Effect of Behaviour Change Communication to Prevent Anemia and Haemoglobin Concentration Among Children Growth Age 6 -59 Months in Central Highland of Ethiopia: Cluster Randomized Control Trial

Abebe Ferede[1]*, Tefera Belachew[2] and Muluemebet Abera[3]

[1]Department of Public Health, Arsi University, Ethiopia

[2]Department of Nutrition and dietetics, Jimma University, Ethiopia

[3]Department of Population and Family Health, Jimma University, Ethiopia

*Corresponding author: Abebe Ferede, Department of Public Health, Arsi University, Ethiopia.

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ABSTRACT

Background: The study aimed to assess the effect of Nutrition Behaviour Change (NBC) on haemoglobin concentration among the growth of children age 6 to 59 months.

Materials and Methods: A clustered Randomized Control Trial (CRCT) was used from February 2017 to April 2019. "Kebeles" (small administration units) were randomly assigned to either the intervention or control clustered arm and a sufficient buffer zone made between clusters to avoid information contamination. Mothers (Care) givers and their index children were selected from each kebele with a systematic random sampling technique. Blood samples were collected from children before and after 15 months for Haemoglobin (Hb) concentration. T-test and a Generalized Estimating Equations (GEE) models were fitted to isolate independent predictors of haemoglobin concentration.

Results: At baseline 1012 and end-line 815 mothers and their children participated in the study. The mean (±sd) Hbc level was 143g/L+1.6g/L. The differences in the mean haemoglobin level was 7.69 for the intervention and 3.81 for the control (P=0.001). On the GEE analyses, after adjusting for the background variables the intervention group had increased Hbc by 9.93 mg/dl (β=9.93, P <0.05). Similarly, height for age Z-score was positively associated with Hbc mean level (β =7.151, P <0.05).

Conclusions: The study demonstrated the positive effect of NBC on Hbc of children implying the need for galvanizing efforts to disseminate nutrition behaviour change communications to mothers and caregivers of the under five years old children to curb the increasing concern of anemia among these target group.

Introduction

Particularly, iron deficiency (ID) in children is specifically associated with impaired mental and physical development. In advance of its effect, cognitive disturbances can be developed without a sign of anemia [1]. Children during their infantile period of age 2 to 6 months have a high risk of iron deficiency due to their rapid growth [2]. Many reports state that untreated iron deficiency can affect a child's growth and development [3]. According to a

WHO, globally estimated to over 2 billion people are anaemic due to iron deficiency in each year and around 0.8 million deaths (1.5% of the total) are attributed to iron deficiency [4]. In terms of the loss of healthy life, expressed in disability-adjusted life years (DALYs), iron-deficiency anemia results in 25 million DALYs lost (or 2.4% of the worldwide). Specifically, in the African region, about 244 million [46%] of people were estimated to be anaemic [4]. Before

twenty years ago, in developing countries 45% of children aged less than 5 years affected with ID anemia [5]. According to the WHO's global database sources, currently, the prevalence of IDA in children 6 to 59 months excesses to 46% in selected countries of east and southern Africa. From African countries, Uganda leading by 72.6% [6] and followed by Malawi was 62.5% [7]. However, trend analysis for anemia indicates that in East Africa the trend of anemia among children aged 6-59 months reduced from 74% (65-81) in 1995 to 55% (50-59) in 2011 [8]. From various current findings, the prevalence of anemia in developed countries became lower to 7 to 2% among young children due to the application of enhancing enriched foods and change in dietary intake become significant [9].

