Chars Livelihoods Programme

Reducing Extreme Poverty on the Riverine Islands of North West Bangladesh

CLP Annual Nutritional Survey Report 2008-2014

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Innovation, Monitoring Learning and Communications Division

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Acronyms

BMI	Body Mass Index
BMIZ	BMI z-scores
CED	Chronic Energy Deficiency
CLP	Chars Livelihoods Programme
CLP 1	Phase 1 of the Chars Livelihoods Programme
CLP 2	Phase 2 of the Chars Livelihoods Programme
CLP 2.1	Phase 2 of the Chars Livelihoods Programme, first cohort
CLP 2.2	Phase 2 of the Chars Livelihoods Programme, second cohort
CLP 2.3	Phase 2 of the Chars Livelihoods Programme, third cohort
CLP 2.4	Phase 2 of the Chars Livelihoods Programme, fourth cohort
CLP 2.5	Phase 2 of the Chars Livelihoods Programme, fifth cohort
CPHH	Core Participant Households
DFID	Department For International Development
GoB	Government of Bangladesh
HAZ	Height-for-Age
IMLC	Innovation, Monitoring, Learning and Communication
WAZ	Weight-for-Age
WHZ	Weight-for-Height

Executive Summary

1. In the total sample in 2014, about one third of mothers of reproductive age were suffering from Chronic Energy Deficiency (33.7%) and nearly a half were anaemic (46.3%). About two fifths of children suffered from stunting (38.8%), half of the children (50.3%) were underweight, a quarter of them (25.9%) were wasted and nearly a half of the children (46.1%) were anaemic.

2. The nature of a longitudinal cohort study is that the number of children under 5 years of age reduces over time and in 2014 only 11 children remained under 5 years of age in CLP1, 12 in CLP2.1, 30 in CLP2.2, 73 and 30 in CLP2.3 and the control, respectively while CLP 2.4 included 202 children under 5 years of age in Round 10.

3. For mothers' BMI measurements, all cohorts showed significant upward trends throughout the surveys in the post-intervention period (all $p<0.001$). Mothers' BMI in CLP1 increased on average by 1.8 units and CLP2.1 and CLP2.2 improved by just about 1 unit between 2010 and 2014. CLP2.3 increased by 0.24 units from 2012 to 2014 although the control also increased by 0.8 units, on average.

4. Mothers haemoglobin concentration did not show any significant improvement, except in CLP2.3 which improved between 2012 and 2014 ($p=0.010$). A few significant reductions (worsening) were found; 2010 to 2012 in CLP1 and 2012 to 2014 in CLP2.4 ($p=0.004$ and $p<0.001$, respectively).

5. HAZ in children showed improvements in the post-intervention period. After downward trend of HAZ was found from 2008 to 2009, CLP1 showed a significant improvement in HAZ score in children between 2009, 2010 and 2012 ($p=0.001$ and <0.001, respectively) although no significant change was found after 2012. Other cohorts showed significant improvement in HAZ from 2012 to 2014 (CLP2.1 and 2.2; $p=0.001$, CLP2.3, 2.3 control and 2.4; $p<0.001$). There was no significant change in CLP2.1 between 2010 and 2011.

6. In general WAZ worsened in all cohorts. WAZ score significantly worsened from 2008 to 2009 in CLP1, but the downward trend after 2009 were not significant. No significant changes were found in CLP2.1 over the surveys. WAZ in CLP2.2 worsened significantly from 2010 to 2012 ($p=0.037$), but not after 2012. CLP2.3 and its control and CLP2.4 also significantly worsened between 2012 and 2014 ($p<0.001$, <0.001 and 0.003, respectively).

7. BMI z-scores (alternative score to WHZ) worsened significantly after 2010 in CLP1 and after 2012 in CLP2.1. CLP2.2 showed downward trend but not significant. CLP2.3 and its control and 2.4 worsened significantly from 2012 to 2014.

8. Haemoglobin concentration in children showed upward trends in all cohorts. CLP1 showed significant consistent improvement after intervention from 2010 to 2014 (total $p<0.001$). CLP2.1 and 2.2, however, did not show any significant improvement in means from 2010 to 2014. CLP 2.3 and its control and 2.4 increased significantly from 2012 to 2014 (all $p<0.001$).

9. Tests of nutritional status in mothers between CLP2.3 and its control group after Round 7 showed that; 1) in CLP2.3 BMI improved consistently by about 1.3 units compared with

the control group over the three surveys and 2) no difference in haemoglobin concentrations was found over the three surveys.

10. Comparison of children's nutritional status in CLP2.3 and its control group revealed; 1) HAZ in CLP2.3 was about 0.4SD better than its control from Rounds 7 to 8, however the control group showed significantly greater improvement than CLP2.3 after Round 8 (p=0.001), 2) CLP2.3 showed nearly 0.4SD better WAZ score than its control group from Rounds 7 to 8 but the control group improved about 0.4 SD between after Round 8 (p=0.002), 3) there were no overall mean differences and the trends of WHZ and BMIZ and both were very similar across the three surveys in both groups, and 4) CLP2.3 had, on average, about 1g/dl higher mean haemoglobin concentration than the control in Round 7 and the difference did not change in Round 8, however the mean in the control group showed a significantly greater improvement than CLP2.3 after Round 8 (p<0.001).

11. Tests between CLP2.3 and its control and CLP 2.4 aimed to compare groups with different lengths of intervention between Rounds 8 to 10; CLP2.3 had already received 1 year of intervention at Round 8 while for CLP2.4 it was the baseline survey. 1) Mothers' BMI in the control group of CLP2.3 showed significant lower overall BMI means than CLP2.3 and 2.4 (p<0.001) and the differences were consistent over the two surveys. 2) CLP2.4 showed a reduction in haemoglobin concentration from Rounds 8 to 10 whereas CLP2.3 and its control increased and the overall mean of haemoglobin concentration in CLP2.4 was significantly lower than in CLP2.3 and it control (p=0.005).

12. There were no clear nutritional differences in children between the cohorts in relation to length of intervention. 1) Mean HAZ in the CLP2.3 control group at Round 8 was about 0.4SD on average poorer than CLP2.3 and 2.4, however it showed a sharp rise from Rounds 8 to 10 and there was no overall mean differences between the groups (p ns). 2) mean WAZ in CLP2.3 control group also increased from Rounds 8 to 10 whereas CLP2.3 and 2.4 did not change. 3) Both WHZ and BMIZ changes were not different by cohorts. 4) Haemoglobin concentration between cohorts did not show significant differences over the two surveys.

1. Background of the Surveys

CLP has been conducting annual longitudinal nutritional surveys since 2008 and measured anthropometry (weight and height) and haemoglobin concentration (as an indicator of iron deficiency anaemia) of mothers and children below 5 years of age across 10 Districts, 28 Upazilas, 61 Unions and 144 island chars. This report uses longitudinal and cross-sectional analyses of the nutritional status of the 10 cohorts. The nutritional status has been measured by Body Mass Index (BMI) and anaemia status (haemoglobin concentration) in mothers and by height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) and haemoglobin concentration in children. BMI below 18.5 is a measure of Chronic Energy Deficiency in adults, HAZ is a measure of chronic undernutrition (stunting), WHZ is a measure of acute undernutrition (wasting) and WAZ is a combination of both acute and chronic undernutrition (underweight) in children. A haemoglobin concentration below 12.0g/dl in non-pregnant mothers and below 11.0g/dl in children under 5 years of age and 11.5g/dl in children aged above 5 years is a measure of anaemia.

2. Data sources

Data were available from a total of 10 surveys conducted between March 2008 and October 2014. As can be seen from Table 1, CLP1 measured anthropometry of mothers and children up to 10 times and haemoglobin measurements up to 5 times beginning in 2010 (Round 5). Information on anthropometry and haemoglobin are available 5 times in CLP2.1 cohort, 4 times in CLP2.2, 3 times in CLP2.3 cohort and its control group (CLP2.3 cohort has additional measurement in Round 9 in 2013). Round 10 measured a cohort of CLP 2.5 which was 1 year after the intervention commenced and CLP2.6 was measured as baseline. The numbers of households are also described in Table 1. Rounds 2, 4, 6, 8 and 10 were measurements at the same season (October, highlighted). Post-intervention measurements are highlighted in red; CLP1's intervention in 2009, CLP2.1's intervention ended in December 2011, CLP2.2's intervention ended in June 2012, CLP2.3's intervention ended in June 2013 and CLP2.4's intervention ended in June 2014.

Table 1: History of CLP Nutrition Surveys and the numbers of sample in the data

Rounds	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Measurements	Anth	Anth	Anth	Anth	Anth +Hb	Anth +Hb	Anth +Hb	Anth +Hb	Anth +Hb	Anth +Hb
Cohorts										
1	1394	1464	1330	1488	642	602	588	575	-	495
2.1					410	387	365	357		295
2.2						409	375	360		429
2.3							424	406		355
2.3 control							432	401	430	145
2.4								414		347
2.5										377
2.6										431
Total	**1394**	**1464**	**1330**	**1488**	**1052**	**1398**	**2184**	**2513**	**430**	**2874**

NB: Anth (anthropometry measurement), Hb (haemoglobin measurement), in red: post-intervention meaurements

3. Prevalences of undernutrition in non-pregnant women aged 15-49 years and children below 5 years of age

This analysis described the prevalence of undernutrition in women of reproductive age (non-pregnant and aged 15-49 years) and children below 5 years of age.

3.1 Prevalence of Chronic Energy Deficiency and anaemia in non-pregnant women aged 15-49 years

In general there was a reduction in Chronic Energy Deficiency (CED) across all cohorts. For example, nearly half of the mothers in CLP1 (49.0%) were suffering from CED at baseline and there was about 20% reduction (30.9%) in the 6 years from 2008 to 2014 (Table 2). The prevalences of CED in CLP2.1 and CLP2.2 were 38.7% and 46.9%, respectively, at baseline (Rounds 5 and 6) and they reduced by about 9% and 15%, respectively, over the 4 years up to 2014. The control group of CLP2.3 had a slightly higher prevalence of CED at baseline (48.7% vs 41.3%, respectively) and the control group reduced by 4% whereas CLP2.3 reduced by 9% by 2014. CLP2.5 and 2.6 had around 40% of mothers with CED.

However, the prevalence of anaemia in mothers showed an inconsistent pattern in general. For example, around half of the CLP1 mothers (44-52%) suffered from anaemia over the 6 surveys (Table 3). In CLP2.1, 43.4% of mothers had anaemia at baseline and the prevalence increased by 13% up to Round 7 (56.7%), and a reduction showed as similar level at baseline in Round 10 (47.4%). The proportion of mothers suffered from CED was similar in CLP2.2 for the 4 years from 2010 to 2014 within the range of 49-54%. Mothers in CLP2.3 suffered from anaemia about 7% more than the control group at baseline (46.5% vs. 39.6%) but at Round 10, the control group had 6% more mothers with anaemia than CLP2.3 (43.9% vs. 37.9%). Just below half of mothers were anaemia in CLP2.4 at baseline and about a 12% reduction was found by 2014. In CLP2.5 nearly half of the mothers were anaemic and about 40% in CLP2.6 in 2014.

Table 2: Prevalence (%) of Chronic Energy Deficiency in non-pregnant women aged 15-49 years

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	49.0	53.6	44.9	47.0	38.7	42.7	40.1	35.8		30.9
2.1					38.7	46.0	49.2	36.8		29.7
2.2						46.9	44.8	45.3		32.1
2.3							41.3	41.3		32.4
2.3 control							48.7	51.8	41.9	44.9
2.4								41.5		26.9
2.5										41.1
2.6										39.1
Total	49.0	53.6	44.9	47.0	38.7	44.8	42.7	44.0	41.9	33.7

Table 3: Prevalence (%) of anaemia in non-pregnant women aged 15-49 years

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-	-	-	-	45.7	43.5	51.6	49.2		47.0
2.1					43.4	50.2	56.7	52.6		47.4
2.2						51.4	53.8	49.1		50.9
2.3							46.5	44.7		37.9
2.3 control							39.6	50.2	33.6	43.9
2.4								45.1		57.0
2.5										48.9
2.6										40.2
Total					44.8	47.5	49.4	48.2	33.6	46.3

3.2 Prevalence of stunting, underweight, wasting and anaemia in children aged under 5 years and all children

The nature of a longitudinal cohort study is that the number of children under 5 years of age reduces year by year. Only 11 children remained under 5 years of age in the longest studied cohort (CLP1), followed by 12 (CLP2.1), 30 (CLP2.2), 73 and 30 in CLP2.3 and the control, respectively while CLP 2.4 included 202 children under 5 years of age in Round 10.

