implementing integrated agriculture programme among pregnant women in Kenya to be US$110 [22]. In addition, the average financial costs of implementing diet aid maternal and child health and nutrition (DA-MCHN) among mother–child pairs in Burundi was estimated to be US$770 [23]. In a recent study conducted in Ghana, Aryeetey and colleagues estimated both the financial and economic costs of implementing a community-based health and nutrition-sensitive interventions targeting

Ghanaian households to reduce wasting and stunting to be US$924.08 and US$1,176.70 respectively [24]. To the best of our knowledge, there is no study that has estimated both financial and economic costs of implementing interventions to reduce anaemia among women fish processors in Ghana.

This study seeks to bridge this gap by estimating both financial and economic costs of interventions aimed at reducing anaemia among women fish processors to present full range of costs required to implement the IFs project in Ghana.

Methods

Description of the invisible fishers project

The IFs project builds on the knowledge that links animal source food (ASF) value chains to reduction of anaemia. The IFs study identified the fisheries value chain as a favorable sector for interventions to reduce anaemia among women in Ghana. Three interventions were considered: The BCC was the first component of the strategies which taught participants about the causes of anaemia and risk reduction strategies, through mobile phone audio messages delivered to women fish processors twice weekly, and a twice monthly guided group discussions including household members. This component (BCC) was part of components two and three.

The second component involved SME + BCC. This component addressed the problem of inadequate fish storage facilities, physical distance from the markets, and inability to access credit facility by providing interest-free loans to women, entrepreneurship training, and daily access to market price information. The third component, FST + BCC, introduced and promoted improved fish-smoking oven called "ahotor oven" designed to reduce women fish processors' exposure to airborne pollutants associated with fish smoking. Promotional workshops advertising the "ahotor oven" were publicly held in participating communities and program participants were given one-on-one training sessions to enhance product quality. Participants were also offered the "ahotor oven" at a subsidized price, with the option of an incremental payment plan. The overall objective of the project was to develop, adapt, and pilot test a set of interventions within Ghana's fisheries value chain aimed at mitigating anaemia among women.

The research questions of the study were to examine whether the interventions were able to successfully be implemented, and also examine the extent to which there were changes among the participants in the expected directions in knowledge, behaviours, biomarkers, and exposure associated with the interventions. The study did not aim to assess the impact of the intervention on anaemia, and was not statistically powered to do so. The IFs study only measured changes in anaemia resulting from the intervention, hence the current study conducted cost analysis instead of cost-effectiveness analysis to understand the cost of implementing the interventions for scale-up decision.

Target population

The Invisible Fisher's Project was implemented among women whose ages ranged between 15 and 49 years and were engaged in fish processing as a primary source of work or activity and had no intention of moving out of the study area. The age range of 15–49 was prioritized because they are the population at highest risk of anaemia due to iron deficiency linked with pregnancies and menstruation [25]. Pregnant women were excluded from participating in the study due to the potential confounding influence of plasma volume expansion on haemoglobin assessment during pregnancy.

Study design and setting

The design of the IFs project was pilot-scaled randomized control trial**.** The study was conducted in two regions of Ghana-Central and Volta regions between January 2018-November 2019. The two regions are characterized by distinct small-scale fisheries systems (marine and freshwater, respectively) making them suitable in assessing context-specific factors that influence the impact of the interventions on anaemia. The two regions also shared some similarities including strong dependence on local fisheries for livelihood, dominance of smoked fish in the fisheries value chains, the central importance of women processors within these chains, market constraints among small-scale processors, and a high burden of anaemia among women.

Sampling

In each region, six communities were purposely selected for participation. Each community consisted of ten participants, thus a total of 60 participants were selected from each region. In total, 120 women were selected from a total of 12 communities across the two regions.

Two communities in each region were assigned to one of the three treatment arms. Ten women in each community were purposively selected for participation to ensure intra-community variation on participant's age, socioeconomic status, years of experience with fish smoking, and the scale of fish smoking enterprises (Fig. 1).