In Ethiopia, the prevalence of anemia within children of ages 6 to 59 months has been increasing from time to time. At this age group, the trend of anemia was 54 percent in 2005, 44% in 2011, and 56% in 2016 [10-12]. Few studies have been conducted in this country and mostly iron supplementation trials to prevent IDA. However, these studs did not evaluate increasing haemoglobin concentration (Hbc) through dietary behavioural change. To change young children's dietary intake, mothers or caregivers must get knowledge and attitude related to food sources and their preparation means of self-monitoring in gastrointestinal absorption enhancing and inhibiting dietary behaviours. This NBC interventional study had initially taken a baseline assessment that addressed the past behaviour of mothers/ caregivers in young children feeding, determined Hbc level, and nutritional status of the

children for the base of NBC intervention [13]. The online survey was focused to determine the effect of the current NBC intervention project that compressed mothers/ caregivers had modified their behaviour and the meeting point of self-monitoring was extant to increasing their children's Hbc and growth compared to the clustered control group.

Materials and Methods

Study Area and Period

The study was conducted from February 2018 to April 2019 (for 15 months) in Central highland of Ethiopia which includes area found near to Arsi Bale plateau and the neighbouring of Chilalo Mountain. This includes Tiyo, Limuna Bilalo, Digeluna Tijo Districts, and Asella Town. A study area is mountains and has an altitude of above 2400 meters with an average of 350m [14]. Community-based Cluster Randomized Control Trial (CRCT) was used to answer the study hypothesis. Sixteen *kebeles* were selected from Highland Districts of Arsi Zone and randomly assigned either to the intervention group or the control group. All children age 6-59 months and their pair mothers/caregivers found in districts Central Highland of Ethiopia were considered as the source population while children age 6 to 59 months old and their pair mothers/caregivers selected for this study form selected districts found in Central Highland of Ethiopia were considered as the study population.
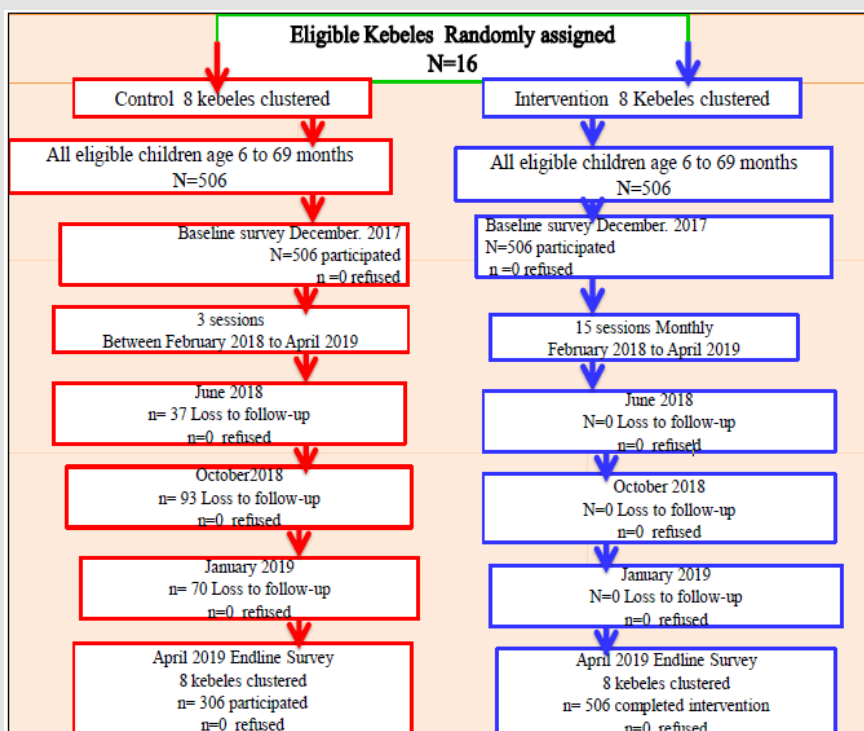

Figure 1: The intervention and control clusters and members of each group substance participation in baseline survey, fellow-up and end-line survey of this study.