3.2.1 Children under 5 years of age

About one third of children in CLP1 were stunted at baseline (37.4%) and the prevalence increased to 61.0% in Round 5 but then showed reductions later (Table 4). CLP2.1 and 2.2, however, did not show any clear reductions from baseline to 2014 (53.6% to 50.0%, 42.9% to 43.3%, respectively). About half of the children in CLP2.3 were stunted at baseline and there was a 7% reduction by 2014. However the control group showed nearly 2.5 times greater reduction (18%) from Rounds 7 to 10 (53.9 to 35.5%). In CLP2.4, one third of children were stunted and the prevalence increased by 8.5% (46.1%) in the 2 years up to 2014. Nearly half of the children in CLP2.5 and 2.6 were stunted in 2014 (47.7% and 41.2%), respectively.

The prevalence of underweight in children in CLP1 was 37.0% at baseline increasing to 63.3% in Round 5 followed by a reduction to 38.2% in Round 8 and 40.0% in Round 10 (Table 5). CLP2.1, 2.2, 2.3 and its control and 2.4 showed upward trends in underweight; 50% to 75% from Rounds 5 to 10, 41% to 50% from Rounds 6 to 10, 43% to 51% and 45% to 36% from Rounds 7 to 10, respectively. Just below 50% of children were underweight in CLP2.5 and 2.6 at Round 10.

Wasting in CLP1, 2.1 and 2.2 did not change dramatically throughout the surveys (15-21% in CLP1, 19-24% in CLP2.1 and 19-24% in CLP2.2) except in Round 10 which may be confounded due to the small sample sizes (Table 6). More wasting was found in CLP2.3 than in the control in Round 7 (15.8% vs. 13.2% respectively) but the control group showed more wasting than CLP2.3 at Round 10 (29.0% vs. 24.7% respectively). One in five children suffered from wasting in CLP2.4 at baseline and there was a 5% increase in the 2 years to 2014. In CLP2.5 and 2.6, 23.6% and 21.8% of children were wasted, respectively in 2014.

When the haemoglobin concentration measurements started in Round 5, about half of the children under 5 years of age were anaemic in CLP1 and the prevalence of anaemia fell to 37% at Round 7 but increased to 46% at Round 8 (Table 7). In CLP2.1, about 50% of children were anaemia at baseline reducing to 41% in Round 8 but increasing to over 80% in Round 10. The high prevalence in Round 10 may be confounded by the small sample size. About half of the children in CLP2.2 suffered from anaemia in Rounds 6 to 8 (47.3%, 43.4% and 50.9%, respectively). CLP2.3 control had 5% higher prevalence of anaemic children than CLP2.3 at baseline in Round 7 (58.1% vs. 53.1%) and CLP2.3 showed about a 14% reduction but the control group showed about a 25% reduction in anaemia in Round 10. More than a half of children in CLP2.5 and just below a half of the children in CLP2.6 were found to be anaemic in Round 10.

Table 4: Prevalence (%) of stunting in children under 5 years of age

	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	37.4	48.8	55.5	61.0	64.0	58.0	54.9	27.3		18.2
2.1					53.6	54.6	56.6	48.8		50.0
2.2						42.9	47.5	39.6		43.3
2.3							50.7	44.9		43.8
2.3 control							53.9	43.0	63.4	35.5
2.4								37.6		46.1
2.5										47.7
2.6										41.2
Total	37.4	48.8	55.5	61.0	59.0	51.2	52.4	41.0	63.4	43.8

Table 5: Prevalence (%) of underweight in children under 5 years of age

	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	37.0	39.2	23.3	51.5	63.3	58.4	51.9	38.2		40.0
2.1					50.2	50.0	52.7	56.8		75.0
2.2						41.4	45.4	46.3		50.0
2.3							43.2	50.8		50.7
2.3 control							44.9	60.3	39.5	35.5
2.4								40.3		51.0
2.5										46.8
2.6										47.2
Total	37.0	39.2	23.3	51.5	56.9	49.4	46.8	49.3	39.5	47.8

Table 6: Prevalence (%) of wasting (WHZ below -2) in children under 5 years of age

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	19.7	15.3	17.2	15.1	20.8	20.5	21.2	20.0		40.0
2.1					19.3	19.0	24.0	23.3		33.3
2.2						19.2	23.5	18.9		20.0
2.3							15.8	25.7		24.7
2.3 control							13.2	35.2	18.4	29.0
2.4								19.7		25.0
2.5										23.6
2.6										21.8
Total	19.7	15.3	17.2	15.1	20.1	19.6	19.5	24.7	18.4	23.6

Table 7: Prevalence (%) of anaemia in children under 5 years of age

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-	-	-	-	49.0	37.6	37.1	45.5		27.3
2.1					52.0	49.8	44.2	40.9		81.8
2.2						47.3	43.4	50.9		37.9
2.3							53.1	50.6		38.9
2.3 control							58.1	60.3	41.7	33.3
2.4								58.0		52.5
2.5										57.5
2.6										48.7
Total					50.5	45.0	48.8	53.5	41.7	50.4

3.2.2 All children

The prevalence of undernutrition in all children is presented in Tables 8 to 11. BMI z-scores (BMIZ) were calculated using an alternative wasting score because WHZ z-scores were available only for children below 5 years of age. Seasonal changes in food availability and security as well as infection burden impact on nutritional status in general, therefore it makes sense to make comparisons at the same season (October surveys in Rounds 2, 4, 6, 8 and 10).

Just above one third of children suffered from stunting at the baseline survey in CLP1 and it increased by 16% after 2 years (37.4% to 53.5% in Rounds 1 to 4) and then fell to 29.0% in Round 10. More than half of the children in CLP2.1 were stunted (53.6%) at baseline and there was an 18% reduction by 2014. The prevalence of stunting in CLP2.2 was 43% in 2010 at baseline and fell by 7.5% for the 4 years until 2014. In CLP2.3 and the control group, just over 50% of children were stunted at baseline in 2012 (50.7% and 53.9%, respectively) and the prevalence fell by nearly 14% in both CLP2.3 and the control group by 2014. In CLP2.5 and 2.6, over 40% of the children suffered from stunting at Round 10 (46.6% and 41.6%, respectively).

The prevalence of underweight in CLP1 children was 37% at baseline and increased by 23% at Round 5 (60.1%), then the prevalences stayed around 56-60% up to Round 10. In CLP2.1, more than a half of the children suffered from underweight consistently. About 40% of children in CLP2.2 were underweight at baseline and the prevalence increased by 13% in the 4 years up to 2014. The prevalences of underweight in CLP2.3 and its control were similar at around 43%-45% at baseline and increased by 7-8% in both groups from Rounds 7 to10. About 40% of children in CLP2.4 were underweight and the prevalence increased by about 7% for the 2 years since 2012. In CLP2.5 and 2.6, just under a half of the children suffered from underweight in 2014.

One in six children suffered from wasting (using BMI z-scores) in CLP1 at the beginning (16.8%) and the prevalence increased and nearly doubled by 2014 (39.8%). In CLP2.1, the prevalence of wasting in Round 6 was the lowest (15.5%) but by 2014 the prevalence had doubled to 33.3%. CLP2.2 also showed an upward trend in wasting from 17.6% to 28.7% over the 4 years. About 11% of children were wasted in both CLP2.3 and its control group at baseline and CLP2.3 wasting increased by 12% but by 19% in the control group by 2014. About 16% of children in CLP2.4 were wasted at baseline increasing by about 4% in the 2 years to 2014. Wasting in CLP2.5 and 2.6 was around 20% in 2014.

About half of the children in CLP1 suffered from anaemia at Round 5 and the prevalence fell to 31% by Round 10. More than half of the children in CLP2.1 were anaemia at baseline falling to 42% in 2014. There was no clear reduction of CLP2.2 with prevalences of between 46-49% throughout the surveys. Between 53% and 58% of children were anaemic in CLP2.3 and its control respectively and both showed reductions of 12%-14% up to 2014. About 60% of children in CLP2.4 were anaemic at baseline reducing to 51% in 2014. In CLP2.5 more than half of the children suffered from anaemia while in CLP2.6 just under half of the children suffered from anaemia in 2014.

Table 8: Prevalence (%) of stunting in all children

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	37.4	48.0	50.3	53.5	50.2	48.7	45.1	33.2		29.0
2.1					53.6	52.9	50.0	39.5		35.7
2.2						42.9	44.9	42.8		35.4
2.3							50.7	46.7		37.0
2.3 control							53.9	44.7	60.0	39.7
2.4								37.4		40.1
2.5										46.6
2.6										41.6
Total	37.4	48.0	50.3	53.5	51.5	48.0	48.5	40.1	60.0	38.8

Table 9: Prevalence (%) of underweight in all children

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	37.0	38.9	23.2	50.2	60.1	57.0	56.9	59.0		55.8
2.1					50.2	50.0	50.5	55.9		53.6
2.2						41.4	44.9	49.5		54.2
2.3							43.2	52.0		51.3

2.3 control							44.9	60.8	50.0	52.3
2.4								40.6		48.4
2.5										46.9
2.6										47.5
Total	37.0	38.9	23.2	50.2	56.4	50.4	48.7	53.0	50.0	50.3

Table 10: Prevalence (%) of wasting using BMI z-score below -2 in all children

	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	16.8	12.9	12.4	12.0	22.1	20.1	22.2	38.7		39.8
2.1					22.8	15.6	21.4	22.7		33.3
2.2						17.6	15.8	22.2		28.7
2.3							11.4	19.1		23.4
2.3 control							11.1	24.2	11.6	30.4
2.4								15.9		20.0
2.5										20.1
2.6										20.6
Total	16.8	12.9	12.4	12.0	22.4	18.2	16.6	24.3	11.6	25.9

Table 11: Prevalence (%) of anaemia in all children

	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-	-	-	-	48.7	38.6	45.4	46.1		31.1
2.1					52.0	48.5	47.5	44.7		42.3
2.2						47.3	46.4	48.9		47.2
2.3							53.1	51.3		41.2
2.3 control							58.3	60.4	48.5	44.8
2.4								58.2		51.0
2.5										56.9
2.6										48.3
Total					49.9	43.9	49.8	51.8	48.5	46.1

4. Mean changes in nutritional measurements in all mothers and children from 2008 to 2014

4.1 BMI and haemoglobin concentration in mothers

CLP1 mother's mean BMI in 2008 was just above the cut-off level of CED (18.87 and 18.65 in Rounds 1 and 2 respectively) and improved consistently across surveys to reach 20.47 in 2014 (Table 12). In CLP1, BMI increased on average by 1.8 units from 2008 to 2014. CLP2.1 and CLP2.2 also showed about 1 unit improvement from 2010 to 2014. CLP2.3 increased by 0.24 units from 2012 to 2014 although the control also increased by about 1 units, on average.

However mean haemoglobin concentration did not show any clear changes (Table 13). In CLP1 and CLP2.1, the haemoglobin concentrations started at similar levels (11.95 and 11.94g/dl, respectively) and increased by 0.21 and 0.07g/dl on average, respectively, from 2010 to 2014. CLP2.2 showed a small reduction of 0.02g/dl from 2012 to 2014. CLP2.3 and its control group's mean were very similar at baseline (12.04 and 12.07g/dl, respectively) and CLP2.3 increased by 0.14g/dl although the control group increased by 0.36g/dl, on average, from 2012 to 2014.

