LC-LQAS SURVEY REPORT

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MINISTRY OF HEALTH, UZBEKISTAN

NATIONAL FLOUR FORTIFICATION PROGRAM

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Authors

Christine Northrop-Clewes
Lauren Hund
Joe Valadez
Lusine Mirzoyan
Munira Irisova

Statistical analysis

Lauren Hund
Joe Valadez
Marcello Pagano

Biochemical analysis

Ronald Nazario
Dilora Suleymanova
Mamatkulova Dilrukh
Narmetova Munavar
Davlatova Gyulchekhra
Kuliev Ozod
Alimov Timur

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Survey teams (listed in alphabetic order by second name)

Coordinators	Supervisors	Interviewers	Blood collection specialists
Munira Irisova	Musharraf Abdulaev	Sanjar Abdukudusov	Dilbar Abdurakhmatova
Suleymanova Dilorom	Mukhayo Abdusalamova	Mastura Abdurakhmanova	Shakhnoza Akbarova
	Nargiza Akjigitova	Eminjon Boronov	Guzal Akhmatova
	Nargiza Almedova	Khalim Kamilov	Guli Azimbaeva
	Nargiza Ishmuratova	Gulnara Khalilova	Dildora Davlatova
	Khurmatoy Irgasheva	Elvira Khudayberdyeva	Shaira Gazikhanova
	Mavluda Khodjaeva	Nargiza Kulakhmedova	Khalida Jarimbetova
	Gulbakhor Nurymbetova	Zakhro Madalieva	Marjongul Jumanova
	Dilafruz Ortikova	Elmira Madreimova	Khalima Kuchkinova
	Elena Plaksina	Shirin Matkarimova	Maxuda Mirkhonjaeva
	Dildora Tursunova	Fazilat Matyakubova	Nasiba Muratova
		Javokhir Makhmudov	Mukharram Najmitdinova
		Ugiloy Nazirova	Zulkhumor Rustamova
		Anvar Nurkhadjaev	Anna Pak
		Iroda Nurmatova	Mukadas Topilova
		Anvar Nurkhodjaev	Makfuza Usmanova
		Madina Pulatova	Oyjamol Faizulaeva
		Janat Sultanova	Feruza Khalilova
		Akkal Tasbaltaeva	Zulfia Khalmuratova
		Abror Tojibaev	
		Nargiza Yusupova	

ACRONYMS

ADB	Asian Development Bank
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CRP	C-reactive protein
DHS	Demographic and Health Survey
GAIN	Global Alliance for Improved Nutrition
HH	Household
IDA	Iron Deficiency Anemia
JPIB	Joint Project Implementation Bureau
LC-LQAS	Large Country-Lot Quality Assurance Sampling
LQAS	Lot Quality Assurance Sampling or Local Quality Assurance Supervision
MARP	Most-at-Risk Population
MOH	Ministry of Health
NFFP	National Flour Fortification Program
Pre-SAC	Pre-school children (6 -59 months old)
PPS	Probability Proportional to Size
SA	Supervision Area
SRS	Simple Random Sampling
SVP	Rural Health Point (Selskiy Vrachebniy Punkt)
UDM	Uzdonmakhsulot, a state joint stock company association for the wheat flour.
WHO	World Health Organization
WB	World Bank
WRA	Women of reproductive age (15-49 years)
UNICEF	United Nations International Children's Fund

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Executive Summary

i. Background

In 2003, the Ministry of Health of Uzbekistan received a grant from the Global Alliance for Improved Nutrition (GAIN) for the implementation of a national flour fortification program (NFFP) to enrich local first grade flour with iron, folic acid, zinc, niacin, vitamins B_1 (thiamin) and B_2 (riboflavin). The grant was managed by the World Bank and the Ministry of Health. Hemoglobin data from the Demographic and Health Survey (DHS) data of 1996 was used as baseline data for anemia prevalence. The objective of the program was "to reduce anemia among women of reproductive age (WRA) to 48% within five years of the project start date".

Uzbekistan produces four grades of flour: premium, first, second and third. The fortification program targeted only 'first grade' *Uzdonmakhsulot* (UDM) flour as the best vehicles for fortification. First grade flour is used, often in combination with other flours, by women to bake bread in their homes and the 'grey loaf' is made from this flour in commercial bakeries,

Initially, a project monitoring and evaluation (M&E) draft plan was developed with technical assistance from the U.S. Centers for Disease Control and Prevention (CDC). Monitoring the changes in health and nutrition, as well as coverage of fortified flour and other related indicators was undertaken initially using sentinel sites, randomly sampling 40 households within a selected pilot region. Between 2004 and 2007, using the sentinel site data, estimates of anemia prevalence decreased from 51.3% to 27.8%; folate prevalence decreased from 33.3% to 24.1% and estimated low ferritin concentration rates increased from 28.2% to 33.3% among WRA (15 – 49 years). Confidence intervals (CI) for these estimates were not provided, but the results were not statistically significant. The sentinel study had several limitations: only one sentinel pilot location was selected, the data were collected at different times of the year, and only 40 WRA were tested at each round of surveillance (4). Subsequently, a Large Country-Lot Quality Assurance Sampling (LC-LQAS) survey was undertaken with the inclusion of biological assessment as an appropriate method to evaluate project impact after 5 years of implementation of the NFFP.