The study sample was determined using G power 3.0 software with assuming a power of 95%, precision of 5%, and the effect size of 0.227. Therefore, a total of 1012 mothers and their pair of children were included at the baseline of the study. The mean number of participants per cluster was 506 that had been a ratio of one (equal arm) between interventions: control clusters. Although, 506 (100%) from the intervention group and 309 (61.07%) from the control group participated in the end-line survey. Study participants among the control group were declined by 38.93% during the intervention period because 110 children lost to follow up related to exclusion criteria applied for children appeared with iron deficient in the control group at the baseline survey and 87 of children age was greater than 59 months during the end-line survey (Figure 1).

A multistage sampling method was applied to allocate intervention and control clusters. First, sixteen *kebeles* were randomly assigned to either intervention or control cluster using Emergency Nutritional Assessment (ENA) software, and eight *Kebeles* were allocated to intervention, while the remaining eight were allocated to control. Finally, individual households (HH) and correspondent mothers/caregivers with their index children 6 -59 months were selected using a systematic random sampling technique. During the first months of the survey, assessment of women's knowledge and attitude (KA) about the prevention of IDA and dietary intake of children was assessed [13]. Different recommended dietary sources intake and complementary foods modes used by children were assessed. During the baseline survey, Hbc was measured to determine the past experiences that could sufficiently provide children with enough essential iron nutrients [13].

NBC on Dietary Diversity Intake to Prevent Iron Deficiency

Monthly oral explanation and figure charts used to change knowledge of mothers/caregivers, and although food modification, preparation and handling approach were focus area of the intervention to promote children dietary intake. In the baseline survey, greater than 80 % of children had been introduced with complementary food at their age of 6 months but, household dietary diversity form the food sources acknowledged by WHO and FAO [15,16] averagely 4 or less food groups used and only 18.2% mothers/caregivers used food diversification [13]. The BCC was given for 15 months with every month frequency for each *kebels* by correspondent trained HEW and major activities of this intervention were accomplished mainly by HEW. Conducted intervention events supervised and supported feedback given at completion of each period BCC intervention events.

About maintaining plant and animal food sources when availability or affordability limited in community, complementary foods prepared for the small child have contained sufficient nutrient and density with micronutrient can increase the bioavailability of iron. This may be affected by absorption inhibitors in the diet and challenges of plant-sourced based meals were a focused area of the intervention program. Most of the intervention time women were invited to ask about the massages that were needed revision or clarification any of the knowledge or behavioural barriers at their homes related to iron nutrient intake.

Measurements

Blood Test for Hemoglobin (Hbc)

Before blood sample was collected during baseline for 1012 and end-line for 815 children. Mothers/guardians had been informed about the required blood sample and each child's hand was warmed and relaxed for a safe and precise finger prick at the child's finger to prevent minimum risk. Consequently, after the mother/guardian agreed, she was asked to comfortably hold of her child to prevent sudden movement and accidental injury. Trained laboratory technologists collected each child's blood samples for both periods of baseline and endpoint survey. Hemoglobin concentration (Hbc) was determined using HemoCue Hb 301® analyzer. Each analyzed Hbc was adjusted for altitude [17]. According to the WHO recommendation, correcting the cut-off point of hemoglobin to define anemia in high-altitude populations that range from adding up 0.20g/L to the cut-off for people living at 1000m to 45g/L for those living at ≥4500m [15]. Based on the WHO assumption, the adjusted Hbc was summarized with the study area altitude (>2400m and average of 3500m) which required a reduction of Hbc by 27 g/l [17].

Anthropometric Measurements

Height was measured with bare feet to the nearest 1cm using a stadiometer (a vertical tape fixed perpendicular to the ground on the wall) used for children age ≥24 months. Length board was used for children age less than 24 months. During measurement, the individual child relaxed with no shoes on and lied parallel to the long axis of the board, and then measurement had been taken using 2 trained data collectors. Each child's height was taken and calculated against his/her age for more anthropometric indices such as height for age Z score (HAZ) index to determined children's growth. Weight measured in kilogram (Kg) without shoes and with a slight cover dress, using a battery-powered digital scale for children who were able to stand and hanging spring scale for children <2 years to the nearest of 100gm to 200grams. The weight scale was calibrated to zero before taking the next measurement. Additionally, each child's weight taken was calculated against height for better anthropometric understanding using weight for height Z score (WHZ) indices to measure thinness. These anthropometric indices were taken and interpreted based on WHO reference [18].