Repeated measures analysis of variance was used to test the trends of within-mother changes in BMI scores in the same season in 2008 (Round 2), 2009 (Round 4), 2010 (Round 6), 2012 (Round 8) and 2014 (Round 10) and haemoglobin concentrations in 2010 (Round 6), 2012 (Round 8) and 2014 (Round 10). Paired sample t-test was used to examine the within-mother change between 2012 and 2014 using estimated means after taking into account effects of age.

For BMI measurements, all cohorts showed significant upward trends throughout the surveys (all $p<0.001$) and also between 2008 and 2009, 2009 and 2010, 2010 and 2012 and 2012 and 2014, including the CLP2.3 control group (Figure 1).

However tests of within-mother changes in haemoglobin concentration did not show significant improvements, except for CLP2.3 from 2012 to 2014 ($p=0.010$, Figure 2). A few significant reductions (worsening) were found; 2010 to 2012 in CLP1 and 2012 to 2014 in CLP2.4 ($p=0.004$ and $p<0.001$, respectively).

Table 12: Mean BMI values in mothers over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	18.87	18.65	19.07	18.99	19.60	19.41	19.76	19.80		20.47
2.1					19.08	18.85	19.03	19.11		19.77
2.2						19.09	19.19	19.37		20.12
2.3							19.50	19.49		20.27
2.3 control							18.74	18.67	19.41	18.91
2.4								19.26		20.02
2.5										19.42
2.6										19.91
Total	18.87	18.65	19.07	18.99	19.16	19.29	19.25	19.42	19.41	19.90

Table 13: Mean Haemoglobin values in mothers over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-	-	-	-	11.95	12.02	11.74	11.85		11.81
2.1					11.94	11.87	11.66	11.76		11.80
2.2						11.79	11.66	11.81		11.81
2.3							12.04	11.90		12.13
2.3 control							12.07	11.80	12.18	11.94
2.4								11.91		11.55
2.5										11.77

2.6										12.06
Total					11.95	11.91	11.84	11.84	12.18	11.86

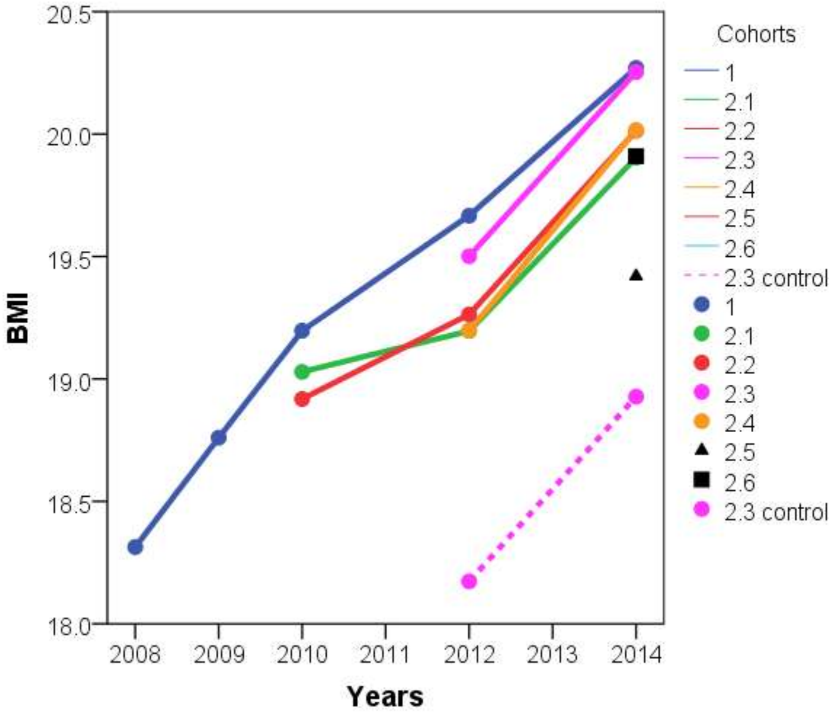

Figure 1: Within-change of mean BMI in mothers at the same season

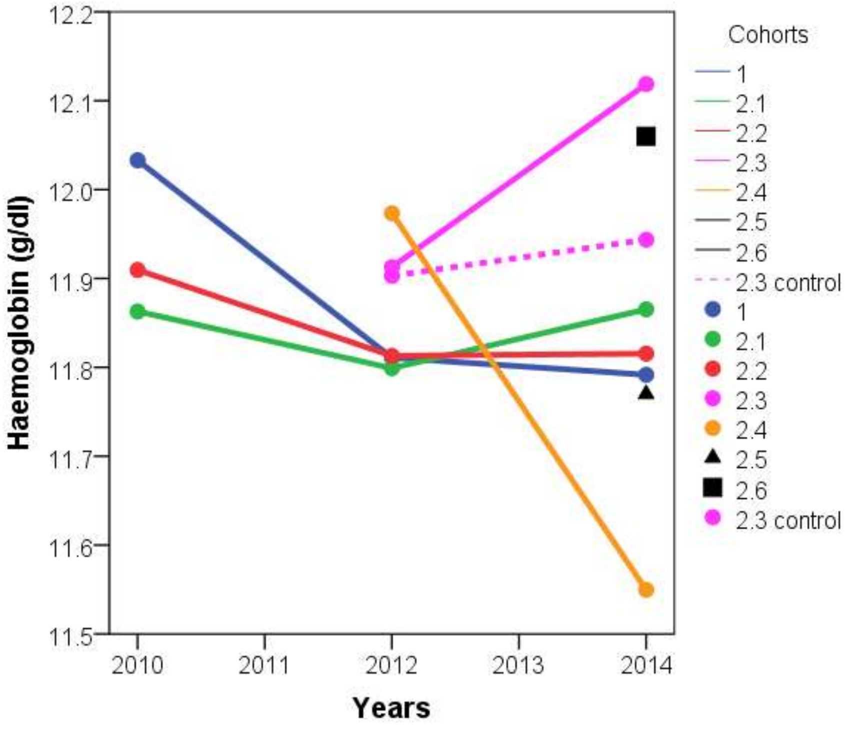

Figure 2: Within-change of mean haemoglobin concentration in mothers at the same season

4.2 Z-scores and haemoglobin concentration in children

The z-scores of children and haemoglobin concentrations were calculated taking into account age and sex effects and the mean scores are shown in Tables 14 to 18.

Mean HAZ in CLP1 was -1.50 and it declined by about 0.5SD from Rounds 1 to 4 and then improved by 0.39 SD up to 2014. Mean HAZ in CLP2.1 at baseline was below the -2.00 cut-off point for stunting (-2.13) but improved by nearly half a SD (+0.44 SD) from Rounds 5 to 10. The mean HAZ in CLP2.2 was close to -2.00 at baseline (-1.95) and it improved by 0.27 SD in the 4 years since 2010. CLP2.3 and its control had the same mean at baseline (both -1.98) and both improved to -1.68 and -1.69, respectively by 2014. The baseline mean of HAZ in CLP2.4 was -1.76 and it showed a small improvement (+0.09 SD) in the 2 years from 2012. CLP 2.5 and 2.6 both had means of -1.66 in 2014.

WAZ showed an inconsistent trend due to the seasonality effect but overall there was a worsening in mean scores; for example in CLP1, at baseline the mean was -1.67 and it worsened by about half a SD in the 6 years from 2008 to 2014. Mean WAZ for CLP2.1 at baseline was below the -2.00 cut-off point of underweight (-2.16) and it worsened slightly by 0.06 SD, on average, at Round 10. The mean WAZ in CLP2.2 was just about -2 at baseline and it worsened by -0.18 SD by Round 10. CLP2.3 and its control had similar means at about -2 throughout the three surveys in Rounds 7, 8 and 10. In CLP2.4 the mean WAZ did not show much change and remained between -1.93 and -1.98. CLP2.5 and 2.6 had similar means of -1.84 and -1.82 respectively in 2014.

WHZ and BMIZ showed similar inconsistent trends due to the seasonal variation. BMI mean z-scores in CLP1 in 2008 was about -1 and improved to -0.15 in Round 3 then fell back to the level of -1 in Round 4, then continued to fall to -1.82 in 2014. CLP2.1 and 2.2 were about -1 at baseline and worsened to -1.65 and -1.58, respectively, in 2014. Mean of BMIZ in CLP2.3 and its control were both about -1SD and both worsened to -1.42 and -1.38, respectively in 2014. CLP 2.5 and 2.6 had means of -1.14 and -1.11, respectively in 2014.

All cohorts showed small but constant improvements in haemoglobin concentrations throughout the surveys. CLP1 at Round 5 was 11.15g/dl on average and it improved slightly to 11.80g/dl in 2014. Mean haemoglobin in CLP2.1 and 2.2 was 10.79 and 10.83 g/dl respectively at baseline and they increased to 11.54 and 11.44g/dl respectively in 2014. CLP2.3 and its control showed similar means (10.69 and 10.71g/dl respectively) at baseline and both increased by around 0.5g/dl from Rounds 7 to 10. Mean haemoglobin in CLP2.4 was 10.80g/dl at baseline and increased by 0.25g/dl for 2 years. CLP 2.5 and 2.6 showed similar means (10.78 and 10.74g/dl, respectively) at Round 10.

Repeated measures analysis of variance tested for the trends of within-child HAZ, WAZ, WAZ, BMIZ score changes and haemoglobin concentration at the same season in 2010, 2012 and 2014, after taking into account of sex and age effects. A paired sample t-test was used to examine the within-child change between 2012 and 2014 using estimated means after taking into account of age and sex.

HAZ showed an inconsistent pattern in all cohorts (all $p<0.001$, Figure 3). HAZ in CLP1 worsened significantly from 2008 to 2009 ($p=0.004$), however it then improved from 2009 to 2012 ($p=0.001$ and <0.001, respectively) although no significant change was found after 2012. Other cohorts showed significant improvements in HAZ from 2012 to 2014 (CLP2.1 and 2.2; $p=0.001$, CLP2.3, 2.3 control and 2.4; $p<0.001$). There was no significant change in CLP2.1 between 2010 and 2011.

WAZ worsened consistently, in general, in all cohorts (Figure 4). A significant downward trend was found from 2008 to 2009 in CLP1, but the trend after 2009 was not significant. No significant changes were found in CLP2.1. CLP2.2 significantly worsened from 2010 to 2012 ($p=0.037$), but not after 2012. CLP2.3 and its control and 2.4 showed significant downward trends between 2012 and 2014 ($p<0.001$, <0.001 and 0.003, respectively).

WHZ within-child changes could not be tested as the sample sizes were too small in the later surveys but the means after controlling for age and sex are presented in Figure 5. The tests of within-child changes in BMI z-scores showed significant downward trends after 2010 in CLP1 and CLP2.1 (Figure 6). There was no significant trend in CLP2.2. CLP2.3 and its control and CLP2.4 showed a significant downward trend from 2012 to 2014.

Haemoglobin concentration showed upward trends in all cohorts (Figure 7). CLP1 showed a significant constant increment from 2010 to 2014 (total $p<0.001$). CLP2.1 and 2.2, however, did not show any significant improvement in means from 2010 to 2014. CLP 2.3 and its control and 2.4 increased significantly from 2012 to 2014 (all $p<0.001$).