Methods for the costing study

Study design

The design of this study was a descriptive cross-sectional design that used the ingredient-based approach to estimate costs**.**

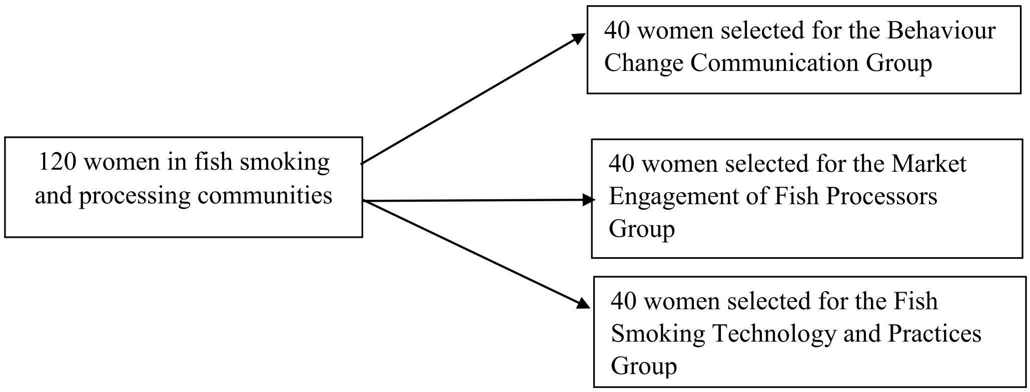

Fig. 1 Research design

Data collection

Both financial and economic costs were estimated. Financial cost refers to the direct cash expenditure on goods and services that were incurred in undertaking the Invisible Fishers project. Economic costs or opportunity costs on the other hand, were the alternative uses of resources that have been forgone for using it on the implementation of the project. The concept of economic cost or opportunity cost recognizes the cost of using resources as those that are unavailable for productive use in other competing intervention programmes. The economic costs is made up of direct costs plus indirect costs. All costs were identified, measured prospectively, and valued at 2018 prices to represent the costs of the IFP. Costs of items that were expressed in Ghana cedis (GHC) were converted to the United States dollars (US$) at an annual exchange rate of GHC 4.59 = US$1 for Bank of Ghana 2018 expenditure year. Costs relating to research were excluded, as this did not form part of the core implementation activities.

Data on time spent by volunteers and women participating in the intervention were obtained using structured questionnaires and project records. This information was used to estimate the direct and indirect costs of volunteers and women participants. In all, there were 12 volunteers on the entire project, however one volunteer dropped out of the study. Four volunteers, each were assigned to the BCC, and SME + BCC interventions, whilst three volunteers were assigned to the FST + BCC intervention. Financial records of each intervention were obtained from receipts, invoices, and other financial records kept by the finance officer. Records from the general project administration were also reviewed to reconcile information from the interventions where inconsistencies were identified in the records kept by finance officers of the intervention.

The activities that were costed in the intervention implementation are indicated in Table X (Supplementary file 1).

Cost analysis

Costs were analyzed from the societal perspective, which means that cost to all those involved in the intervention implementation were estimated. These included costs to the implementers of the project-University of Ghana, University of Michigan, Innovation for Poverty Action, Netherland Development Organisation, and VIAMO mobile, the women fish processors, caretakers of women fish processors, and community volunteers who donated their time in the implementation activities but were not remunerated. The cost of time for women fish processors, community volunteers, and caretakers were evaluated based on the daily wage rate of their work. Staff of the implementing institutions were paid based on the equivalent of the daily wage rate earned in their formal work. The time horizon for the intervention analysis was 18 months, which was the period for the intervention implementation.