Data Processing and Analysis

At the first step of data entering, children's' height (Ht), weight (Wt), age, and sex were entered using Emergency Nutrition Assessment (ENA) software to determine children's nutritional status. These variables were transformed into HAZ and WHZ for each study subject. HAZ = $\geq$-2 Z-score standard deviation (ZSD) predicts as normal growth status and HFA = <-2 ZSD evidenced that child's growth was stunted. In addition to this, WHZ analyzed for each child to determine credence of body mass with his/her height and WHZ= $\geq$-2ZSD specify as normal, and WHZ <-2ZSD had been considered as an individual had thinness [wasting] [18,19]. An independent sample T-test was used for Intention to Treat (BCC intervention) for the differences of difference between intervention and control groups and other variables significance against Hbc declared at T-test Pv <05. Variables that had P >0.2 were taken for further analyses with Generalized Estimating Equations. The results were presented using Beta coefficients (β) and 95% confidence intervals.

Results

Table 1: Mothers'/caregivers' and paired children Socio- demographic status of in Central Highland of Ethiopia, 2019.

Variables	Frequency (n=812)	Percent (%)
Maternal Age		
Age <20	118	14.53
Age 20-35	502	61.82
Age>35	192	23.65
Education Levels		
Illiterate	183	22.54
Grade 1-4	166	20.44
Grade 5-8	273	33.62
Grade 9-12	190	23.40
Marital Status		
Single	36	4.43
Married	710	87.44
Divorced	46	4.48
Widowed	20	2.46
Occupation		
Housewife	463	57.02
Farmer	244	30.05
Businesswomen	56	6.90
Gov/NGO employee	7	0.86
Daily labourer	42	5.17
Annul income (Birr)		
<1000	250	30.79
1000-5,000	446	54.93
5001-10,000	87	10.71
>10,000	29	3.57
Total	812	100%

From 1012 children and their mothers/caregivers who were participated during the baseline survey, only 80% completed their period of intervention and participated during the end-line survey. Most (61.82%) of mothers/caregivers were found within the reproductive age (20 to 35 years) and over half (54.72%) were found from households that had 1000-5,000 annual income (Table 1). The entire (100%) intervention group participants completed their Dietary BCC intervention and participated in the end-line survey. But due to different grounds, only 61.07% of the controls participated in the end-line survey. At baseline, children age <24 months were 50.2% but, at the end-line survey, the majority of children (70.92 %) were age $\geq$24 months and children age <24 months was become 29.08 % because of their age increased by 15 months, which was spent for this intervention. Regarding their sex, 51.2% of males and 48.8% of females were enrolled in the study. On the other point, an exclusion criterion was applied for children from control group were with IDA (27%, n=137) during baseline survey and 63 (12.45%) loosed their follow-up due to increased age of children above 59 months from control group (Table 2).

Table 2: Mean HbC differences between baseline and endpoint survey within different variables among children age 6 to 59 months in Highland of Arsi zone, Oromia, Ethiopia, 2019.