Table 14: Mean HAZ over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-1.50	-1.91	-2.00	-2.08	-1.93	-1.88	-1.83	-1.82		-1.69
2.1					-2.13	-1.93	-1.91	-1.80		-1.69
2.2						-1.95	-1.93	-1.79		-1.68
2.3							-1.98	-1.77		-1.68
2.3 control							-1.98	-1.78	-1.94	-1.69
2.4								-1.76		-1.67
2.5										-1.66
2.6										-1.66
Total	-1.50	-1.91	-2.00	-2.08	-2.03	-1.92	-1.92	-1.79	-1.94	-1.67

Table 15: Mean WAZ over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-1.67	-1.72	-1.38	-2.01	-2.14	-2.06	-2.09	-2.18		-2.26
2.1					-2.16	-2.01	-2.00	-2.08		-2.22
2.2						-1.99	-1.98	-2.05		-2.17
2.3							-1.98	-1.98		-2.05
2.3 control							-1.99	-1.97	-1.78	-2.03
2.4								-1.93		-1.98
2.5										-1.84
2.6										-1.82
Total	-1.67	-1.72	-1.38	-2.01	-2.15	-2.02	-1.99	-2.03	-1.78	-2.00

Table 16: Mean WHZ over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-1.12	-0.92	-1.16	-1.12	-1.40	-1.28	-1.24	-1.40		-1.33
2.1					-1.35	-1.26	-1.19	-1.39		-1.54
2.2						-1.25	-1.18	-1.37		-1.46
2.3							-1.10	-1.35		-1.47
2.3 control							-1.11	-1.34	-0.91	-1.38
2.4								-1.31		-1.40
2.5										-1.27
2.6										-1.25
Total	-1.12	-0.92	-1.16	-1.12	-1.38	-1.26	-1.15	-1.35	-0.91	-1.31

Table 17: Mean BMIZ over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-1.03	-0.72	-0.15	-0.98	-1.33	-1.23	-1.32	-1.51		-1.82
2.1					-1.18	-1.11	-1.14	-1.38		-1.65
2.2						-1.07	-1.10	-1.34		-1.58
2.3							-0.97	-1.24		-1.42
2.3 control							-0.97	-1.24	-0.80	-1.38
2.4								-1.18		-1.32
2.5										-1.14
2.6										-1.11
Total	-1.03	-0.72	-0.15	-0.98	-1.26	-1.15	-1.12	-1.32	-0.80	-1.38

Table 18: Mean Haemoglobin values over 10 surveys

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Year	**2008**	**2008**	**2009**	**2009**	**2010**	**2010**	**2011**	**2012**	**2013**	**2014**
Month	**Mar-July**	**Oct**	**April**	**Oct**	**May**	**Oct**	**June**	**Oct**	**Oct**	**Oct**
Cohorts										
1	-	-	-	-	11.15	11.31	11.43	11.46		11.80
2.1					10.79	10.94	11.06	11.20		11.54
2.2						10.83	10.97	11.11		11.44
2.3							10.69	10.92		11.20
2.3 control							10.71	10.90	10.97	11.16
2.4								10.80		11.05
2.5										10.78
2.6										10.74
Total					10.97	11.06	11.01	11.07	10.97	11.15