Financial and economic costs were analysed separately. Financial cost represents the actual costs of items and services purchased; thus, costs are described in terms of how much money has been paid for the resources used in the project. The financial cost is usually estimated from the payer's perspective, and costs are resources forgone by the payer. The financial costs estimate the price and quantities of the resources for the project. There are different ways financial costs can be classified- by inputs, activity, level, etc., among others. For this study, financial costs classification was by inputs, mainly considering the lifespan of the items bought and by activity. These include capital and recurrent costs. Capital costs items are those that last longer than one year, and examples include building, oven, vehicles, equipment, and training that usually happens once for the entire duration of the project. Recurrent costs are the cost of items that are used up in the course of a financial year and are usually purchased regularly. Recurrent costs are the running costs of the programme. Examples of recurrent costs include personnel, supplies, building operation and maintenance, recurrent trainings, etc., Adding capital costs and recurrent costs constitute total financial costs. Specific cost items in this study that were estimated under financial costs included oven costs, personnel, transportation, training (recurrent), meeting, field accommodation and office space, among others.

Economic costs or opportunity costs on the other hand define costs in terms of alternative uses that have been forgone by using a resource in a particular way. It means the cost of using resources, as these resources would not be available for productive use elsewhere. The economic cost is the broader way of defining costs. This cost refers to the resources forgone by all society. It is important to note that analyses using economic costs do not replace those using financial costs but supplement them with additional information useful for decision-making. Examples of economic costs include time spent by community volunteers, and donated goods and services. The main economic cost items estimated in this study were the time of community volunteers, women fish processors, caretakers, and the economic cost of capital items.

Resource use was measured based on scheduled activities for each intervention. Financial records were assessed and analyzed to identify and categorize the expenditure of each intervention, representing different activities. An inventory list was created for the various types of resources utilized, and these resources were organized into different cost categories. Costs were classified by resource inputs (capital vs recurrent) and indirect costs. All capital items were depreciated using a discount rate of 3% as this conforms to the rate usually applied in global health evaluations in both developed and developing countries. For depreciation of capital items for the economic costs, the annualization method was applied using the discount rate, the useful life of the capital item, and the annualization factor. The annual financial cost of depreciation for capital items on the other hand, we used the straight-line depreciation method to estimate annual rate of depreciation. This involves identifying the capital cost items, estimating the replacement costs and years of useful life, and finally dividing the replacement costs by the number of years of useful life.

The life span of "ahotor oven", a locally manufactured oven for smoking fish used in fish smoking technology arm was estimated to be 10 years, based on information received from the manufacturers. An average useful life span of three years was assumed for all office equipment, such as computers, printers, office furniture, and mobile phones [26].

Recurrent costs and capital costs were estimated and summed up to constitute financial costs of the interventions. The allowance paid to community volunteers engaged in the implementation activities was added to the recurrent costs of the respective arms.

Data on indirect costs comprised both volunteers' and women participants' time and productive losses, that is the number of workdays lost for participating in the intervention activities. The questionnaire for the indirect costs revealed that total time required to perform activities of each intervention including meeting time, caretakers time, travel time varied among the three interventions based on the number of activities performed in each arm.

The time for women participants and community volunteers were valued based on the reported local wage rate in a month within the intervention communities. The reported monthly wage rate for women fish processors from their fish processing work was used to estimate the value of their time. It was assumed that women fish processors and community volunteers worked for 8 h daily per 6 days in a week. The 6 days in a week was used typically because women worked from Monday to Saturday, whilst Sundays were used for church and other household activities. The value of a woman participant's time was calculated as the number of hours on the project multiplied by the minimum hourly rate per day and week. This same approach was used for calculating volunteers' time. The hourly income rate for women fish processor was estimated to be US$5.95 (GHC23.79). Monetary value or equivalent of workdays lost was estimated by multiplying the number of workdays lost by the hourly wage rate for women fish processors and volunteers within the intervention communities. Summation of capital and recurrent costs constituted financial costs, whilst financial costs plus indirect costs represented the total economic costs of the project.

Sensitivity analysis

Sensitivity analyses were undertaken, varying key cost indicators which had some degree of uncertainty to test the robustness of the cost estimates. Key cost indicators that were varied included discount rate, wage rate, and life expectancy of capital items.