Variables	N=812(%)	Mean HbC g/L	HbC mean differences (Pv)
Groups difference			
Intervention	506(62.31)	141.69	1.54(0.001)
Control	306(37.69)	124.81	
Sex			
Male	416(51.2))	126.68	0.76 (0.832)
Female	396(48.8)	125.91	
Age			
Age >=24 months	575(70.81)	125.93	1.28 (0.471)
Age <24 months	237(29.19)	137.21	
Height for Age			
>= -2 Z SD	574(70.69)	143.12	0.94 (0.001)
< -2 Z SD	238(29.31)	117.87	
Weight for Height			
>= -2 Z SD	513(63.18)	138.42	1.64(0.843)
< -2 Z SD	299(36.82)	121.99	
Meal procured pattern			
>3 times in day	597(59.00)	132.54	1.51 (0.062)
<3 times in day	115(11.36)	121.76	
Meal frequency contained organ meats			
Within day to week	238(29.31)	147.32	1.57 (0.231)
After week or more	574(70.68)	113.56	
Meat such as beef, lamb, goat, chicken			
Within day to week	294(36.20)	132.28	1.85 (0.034)
More than week	518(63.79)	125.67	

HbC, haemoglobin concentration; g, gram; L, Litter; g/L, gram per litter of blood; n, sample; Z, Z score; SD, Standard Deviation.

Mean Hbc was increased (143g/L±1.6g/L) at endpoint than the baseline (125.5±1.73g/L. Mean Hbc among the intervention group was 122.55($\pm$ 17.98)g/L at baseline and 148.34($\pm$14.91)g/L at the end-line survey. However, no meaningful change among the control group (130.71[$\pm$15.67]) at baseline and 130.73($\pm$14.92) g/L at the end-line. The prevalence among children who participated in this study at baseline was (18.2 % [13] and thus, the baseline finding was higher compared to the end-line survey (8.83%), which was almost by more than half of percent of IDA decreased among study subjects. At the baseline survey, the prevalence of iron deficiency anemia (Hbc<110 g/L) among the intervention group was higher (25.89%) than the control group (10.47 %). However, the prevalence of IDA among the control group at the end-line survey almost had not changed (9.71 %) from the baseline finding. But IDA among the intervention group declined by more than three times (8.30%) at the end-line survey than the baseline (Table 2).

In our rank analysis to compare the mean of end-line - baseline difference of the difference in the quintiles of Hbc between intervention and control groups showed that near to 50% control group subjects found at lower ranks (1st and 2nd). However, a significant proportion (40.1%) of in intervention group subjects was found at a higher rank (4th and 5th). But in the advance rank analysis, the proportion of study subjects assigned to the control group had not been found at higher ranks (4th and 5th). For more interpretation perceive Figure 1 (Figure 2). Additionally at the end-line survey, End line differences in HbC among children assigned to intervention and control groups bothered that 24.5% of the intervention group had found at higher (5th) rank compared to the control group (13,1%). In the analysis spectrum, the distribution of study subjects among the intervention group was regular and increased while rank increased. The experience of the control group along the rank appreciated as a higher proportion of study subjects found at lower ranks (24.1%) and less proportion of subjects found at higher ranks (Figure 3).
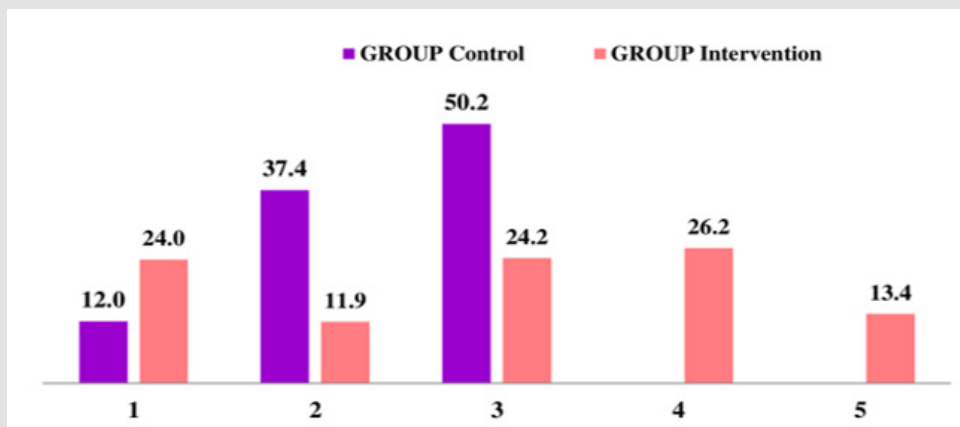
Figure 2: Mean end line-baseline difference of the differences in the quintiles Hbc quintiles between intervention and control groups.
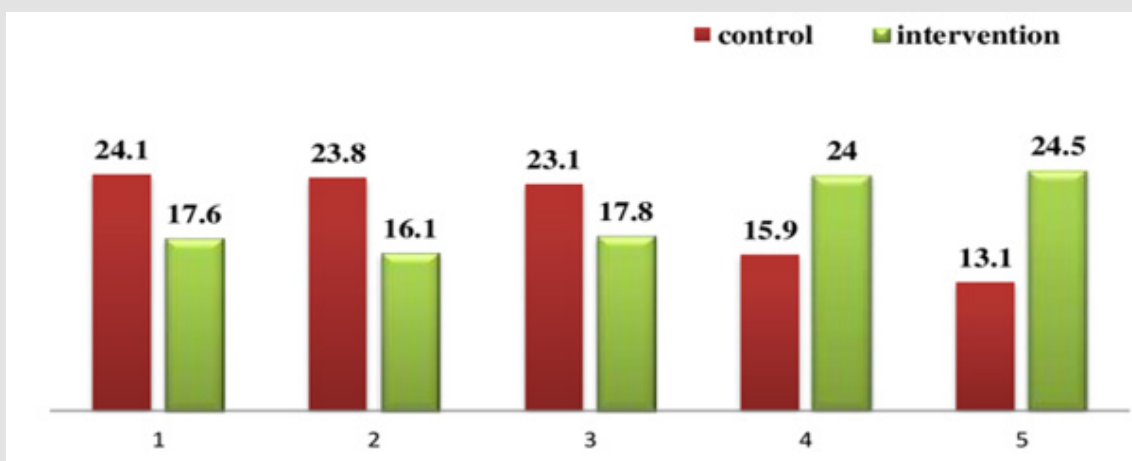