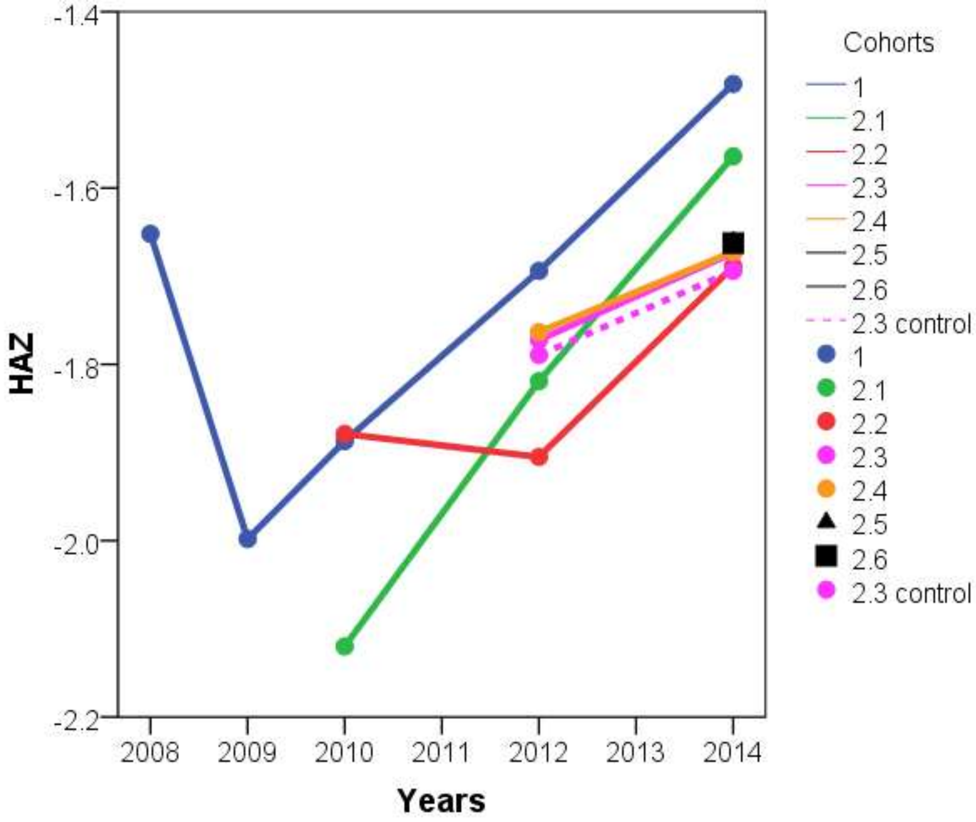

Figure 3: HAZ within-changes in children at same season from 2008 to 2014

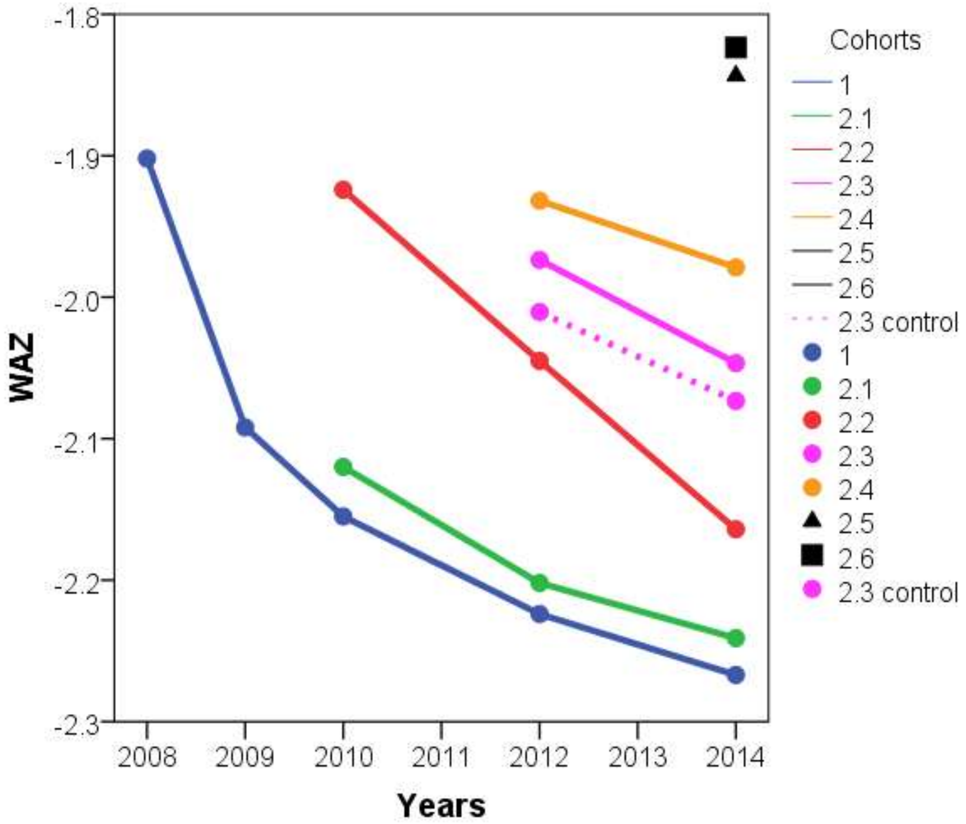

Figure 4: WAZ within-changes in children at same season from 2008 to 2014

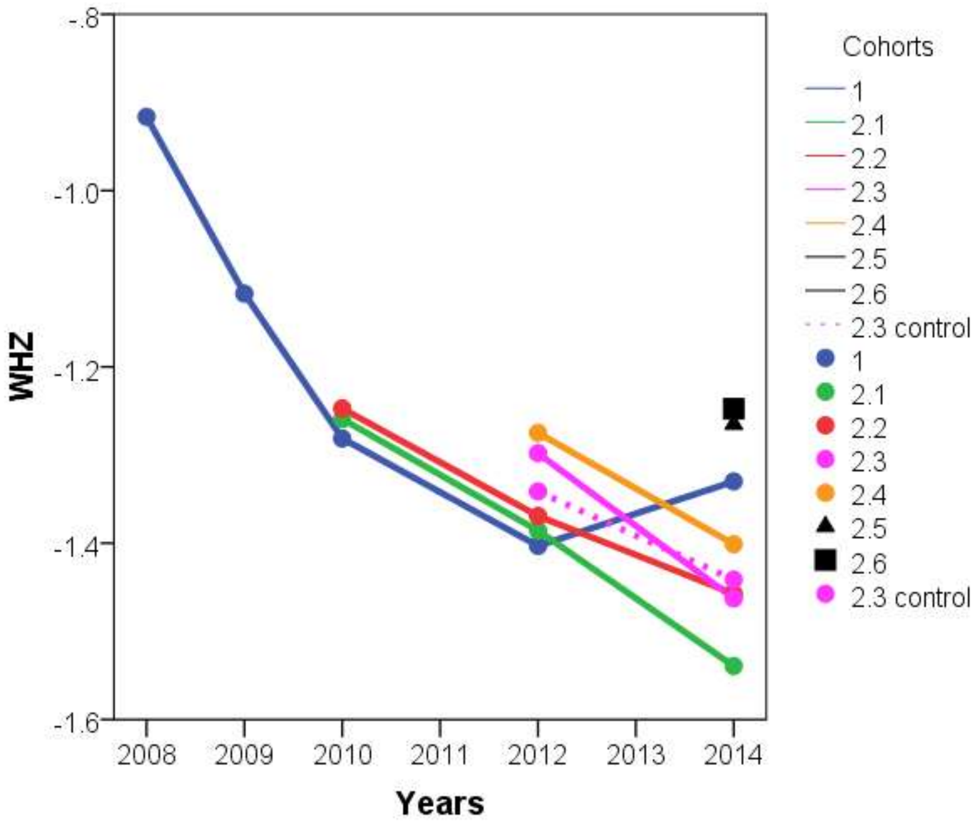

Figure 5: WHZ within-changes in children at same season from 2008 to 2014

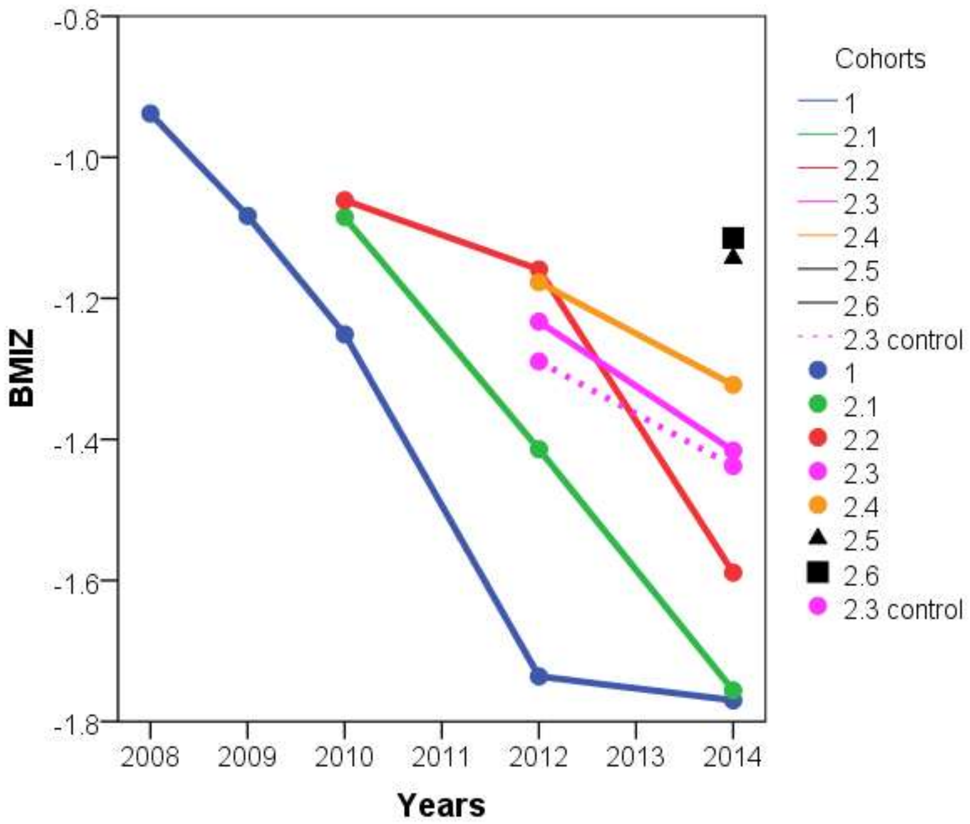

Figure 6: BMIZ within-changes in children at same season from 2008 to 2014

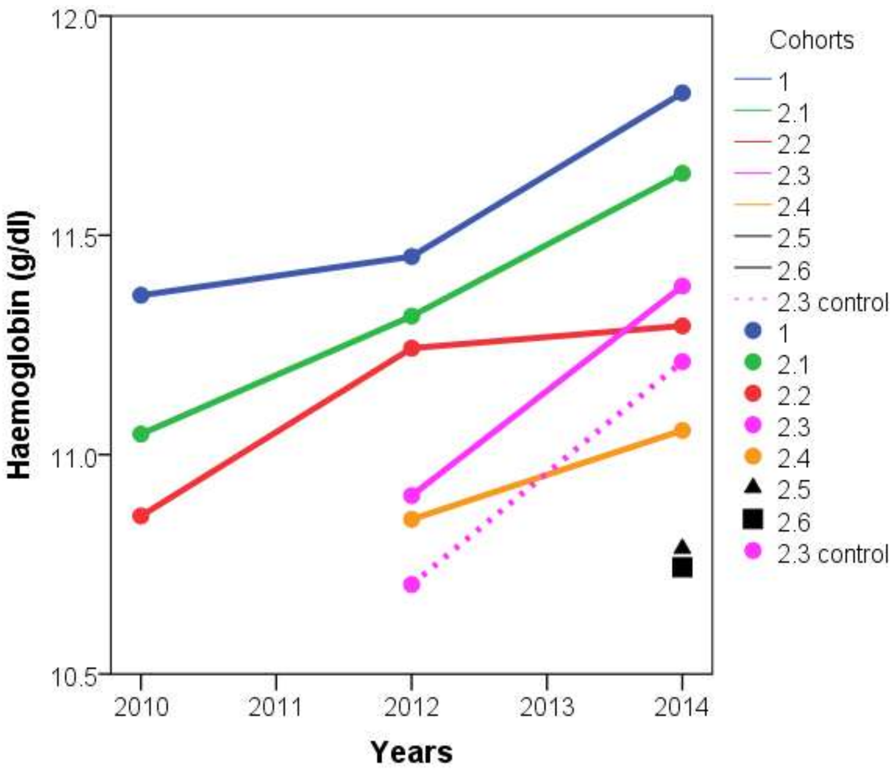

Figure 7: Haemoglobin within-changes in children at same season from 2008 to 2014

5. Difference in nutritional status of mothers and children between CLP2.3 and its control group

Repeated measures analysis of variances was used to examine the pattern of within-subject changes in mothers' BMI and haemoglobin concentration as well as children's z-scores and haemoglobin concentration over the three surveys (R7, R8 and R10) between CLP2.3 and its control group. Therefore, the analyses used samples having complete data for all 3 measurements.

5.1 Mothers' BMI and haemoglobin

The mean BMI of mothers in CLP2.3 was about 1.3 units higher than the control group consistently over the three surveys and the differences were the same (i.e. parallel, see Figure 8). Testing between Rounds 8 and 10 in the same season, gave similar results.

Overall the mean haemoglobin concentration in mothers was not different between CLP2.3 and the control (both 12.0g/dl, p ns; Figure 9). There were no significant differences between groups throughout three surveys. The comparison of Rounds 8 and 10 in the same season also did not reveal any significant differences either.

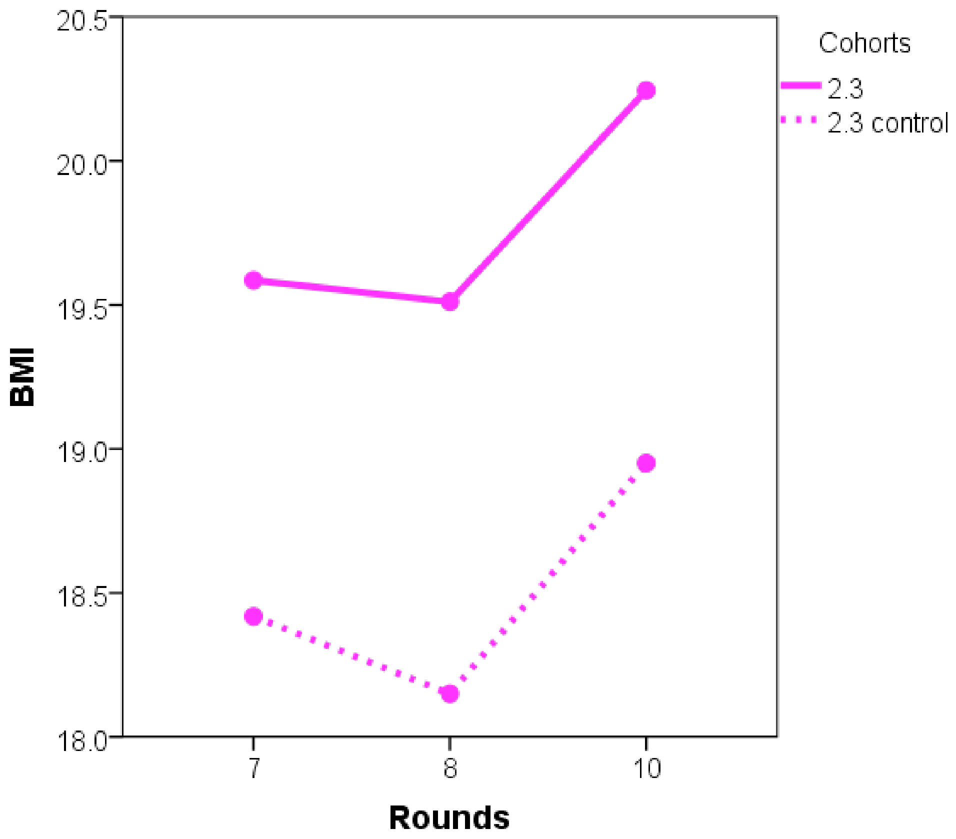

Figure 8: Mothers' mean BMI between CLP2.3 and its control group

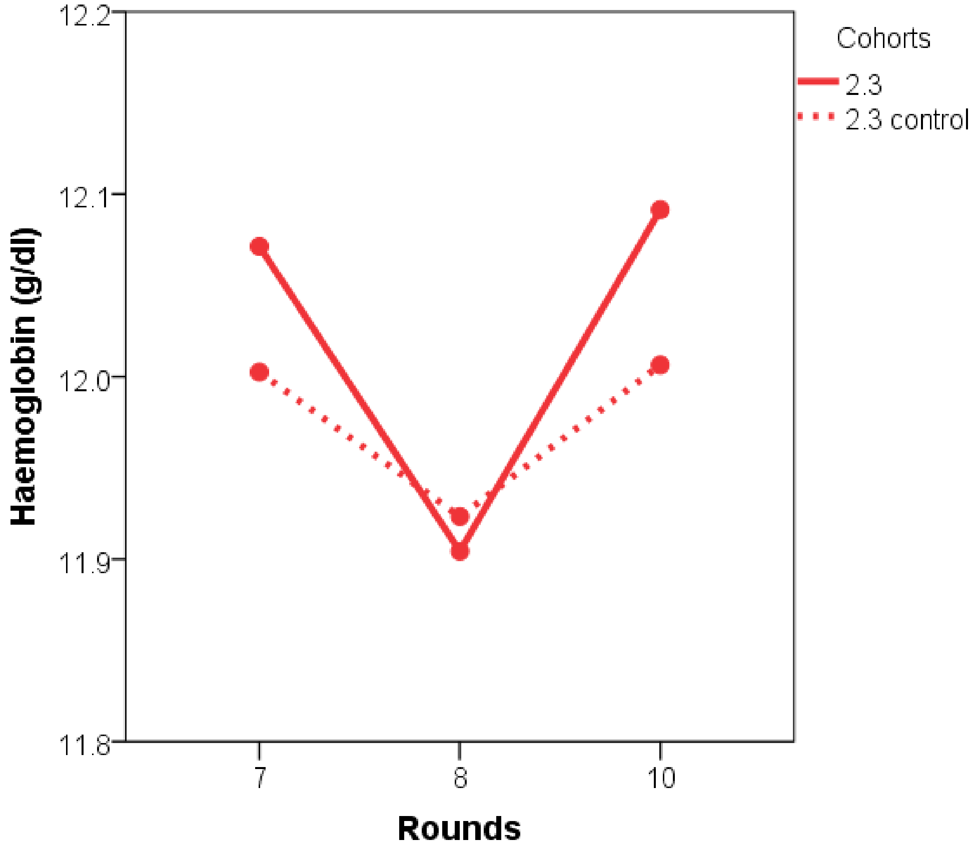

Figure 9: Mothers' mean haemoglobin concentration between CLP2.3 and its control group

5.2 Children's z-scores and Haemoglobin

HAZ in CLP2.3 was about 0.4SD better than in the control group at Round 7 (Figure 10). In Round 8 both cohorts improved by the same amount. However the control group showed significantly greater improvement than CLP2.3 from Rounds 8 to 10 ($p=0.001$). Overall the means from Rounds 7 to 10 were worse in the control group (-2.03) than CLP2.3 (-1.76) but the difference was not significant.

CLP2.3 had a nearly 0.4SD better mean WAZ score than its control group from Rounds 7 to 8 (Figure 11), but the control group improved by about 0.4 SD between Rounds 8 and 10 ($p=0.002$). The overall mean in the control group was about 0.3 SD worse than CLP2.3 (-2.23 and -1.97, respectively), but the difference was not significant.

Mean changes of WHZ and BMIZ showed very similar patterns (Figures 12 and 13). There were no overall mean differences and the trends were very similar across the three surveys in both groups.

Haemoglobin concentration showed upward trends in both CLP2.3 and its control (overall $p<0.001$, Figure 14). CLP2.3 had, on average, about 1g/dl higher mean than the control in Round 7 and the difference did not change in Round 8. However the control group mean showed a significantly greater improvement than CLP2.3 from Rounds 8 to 10 ($p<0.001$). Overall the mean of CLP2.3 was, on average, 0.6g/dl significantly higher value than the control ($p<0.001$). The overall mean difference was significant when comparing in the same season (Rounds 8 and 10), but the different pattern of changes between the two surveys was not statistically significant (p ns).