Firstly, one-way sensitivity analysis was performed using lower (2%), and higher (5%) discount rates in calculating capital costs. Secondly, 5 years, 8 years and 12 years useful lives were assumed for all equipment, furniture, and ahotor oven, respectively, instead of the base years. Thirdly, the national minimum wage rate of GHC11.82 was used to value all volunteers time in place of the local wage rate of the communities involved for the economic costs analysis. In addition, during the project implementation, community volunteers participated in the intervention activities but were not remunerated for their services. In view of this, it was assumed in the sensitivity analyses that community volunteers were given allowance equal to their indirect costs. Finally, a multi-way sensitivity analysis was performed using four different scenarios, varying multiple parameters at the same time. For scenario one, 10% discount rate, and national minimum rate were used to estimate the effect on economic costs; scenario two used 10% discount rate, and higher useful life span of capital items than the base case (5 years for equipment, 8 years for furniture, and 12 years for ahoto oven). Scenario three used 5% discount rate, and the assumption that indirect cost of time was the same as allowances paid to volunteers; whilst scenario four used 10% discount rate, national minimum wage, and indirect costs of community volunteers were assumed to be the same as allowances paid to them.

Results

Financial costs of the IFP

Table 1 shows the average financial costs of the study interventions of the IFs project. The total financial costs of each intervention constitute the total money paid for the resources used in the implementation of the project activities. The average financial cost on the other is the total cost per woman who took part in the intervention implementation, and it's calculated by dividing the total financial costs by the number of women who participated in the project. The average financial costs of the study interventions were US$4,308.48 (GHC19,755.78) for BCC, US$8,180.38 (GHC37,509.71) for SME+BCC, and US$11,185.79 (GHC51,290.49) for the FST+BCC. The total financial costs for delivering the BCC strategy over the period of 18 months constituted US$172,339.23 (GHC790,231.38). The SME+BCC and the FST+BCC on the other hand were estimated to be US$327,215.31 (GHC1,500,388.54) and US$447,431.63 (GHC2,051,619.44), respectively as indicated in Table 2. Recurrent costs constituted 99% of the total financial costs of the BCC, whilst recurrent costs for the SME+BCC, and FST+BCC interventions constituted 98% each (Table 2).

Table 1 Average financial costs of the interventions

Intervention	Costs (US $)
BCC	4308.48
SME + BCC	8180.38
FST + BCC	11,185.79

The economic costs of the IFP

The total economic cost of the interventions is the total financial cost (direct costs) plus the total indirect costs of each intervention, whilst the average economic cost is the total amount of all project costs (both financial and indirect costs) per woman participant in the project. It is calculated by the total economic costs of the project divided by number of women who participated in the IFs project. The total direct costs of the interventions involved in the IFP are demonstrated in Table 3.

The average costs of the interventions are demonstrated in Table 4. The average economic costs of the BCC was estimated to be US$4,651.93 (GHC21,330.61), whilst the average costs for the SME + BCC and the FST + BCC interventions were estimated to be US$8,962.18 (GHC41,094.51) and US$11,898.62 (GHC54,559.04), respectively. The total direct costs of the interventions were US$172,504.33 (GHC790,988.42) for the BCC, US$327,545.51 (GHC1,501,902.62) for the SME + BCC and the FST + BCC was estimated to be US $475,944.98 (GHC2,182,362.42). Recurrent costs constinituted 98% in all the study arms (Table 3). In terms of indirect costs, women fish processors in the BCC strategy spent an average time of 123 h on its implementation including meeting time and debriefing on the previous meeting activities. The time of caretakers who took care of the relatives of the women participants was also evaluated. On average, caretaker spent a total of 122 h during the implementation of the BCC intervention. The SME + BCC on the other hand, an average of 136 h was spent by woman participant on its implementation, whilst caretaker took an average time of 134 h. For the FST + BCC, the average time by woman participant was 127 h, whilst caretaker spent an average of 126 h on its implementation activities. In addition, the total number of volunteer's time for each intervention was equally evaluated. The average time spent by a volunteer on the implementation activities of the BCC was 424 h, whilst time spent on the SME+BCC was 466 h. An average of 436 h was spent on the activities of the FST+BCC. The total indirect costs for the BCC was estimated at US$13,572.96 (GHC62,236.43), whilst the SME+BCC, and FST+BCC amounted to US$30,941.86 (GHC141,878.48), and US$27,719.62 (GHC127,103.47), respectively as indicated in Table 5. Further, the total economic costs for the BCC was US$186,077.29 (GHC853,244.85), and the SME+BCC was estimated at US$358,487.37 (GHC1,643,781.10), whiles the FST+BCC amounted to US$475,944.98 (GHC2,182,362.42) as shown in Table 5. Indirect costs constituted 7% of the total economic costs of BCC. The SME+BCC, and FST+BCC interventions constituted 9% and 6%, respectively (Table 5).