Figure 3: End line differences in Hbc among children assigned to intervention and control group.

The difference of differences in the mean haemoglobin level was 7.69 for the intervention and 3.81 for the control. Mean Hbc during baseline and end-line surveys had differences between intervention and control groups (MD Hbc = 3.88, SE=1.02) g/L, p=0.001). The differences within baseline and end line showed that children who had stunted growth [< -2 Z SD] were more likely to be iron deficient (mean Hbc = 3.76) g/L compared to those children who were normal [HFA $\geq$-2 Z SD] mean Hbc = 7.15) g/L consequential the mean Hbc difference was significant (MD= 3.39, SE=1.21, p=0.001). Also, children, who had WAZ = $\geq$-2 Z SD had higher mean Hbc difference (6.92)g/L compared to children who had WAZ=<-2SD (2.07)g/L and differences mean Hbc among this nutritional status

at baseline and end-line survey statistically significant (MD=4.85, SE=1.89, p=0.001)g/L (Table 3). Concerning children's mothers'/caregivers' knowledge and attitude status towards IDA prevention and self-mentoring in dietary intake behaviour was improved from baseline 49.9 % [13] to 74.72 % end line. There was a difference in the attitude in IDA prevention between the intervention group (80.04%) and the control group [66.02%] (Table 4). The mean Hbc differences end-line-baseline was higher (139.87) g/L among children whose their mothers/ caregivers who modified their commune attitude towards IDA prevention during the intervention period than the control group (118.43) g/L and resulting in mean Hbc difference was significant (MD= 21.44 SE= 2.07, p=0.014).

Table 3: Mothers'/caregivers' knowledge and attitude status about IDA prevention and children dietary intake self-mentoring behaviour in Central Highland of Ethiopia, 2019.