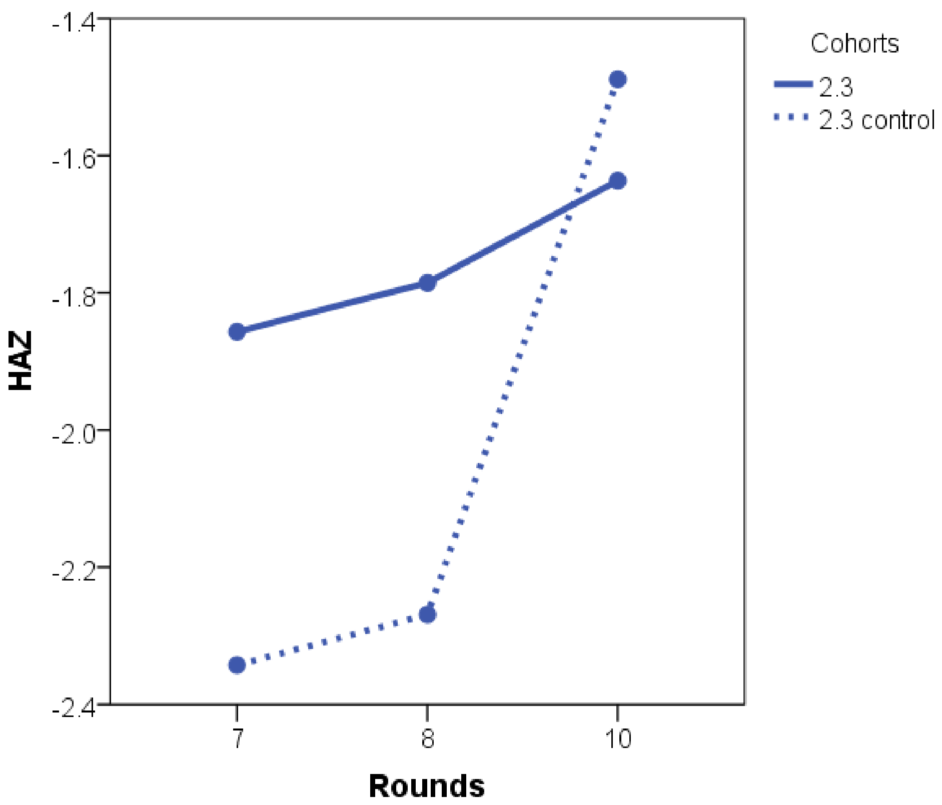

Figure 10: Mean HAZ in children between CLP2.3 and its control

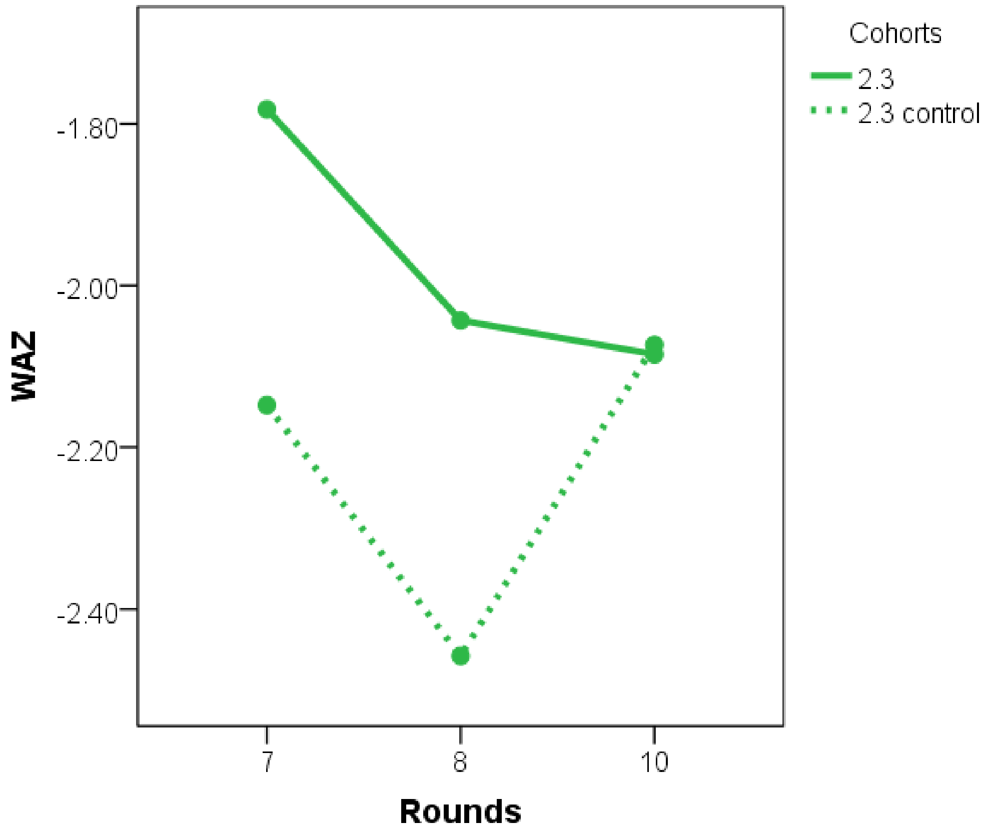

Figure 11: Mean WAZ in children between CLP2.3 and its control

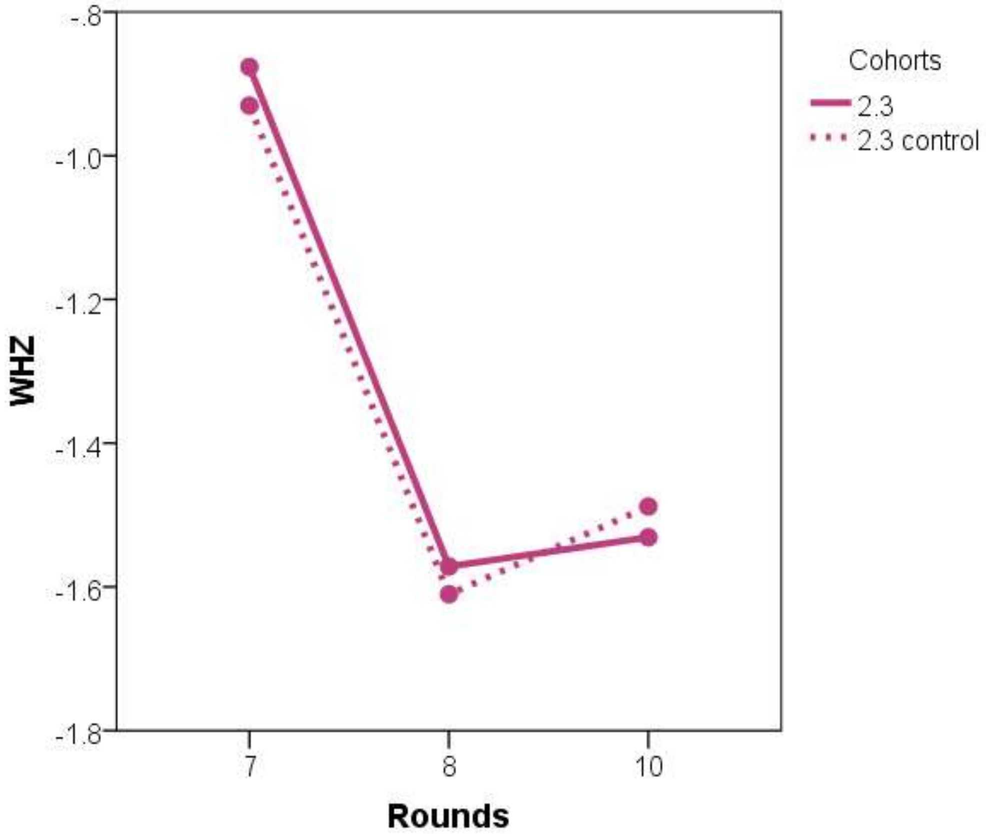

Figure 12: Mean WHZ in children between CLP2.3 and its control

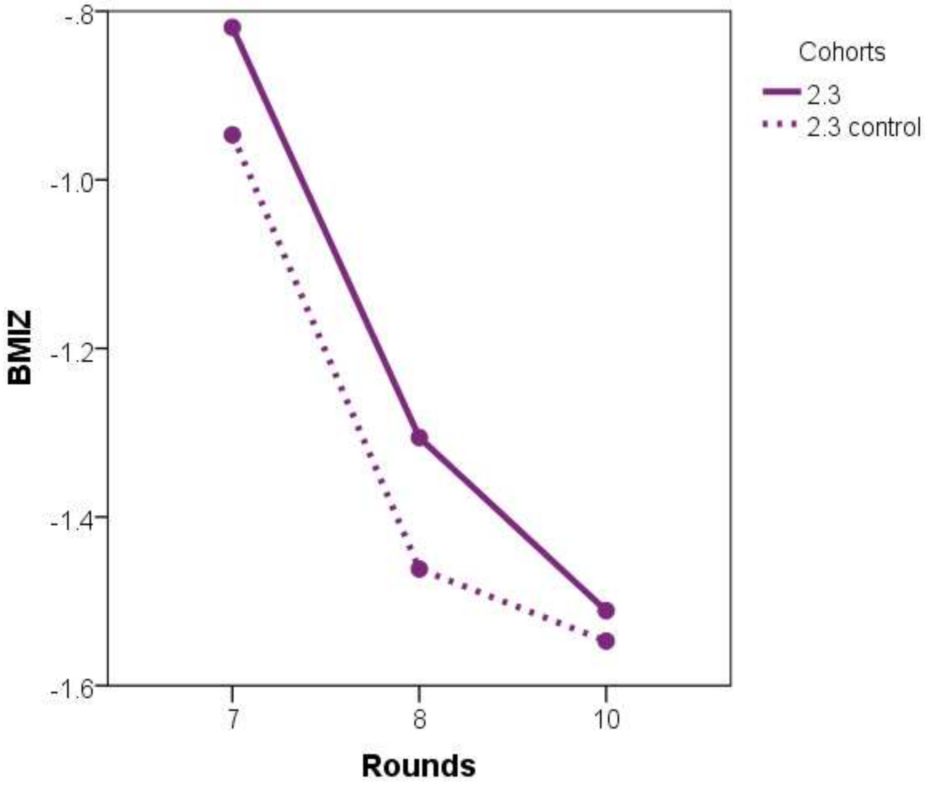

Figure 13: Mean BMIZ in children between CLP2.3 and its control

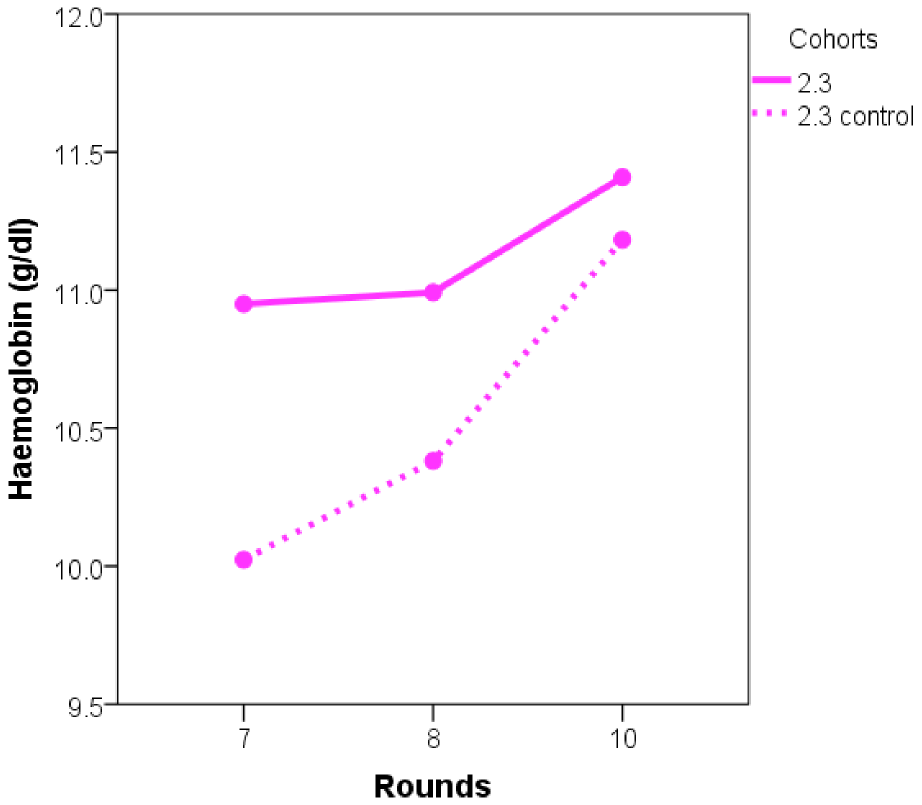

Figure 14: Mean haemoglobin concentration in children between CLP2.3 and its control

6. The difference in nutritional status of mothers and children between CLP2.3 and its control and CLP2.4

Repeated measures analysis of variances was used to examine the pattern of within-subject changes of CLP2.3 and its control as well as the CLP2.4 group in relation to mothers' BMI and haemoglobin concentration as well as children's z-scores and haemoglobin concentration over the two surveys (Rounds 8 and 10). This analysis compared groups with different intervention lengths; in Round 8 CLP2.3 had already received 1 year of intervention while for CLP2.4 Round 8 was the baseline survey.