Table 2 Total financial cost of interventions

Cost item	BCC cost US$	Cost profile	SME + BCC ost US$	Cost profile (%)	FST + BCC cost US$	Cost profile (%) US$	Grand total cost US$	Cost profile (%)
Capital								
Equipment &materials	2497.53	1.45	4995.07	1.53	4995.07	1.12	12,487.67	1.32
Oven	–				2690.13	0.60	2690.13	0.28
Sub-total	2497.53	1.45	4995.07	1.53	7685.20	1.72	15,177.80	1.60
Recurrent								
Personnel	101,798.13	59.07	190,326.51	58.17	256,277.82	57.28	548,402.46	57.91
Training	1448.54	0.84	1448.54	0.44	9,848.54	2.20	12,745.62	1.35
Monitoring	12,362.41	7.17	24,540.28	7.50	25,452.58	5.69	62,355.27	6.58
Transportation	9192.21	5.42	18,383.50	5.66	34,700.81	7.79	62,276.52	6.62
Communication	5459.45	3.17	8820.22	2.70	8,820.56	1.97	23,100.23	2.44
Meetings	1448.54	0.84	1448.54	0.44	1,448.54	0.32	4345.62	0.46
Grants/loans to women	–	–	12,639.38	3.86	–	–	12,639.38	1.33
Field accommodation &office space	4220.44	2.45	8441.31	2.58	8,440.88	1.89	21,102.63	2.23
Freezer space and sample analysis	5752.73	3.34	1,1505.46	3.52	11,505.46	2.57	28,763.65	3.04
IEC materials	–	–	–	–	1,000.00	0.22	1000.00	0.11
Office space utility	–	–	–	–	24,723.02	5.53	24,723.02	2.61
Administrative expenses	26,651.96	15. 46	53,303.92	16.29	53,303.92	11.91	133,257.80	14.07
Other	1360.75	0.79	2721.50	0.83	4,077.76	0.91	8160.01	0.86
Sub-total	169,841.70	98.55	322,220.24	98.47	439,746.43	98. 28	931,368.75	98.40
Total	172,339.23	100.00	327,215.31	100.00	447,431.63	100.00	946,986.17	100.00

Sensitivity analysis

Both one-way and multi-way sensitivity analyses were undertaken. The results of the multi-way sensitivity analysis is indicated in Table 6. For the multi-way analysis, the total costs for BCC, SME + BCC, FST + BCC were reduced by 5%, 6%, and 4%, respectively in scenario one. For scenario two, the costs in BCC and SME + BCC were reduced by 6% each, whilst the total cost was reduced by 0.5% for the FST + BCC. Under scenario three, the cost of BCC was increased by 7%, whilst SME + BCC, and FST + BCC were increased by 9% and 6%, respectively. Finally, the costs of all the interventions under scenario four were reduced from the base case scenario, with SME + BCC having the highest reduction in cost by 6%, followed by FST + BCC, and BCC with 4% and 3%, respectively (Fig. 2).

Discussion

The results of the cost analysis study showed that mitigating anaemia through BCC was the cheapest option compared to FST + BCC, and SME + BCC. The most expensive intervention to mitigate anaemia was through the FST + BCC. The difference in costs of the FST + BCC from the remaining interventions (BCC, SME + BCC) was due to additional personnel hired, frequent transportation to monitor the manufacturing and uptake of the new ahotor oven, and training on the manufacturing activities, oven use and maintenance, among other activities. This is demonstrated in Table 2, where the cost centers mentioned above were substantial in the FST + BCC intervention.