Variables	n=812		HbC mean	
	Yes (%)	No (%)	Mean HbC	differences (P)
Commune attitude in iron deficiency				
Control	212(69.28)	94(30.72.41)	118.43	
Intervention	401(79.24)	105(20.75)	139.87	-4.36 (0.814)

Awareness (knowing) of IDA				
Control	179(61.94)	110(38.06)	123.98	5.06 (0.83)
Intervention	435(83.17)	88(16.82)	147.91	
Understand the cause of IDA				
Control	163(56.40)	126(43.60)	124.27	11.85 (0.061)
Intervention	440(84.13)	83(15.87)	135.45	
Currently no breast-feeding				
Control	109(37.72)	180(62.28)	112.32	1.74(0.010)*
Intervention	104(19.89)	419(80.11)	141.32	
Fruit intake after meal				
Control	135(46.71)	154(53.29)	117.38	-4.17(0.101) *
Intervention	413(78.98)	101(21.03)	148.13	
Use only cow milk as complementary fed				
Control	124(42.90)	165(57.09)	123.61	19.38 (0.131)
Intervention	423((80.88)	55(29.09)	143.22	
Using tee/ coffee with meal				
Control	138(47.75)	151(52.25	124.27	11.85(0.163)
Intervention	432(82.60)	91(31.49)	135.45	

HbC, hemoglobin concentration; g, gram; L, Litter; g/L, gram per litter of blood; n, sample.

Table 4: Generalized Estimating Equations predicting HbC mean difference odds within different predictors among children age 6 to 59 months, in highland of Arsi Zone, Ethiopia, 2019.

Variables	Parameter Estimates	
	β	SE (95%CI)
	9.93	4.97 (3.60-13.74) *
Height for Age	7.151	2.31(1.92-7.38) *
Meal procured pattern	1.014	0.98(0.76-4.02)
Meal frequency contained organ meats	5.352	1.28 (1.04-3.65) *
Meat such as beef, lamb	0.703	2.19 (0 .051-9.03)
Currently no breast-feeding	0.934	0.351(0.103-2.39)
Using tee/ coffee with meal	0.816	0.69 (0.851-4.33)
Cow milk not used exclusively as complementary	8.110	1.63(1.26-5.96) *
Fruit intake after meal	6.173	1.86 (0.05-6.33)
Using tee/ coffee with meal	0.114	0.36 (0.031-6.23)

β, Beta; CI, Confidence interval, SE, Standard Error.

Furthermore, understanding the way of preventing IDA among the intervention group of mothers/ caregivers was increased to their children mean Hbc difference (135.45) g/L compared to the control group (124.27)g/L and this means Hbc difference became substantial (MD = 11.18, SE= 1.34, p=0.016). Mothers/ caregivers who used basic diet from own production among the intervention group had increased mean Hbc difference of their children (MD= 29.0, SE= 3.12, p=0.010) and behaviour experiencing with usual fruit consumption after a meal among household during the intervention period had increased mean Hbc of children [MD= 30.75, SE= 5.17, p=0.001] (Table 4). Finally, on Generalized Estimating Equations (GEE) model, mean Hbc difference increased by 9.93mg/dl among intervention group (β =9.93, 95%,CI: 3.60-13.74), whereas,

children growth (HAZ ≥-2SD) had positive association with Hbc (β=7.151,95% CI:192-7.38). Regarding dietary intake pattern, meal contained organ meats had a likely to increase Hbc mean (β=5.35, 95% CI:1.04-8.65), and having diversified animal and plant sources for complimentary food increased mean Hbc [β=8.11, 95%CI: 1.26-15.96] (Table 4).