6.1 BMI and haemoglobin in mothers

The control group of CLP2.3 showed significant lower overall BMI means than CLP2.3 and 2.4 ($p<0.001$, Figure 15) and the differences were consistent (i.e. the lines were parallel) over the two surveys.

Overall the mean haemoglobin concentration in CLP2.4 was significantly lower than in CLP2.3 and its control ($p=0.005$); mean CLP2.4 showed a reduction in haemoglobin concentration whereas CLP2.3 and its control increased from Rounds 8 to 10.

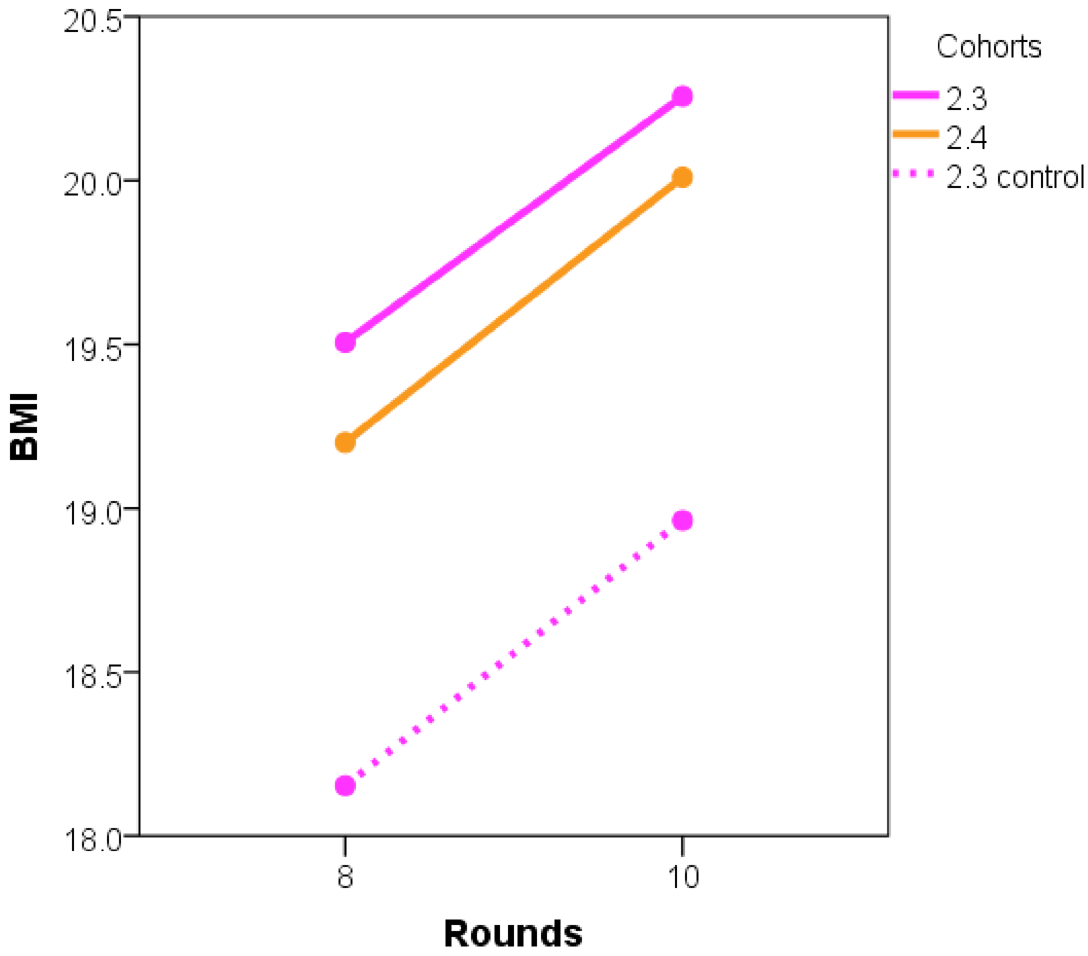

Figure 15: Mean BMI in mothers between CLP2.3 and its control and CLP 2.4

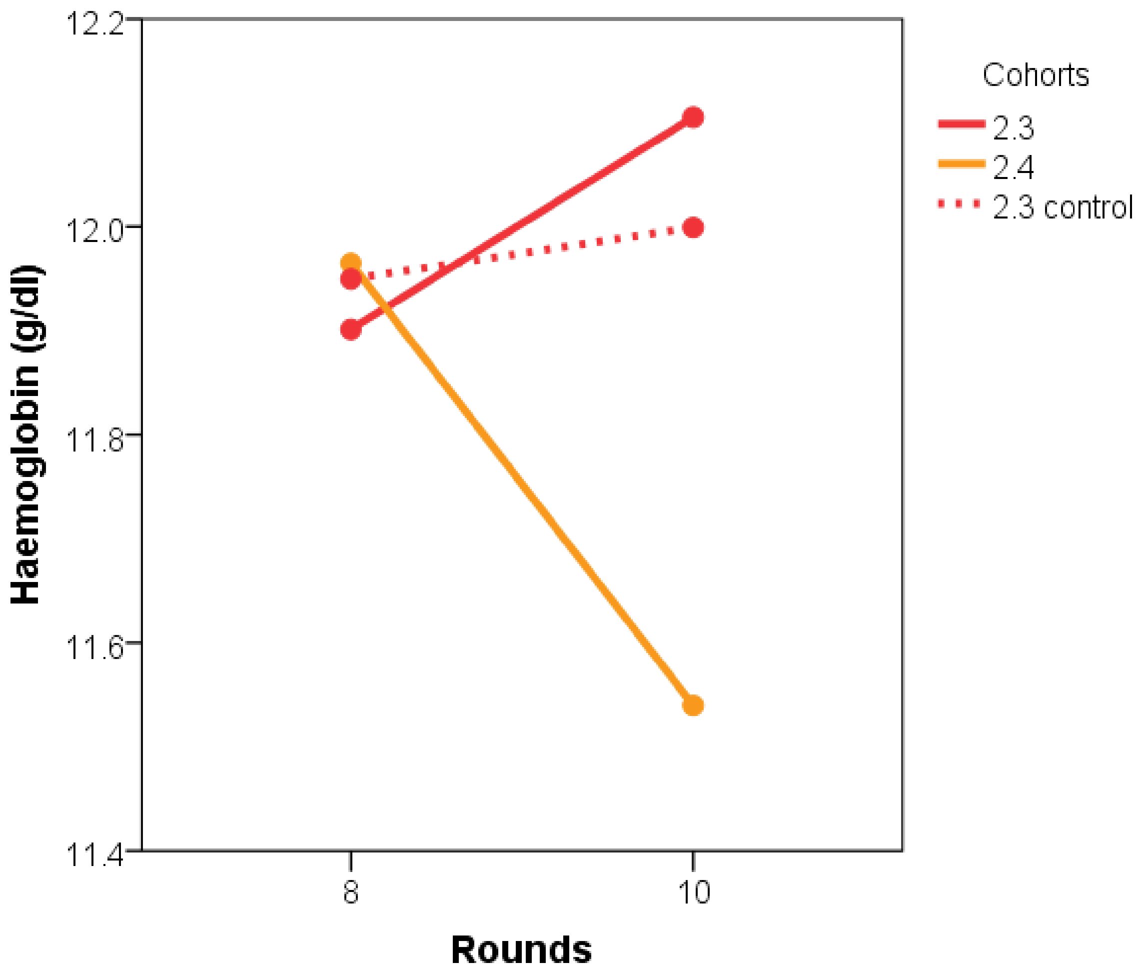

Figure 16: Mean haemoglobin concentration in mothers between CLP2.3 and its control and CLP2.4

6.2 Z scores and haemoglobin concentration in children

Mean HAZ in the CLP2.3 control group at Round 8 was about 0.4SD on average worse than CLP2.3 and 2.4 (Figure 15). However the mean showed a sharp improvement from Rounds 8 to 10 and the difference between CLP2.3 control groups and CLP2.3 and 2.4 became smaller at Round 10 (p=0.002). There was no overall mean difference between the groups (p ns).

Mean WAZ in CLP2.3 control group also improved from Rounds 8 to 10 whereas in both CLP2.3 and CLP2.4 then means worsened slightly (p=0.010, Figure 16). Overall means did not show clear differences (p ns).

Both WHZ and BMIZ changes were not different by cohorts (Figures 17 and 18). Overall the means of the groups did not show significant differences.

Haemoglobin concentration between cohorts did not show significant differences over the two survey and the overall means were also similar between the three groups (Figure 19).