Personnel cost was the highest cost driver in all the three interventions because this novel interventions relied greatly on personnel at both design and implementation phase of the project. However, this cost is expected to decline in the long run since community volunteers (CVs) and women participants who were trained in the implementation process can provide training and monitoring to other communities where intervention may be scaled-up to minimize costs of training, monitoring and other personnel related costs. Financial recurrent costs constituted the highest proportion of cost inputs for

Table 3 Total Direct Cost of Interventions

Cost item	BCC Cost (US$)	Cost Profile (%)	SME + BCC Cost (US$)	Cost Profile (%)	FST + BCC Cost (US$)	Cost Profile (%)	Grand Total ost (US$)	Cost Profile (%)
Capital								
Equipment and materials	2,662.63	1.54	5,325.27	1.63	5325.27	1.19	13,313.17	1.40
Oven	–				3153.66	0.70	3153.33	0.33
Sub-total	2662.63	1.54	4837.68	1.63	8478.93	1.89	16,466.50	1.74
Recurrent								
Personnel	101,798.13	59.01	190,326.51	58.11	256,277.82	57.18	548,402.46	57.83
Training	1448.54	0.84	1448.54	0.44	9848.54	2.20	12,745.62	1.34
Monitoring	12,362.41	7.17	24,540.28	7.49	25,452.58	5.68	62,355.27	6.58
Transportation	9338.75	5.41	18,530.04	5.66	34,700.81	7.77	62,423.06	6.61
Communication	5459.45	3.17	8820.22	2.69	8820.56	1.97	23,100.23	2.44
Meetings	1448.54	0.84	1448.54	0.44	1448.54	0.32	4345.62	0.46
Grants/loans to women	–	–	12,639.38	3.86	–	–	12,639.38	1.33
Field accom-modation &office space	4220.44	2.45	8441.31	2.58	8440.88	1.88	21,102.63	2.23
Freezer space and sample analysis	5752.73	3.33	11,505.46	3.51	11,505.46	2.57	28,763.65	3.03
IEC materials	–	–	–	–	1,000.00	0.22	1000.00	0.11
Office space utility	–	–	–	–	24,723.02	5.52	24,723.02	2.61
Administrative expenses	26,651.96	15.45	53,303.92	16.27	53,303.92	11.89	13,3257.80	14.05
Other	1360.75	0.79	2721.50	0.83	4,077.76	0.91	8160.01	0.86
Sub-total	16,9841.70	98.46	322,220.24	98.37	439,746.43	98.11	931,808.37	98.26
Total	172,504.33	100.00	327,545.51	100.00	448,225.36	100.00	948,275.20	100.00

Table 4 Average economic cost of the interventions

Intervention	Costs (US$)
BCC	4,651.93
SME + BCC	8,962.18
FST + BCC	11,185. 62

all three interventions (Table 2), implying high requirement for recurrent inputs for the implementation of the IFs projectct than capital inputs. The key drivers of the financial costs in all the strategies were personnel, administrative expenses, monitoring, and transportation. Capital costs formed 1% of the BCC strategy and 2% for both BCC and SME + BCC, implying less usage of capital resources in the implementation of the IFs project. Our finding that the IFs project used less capital inputs in its implementation is consistent with other agricultural nutrition and health interventions implemented in Kenya (2%) and Brundi (0.1%) [22, 23].