Discussion

After 15 months of behaviour change communication intervention, the mean haemoglobin concentration among study subjects was higher and changed from 125.5g/L at baseline to 143g/L at endpoint survey compared to global mean haemoglobin trained change between 1995 and 2011 among children age under

5 years showed that minor improvement was reported (from 109 g/L to 111 g/L), but among high-income countries was better (130.0g/L) [8] which is lesser than our current study findings. The prevalence of anemia was very lower (8.74%) at the end-line survey, especially among the intervention group (7.65%) and among control (9.71%) than baseline (18.20%). However, these finding is very low compared to the global findings at different levels. According to WHO 2015 report, the prevalence of anemia among children age 6 to 59 months in 2011 was 42.6% [18] which is higher than our study finding. The national Demographic Health Surveys (EDHS) reported that the prevalence of anemia was 56% and 44% in 2016 and 2011 in that order [10,11]. A study conducted in Kilte Awulaelo districts of Northern Ethiopia showed that the prevalence of anemia among children was 37.3% [20], which is far higher than our findings. These differences could be since our study area has been found at high altitude, where malaria is very less. Furthermore, as the current study has a BCC intervention, it was expected that the prevalence of anemia would be lower in the overall sample.

However, the prevalence of anemia in our current finding suggests that the problem can be considered as a mild public health problem [21] and comparable to that of developed and rapidly developing countries [6-20%] [8]. This is good although a lot of work remains to be improved in encouraging mothers or caregivers about infant and young child feeding to prevent anemia throughout the nation. It was also observed that mean Hbc was significantly associated with height for age z-score, which is consistent with a study conducted in Kazakhstan [22]. A systematic review and meta-analysis study concluded that there no significant association between haemoglobin concentration and children's growth [23]. This might be because the study analysed multiple observational and short interventional studies that might not be sufficient to elucidate the effect of haemoglobin concentration on the growth of children. A positive association between haemoglobin and complementary foods that contain iron-rich sources foods has also been reported [24]. According to World Health Organization (WHO), children under 5 years are at risk of iron deficiency anemia due to not consuming an animal source of foods (liver, meat, and fish) which are rich in iron [25,26], which are comparative report with our findings that shows most of the mothers/ caregivers did not feed iron-rich foods to their young children which could increase the risk of anemia.

It was also observed that households who regularly provided cow's milk to their young children as exclusive complimentary food had lower mean Hbc. Milk contains low iron (about 0.2 to 0.5mg/l) which might not meet the requirement for young children [27]. Especially, frequent milk consumption without alternative complementary food could lead to a lower intake of iron [25]. The introduction of cow milk with the long duration of feeding at the early age of children became the most important dietary risk factor for anemia [28]. Milk contained micronutrients (casein, whey proteins, and calcium) that potentially inhibit the absorption of minute iron found in cow's milk [29]. Our BCC intervention targeted individual mothers/caregivers to promote better processing of household foods into the possible nutritious complementary foods for their children. In a poor resource setting, iron supplementation trials required meticulous for study subjects who are living or coming to areas where malaria and infectious diseases are common [30]. A distinction to this, dietary BCC interventional study would not require these types of precondition to prevent IDA. Progressively more food-based approaches involving fortification, improving dietary quality through diversification/modification and nutrition education, and biofortification is being pursued than iron supplementation [24]. In Ethiopia, although essential nutrition actions behaviour change communication has been going on using urban and rural health extension workers to reduce micronutrient deficiency, the prevalence of anemia rather increased. The findings imply the need for upgrading the level of education being given to mothers/care givers to prevent anemia through dietary approaches. The study did not assess the prevalence of anemia through all citizens which should be considered by future research.

Conclusion

The findings showed that the mean haemoglobin concentration increased from 122.55$\pm$17.98g/L to 148.34 ($\pm$14.91) g/L for the intervention group compared with that of controls which increased from 130.71$\pm$15.67 to 130.73$\pm$14.92) g/L. The study demonstrated a positive effect of behaviour change communication on haemoglobin concentration of children implying the need for the galvanizing efforts to disseminate nutrition behaviour change communications to mothers and caregivers of the under five years old children to curb the increasing concern of anemia among these target group. Dietary BCC intervention is better to use everywhere and at any time contrasts to iron supplement trials.

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