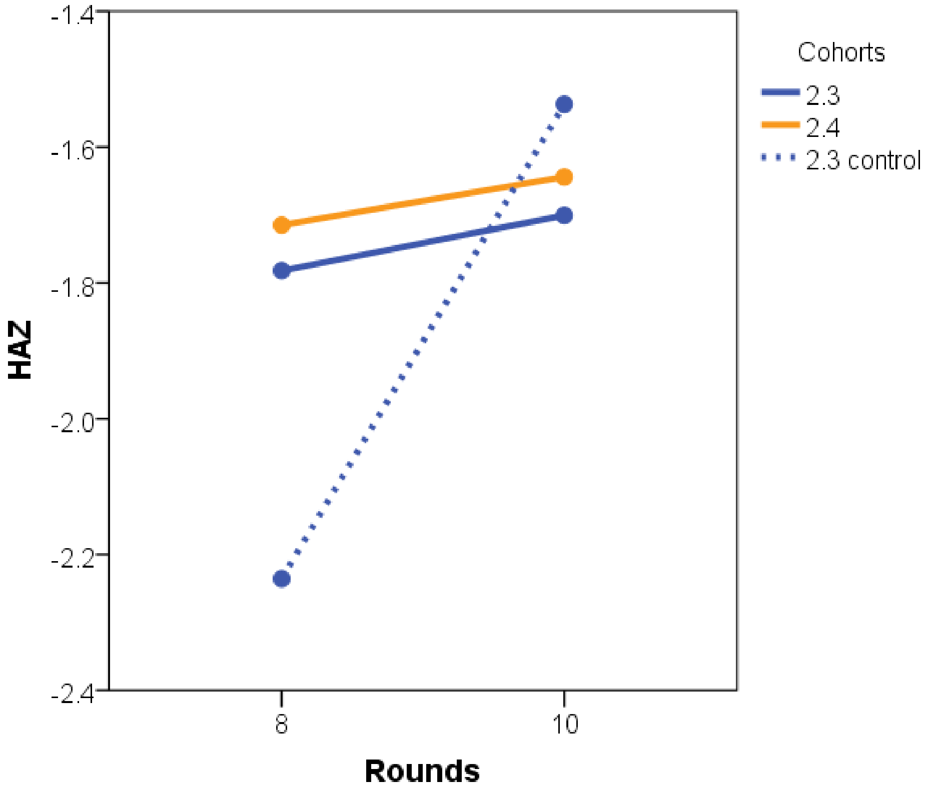

Figure 17: Mean HAZ in children between CLP2.3 and its control and CLP2.4

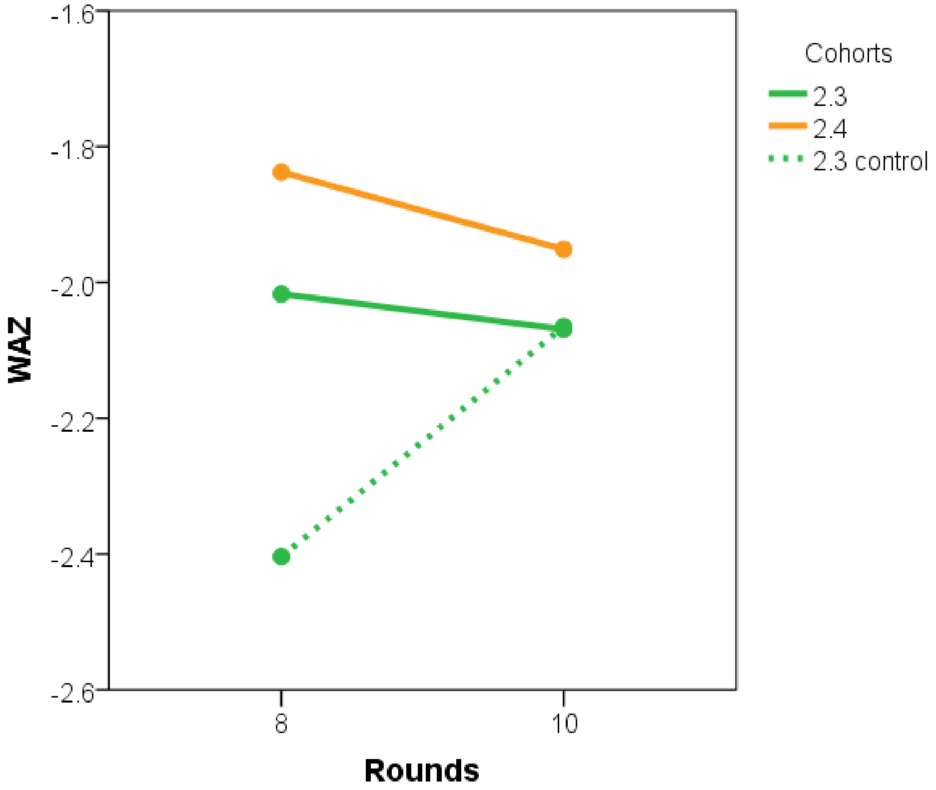

Figure 18: Mean WAZ in children between CLP2.3 and its control and CLP 2.4

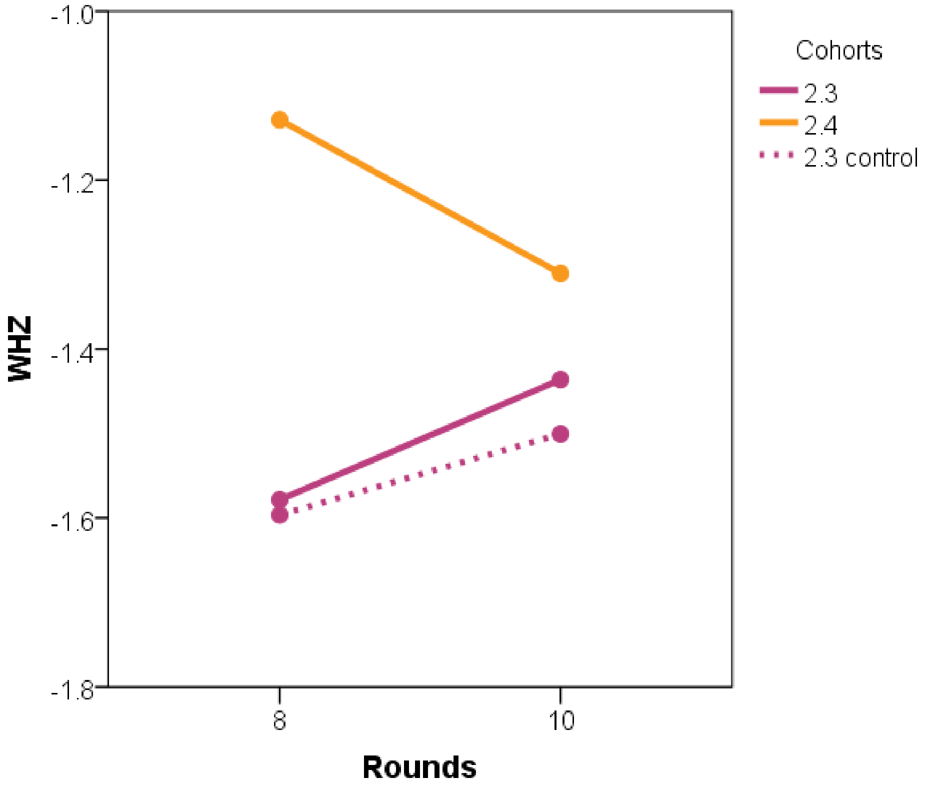

Figure 19: Mean WHZ in children between CLP2.3 and its control and CLP2.4

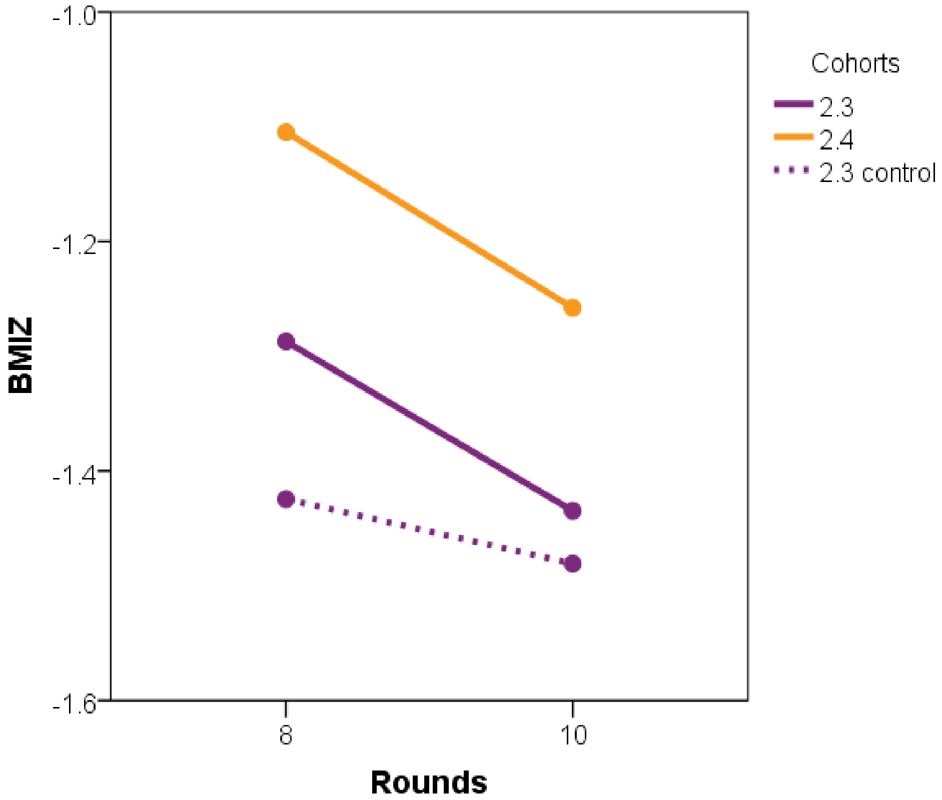

Figure 20: Mean BMIZ in children between CLP2.3 and its control and CLP 2.4

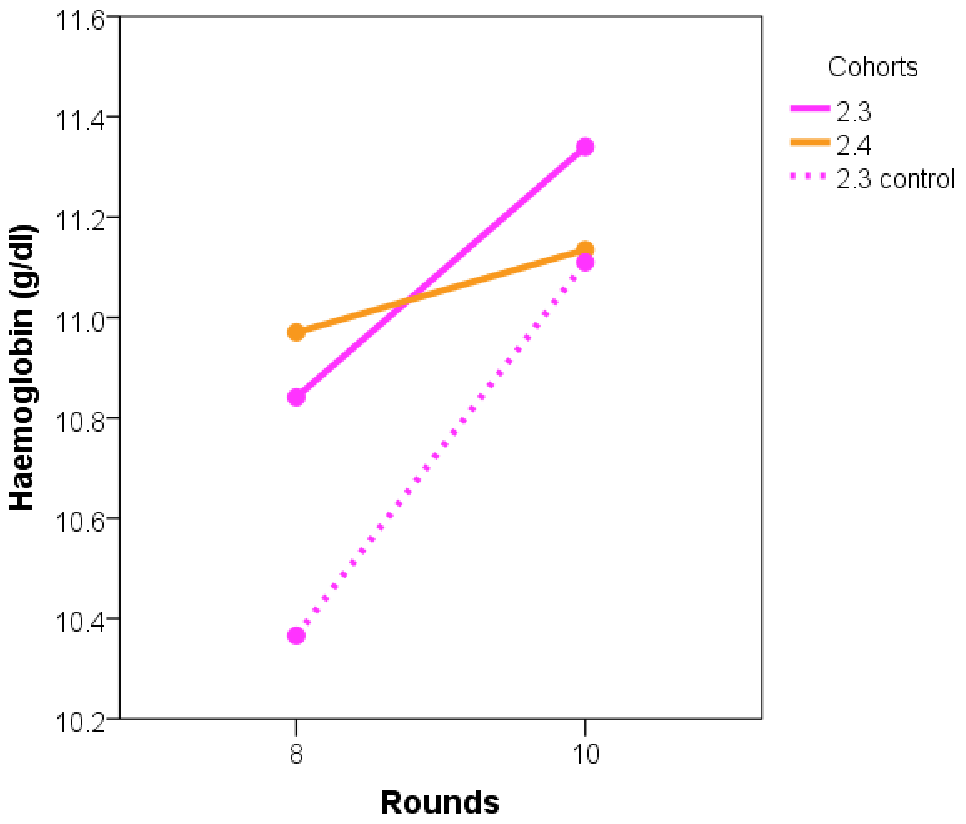

Figure 21: Mean BMIZ in children between CLP2.3 and its control and CLP 2.4

7. Discussion

Mothers and young children living in the chars are suffering from undernutrition. Underweight and anaemia are related to reduction in working capacity and increased morbidity and physical impairments as well as to reduction in cognitive development in children. The average BMI and haemoglobin concentration in mothers are very close to the threshold of Chronic Energy Deficiency and anaemia and nearly a half of children suffered from stunting and underweight as well as anaemia and about one in six children suffered from wasting at the baseline survey.

All CLP cohorts showed significant improvement in mothers' BMI throughout the surveys in the post-intervention period; BMI increased on average by 1.8 units over 6 years, by just about 1 unit over 4 years and by 0.24 units over 2 years in the different cohorts. However, mothers' haemoglobin concentration did not show significant improvement in any of the cohorts.

Children's chronic undernutrition (HAZ) showed significant improvements in the post-intervention period. For example, mean HAZ below the -2.00 cut-off point for stunting improved by nearly a quarter to half a SD in the 4 years. Children's haemoglobin concentration showed a small but upward trend in general, about 0.13g/dl on average improvement per year. However children's undernutrition related to weight growth (WAZ and WHZ) worsened and so did not show improved as a result of the intervention.

These results may indicate that food security and food diversity improved so mothers' body mass and fat increased, although the amount and frequency of animal protein intake was still insufficient to improve haemoglobin status. Heme iron is found in animal foods that originally contained haemoglobin, such as red meats, fish and poultry and the body absorbs the most iron from heme sources. These foods are, unfortunately, still not affordable on a regular basis by poor households in the chars. Mothers also should be encouraged to feed children more heme containing foods.

The results of changes in children's physical growth showed a mixed picture. Children's long-term undernutrition improved, although acute and mid-term conditions of undernutrition (WHZ and WAZ) did not show positive trends. Weight growth reflects frequency of both clinical and sub-clinical morbidity. Infections from early on life damage gut function and leads to maldigestion and reduction of food absorption and allows chronic inflammation status locally and systemically. Improving knowledge of breastfeeding practices and food preparations, cleanliness of utensils and hand washing before cooking as well as improving of basic medical supports may improve children's undernutrition.