The study further showed that the BCC intervention had the least average economic costs (US$4,308.42),

Table 5 Total economic cost of the interventions

Cost type	BCC		SME + BCC		FST + BCC		Grand total	
	Cost (US$)	Cost profile (%)	Cost (US$)	Cost profile (%)	Cost (US$))	Cost profile (%)	Cost (US$))	Cost profile (%)
Direct cost	172,504.33	92.71	327,545.51	91.37	448,225.36	94.18	948,275.20	92.92
Indirect cost	13,572.96	7.29	30,941.86	8.63	27,719.62	5.82	72,234.44	7.08
Total	186,077.29	100.00	358,487.37	100.00	475,944.98	100.00	1,020,509.64	100.00

Table 6 Multi-way sensitivity analysis of cost estimates

Parameter	Total cost					
	BCC	%change	SME + BCC	%change	FST + BCC	%change
Base case	186,077.29		358,487.37		475,944.98	
Scenario 1	176,568.53	− 5.11	336,409.79	− 6.16	457,677.97	− 3.84
Scenario 2[*]	185,046.70	− 0.55	356,426.18	− 0.57	473,765.29	− 0.46
Scenario 3	200,004.29	7.48	390,137.30	8.83	505,167.14	6.14
Scenario 4	180,024.33	− 3.25	338,532.66	− 5.57	458,270.54	− 3.71

[*] Higher useful life was 5 years each for equipment, 8 years for furniture and 12 years for oven

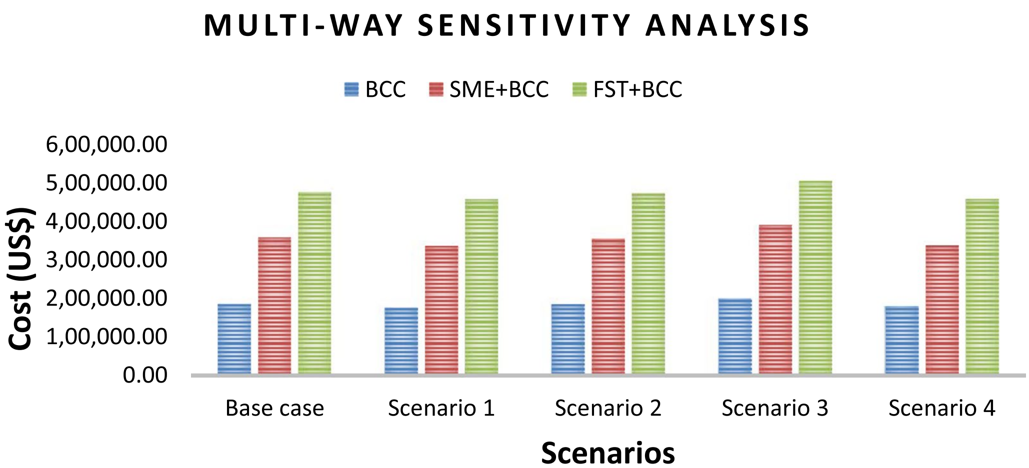

Fig. 2 Multi-way sensitivity analysis of cost estimates

followed by the SME + BCC (US$8,180.38), whilst the FST + BCC constituted the most expensive strategy (US11,185.79). The major cost drivers that led to the differences in costs of FST + BCC from the remaining strategies were the same as those in the financial costs. Just as found in the financial costs of the interventions, personnel formed the highest cost component, followed by administrative costs. This finding corroborate the study of Levin et al. (2019), who reported that personnel and administrative costs constituted the largest economic costs items in the implementation of agricultural nutritional intervention in Kenya. Further, personnel costs as the costliest also validates the study of Maccario, Rouhani [27], when they analyzed the costs of implementing school-based intervention to reduce malaria in Mali.The study further revealed that indirect costs constituted 7% (US$72,234.44) of the total economic costs of the IFs project. The intervention with the highest indirect costs was the SME + BCC, which constituted 43% (US$30,941.86) of the total indirect costs, followed by the FST + BCC with 38% (US$27,719.62), whilst the BCC intervention formed the least indirect costs constituting 19% (US$13,572.96). The SME + BCC had the highest indirect costs due to series of training activities, including training on book keeping, investment, and other business and entrpreneurship tasks, which demanded women participants and volunteers spent more time in meetings and trainings.

The indirect costs of implementing the interventions were high. This calls for the design and implementation of interventions that consider providing financial risk protection against indirect costs to minimize losses to households. Community volunteers had the least indirect costs, which contradicts the findings of Nonvignon, Chinbuah [28], when they opined that indirect costs of Community-Based Agents (CBA's) constituted a considerable part of total economic costs of community programmes in Ghana. However, the difference in the costs of the two studies may be due to the number of CVs employed in the two studies (11CVs in the IFs project as against 661 in the Community Programme). The results further indicate that direct cost of the BCC constituted 93% of the total economic costs, whilst SME + BCC and FST + BCC constituted 91% and 94%, respectively. This study corroborates the findings that direct costs constituted about 71% of the intervention to treat schistosomiasis as part of health programme to minimize anaemia in Tanzania [29]. It further validates the finding of Nonvignon, Chinbuah [28] when they discovered that direct costs formed the highest cost component when they analysed the costs of management of fevers in children under five in Ghana. Generally, the costs of the IFs project is expensive, compared to other forms of interventions. However, programmes that consist of both agriculture and health components are usually expensive (Masters, 2018). Further, the high costs of agriculture and health related interventions aligns with the study of Heckert, Leroy [30], when they estimated the average cost of improving nutrition outcomes through health and nutritional programmes to be US$770 in Brundi. Though the average cost of the IFs project is high compared to similar studies, the project covered few beneficiaries (120), resulting in higher unit costs. Meanwhile, scaling up the interventions to cover larger population may ensure economies of scale, which may help reduce overall costs.

The study has two main limitations. The first is that the cost estimates for women fish processors, community volunteers, and caretakers were based on retrospective data collection. This may have led to recall bias, resulting in either an underestimation or an overstimation of costs.

Second, the study estimated the costs of intervention without the effects (cost effectiveness). As a result, determining the minimum investment required to achieve an expected impact on key outcomes of the project may be challenging.

Conclusion

From societal perspective, implementing the Behaviour Change Communication intervention (BCC) of the Invisible Fishers(IFs) project was the cheapest option to reduce anaemia among women fish processors. Generally, the IFs project is expensive, compared to other forms of anaemia reduction interventions implemented in the sub-region. This is because the benefits of the project spanned only 120 women, leading to high cost per beneficiary. However, the existence of economies of scale should serve as a motivation for project scale-up. This is because as the intervention is implemented as widely as possible, more women fish processors would be covered, meaning fixed costs of the interventions would be spread across wider beneficiaries reducing the cost per beneficiary, compared to only 120 beneficiaries in this study.

The study demonstrates how cost evaluation could be applied to anaemia reduction strategies targeting women fish processors in Ghana. The findings have implications for how cost information for multi-sectoral agricultural nutrition and health interventions can be used as a tool for planning and scaling up similar interventions in the future. Further, the cost data can also serve as a critical input for future cost-effectiveness analyses of similar programmes to improve the well-being of women fish processors in resource-limited settings. Lastly, this is the first study that has estimated the costs of implemnting these novel anaemia mitigating interventions among women fish processors in Ghana, hence contributes meaningfully to literature. Further studies on the cost-effectiveness of the interventions are recommended for scale-up decision.

Abbreviations

ASF	Animal Source Food
CBAs	Community-Based Agents
CHWs	Community Health Workers CVs: Community Volunteers
GHS	Ghana Cedis
IEC	Information, Education, and Communication
IFP	Invisible Fishers Project
ITN	Insecticides Treated Nets
SDG	Sustainable Development Goal
SNV	Netherland Development Organisation
SPRING	Strengthening Partnerships, Results, and Innovation in Nutrition Globally
WHO	World Health Organisation
WRA	Women of Reproductive Age

Supplementary Information

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Supplementary file 1.

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Author contributions

RA conceived and designed the study. JN and RA contributed to the discussion and reviewed the manuscript. JN and JA shaped the methodology, and revised the manuscript substantially. RA reviewed the manuscript, and revised it substantially. FA drafted the manuscript.

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Availability of data and materials

The dataset used and / or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance was granted by the Institutional Review Board (IRB) of the Institute of Statistical, Social and Economic Research (ISSER), University of Ghana (ECH 075/ 20-21) for the study,

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

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