ii. Method

A LC-LQAS survey was conducted in March-April 2008 to evaluate the current coverage and impact of the NFFP. The LC-LQAS method was used to design the sample selection from rayons, cities and towns, (Supervision Areas [SAs]), to provide results that would be representative nationally and within the program catchment areas (oblast level). The selected sample comprised 2584 WRA from 136 SAs (19 individuals per SA) who responded to the questionnaire. The questionnaire included questions about the availability and consumption of UDM first grade fortified flour and the fortified

grey loaf at the household, and knowledge of iron deficiency and anemia. The women also provided samples of flour for the iron spot test, if it was available at the household, and gave blood for the analysis of hemoglobin, serum ferritin, C-reactive protein (CRP) and folate concentrations. Fifty data collectors and supervisors conducted the survey work over 31 days.

The survey methodology, which included hand tabulation of priority indicators immediately after the fieldwork, allowed for timely identification of priority areas within the country where coverage, consumption and/or knowledge about fortification were low. Later the serum samples were analysed at the Hematology and Blood Transfusion Center, Tashkent. Finally, data were entered into an Excel spreadsheet and later analyzed statistically using STATA 12.

iii. Results

The majority of respondents were in the age group 20-39 years, had secondary education, were of Uzbek nationality and were married.

Key findings were:

i. *Anemia*

- Anemia prevalence (hemoglobin <120g/L) in the country was 34.4% (95% CI: 32.0, 36.7), which was much lower than the 60% reported in the DHS in 1996. However, this indicates that anemia is still a moderate public health problem in the country.
- The highest prevalence estimate for women with anemia was found in Surkhandarya oblast (45.6%; 95% CI: 32.4, 58.8), while the lowest prevalence estimates were in Jizak oblast (27.4%; 95% CI: 19.5, 35.3) and Tashkent city (28.4%; 95% CI: 18.3, 35.5).

ii. *Iron and folate deficiency*

- Overall 47.5% (95% CI: 45.1, 49.9) of women had depleted iron stores
- The estimated prevalence of low folate concentrations was 28.8% (95% CI: 26.8, 30.8)
- Among WRA with anemia, 67.3% (95% CI: 63, 71) also had depleted iron stores and 45.9% (95% CI: 42, 50) had low folate. WRA with moderate and severe anemia had the highest prevalence of both depleted iron stores and low folate ($p<0.0001$).

iii. *Availability of UDM first grade flour and percent of UDM first grade flour that was fortified*

- Nationally, UDM first grade flour was available in 59.8% (95% CI: 56.2, 62.2) of households in the country. The reported annual purchase of UDM first grade flour was closely related to its household availability.

- The lowest prevalence of the household availability of UDM first grade flour was in Tashkent city (2.2%; CI: -0.2, 4.6) and Tashkent oblast (33.0%; 95% CI: 18.5, 47), where the commercially produced fortified grey loaf was more popular. The highest prevalence was 81.9% (95% CI: 74.7, 89.1) in Navoi oblast.
- A qualitative iron spot test carried out at the household identified that 41.6% (95% CI: 39.2, 43.9) of all UDM first grade flour tested was fortified.

iv. *Availability of grey loaf or home-baked bread with UDM first grade flour at the household*

- In Tashkent city and Tashkent oblast, the grey loaf was available in 72.1% (95% CI: 64.9, 79.3) and 38.5% (95% CI: 26.2, 50.8) of households respectively. This was high compared to the rest of country, where availability varied from 0.5% (95% CI: -0.5, 1.5) in Surkhandarya to 6.6% (95% CI: 1.8, 11.4) in Navoi oblast.
- Nationally, average consumption of the grey loaf or bread that was home-baked using UDM first grade flour the day before the survey was 82.9% (95% CI: 80.8, 85.0), this relatively high rate did not differ significantly across the country.

v. *Awareness and knowledge about iron deficiency anemia (IDA) and fortified food*

- 54.5% (95% CI: 52.2, 56.8) of WRA reported that they had ever heard about fortified food.
- 47% (95% CI: 44.6, 49.4) of all respondents mentioned first grade UDM flour or grey loaf as a type of food that they knew was fortified.
- Just 3.7% (95% CI: 2.8, 4.6) of all respondents gave at least 3 benefits of fortified flour/bread consumption.
- Only 12.2% (95% CI: 10.6, 13.8) of all respondents were aware that fortified flour can be distinguished from non-fortified flour only by the package label.
- Less than half of the WRA reported ever having seen the “non-polvon” (healthy food) logo (36.9%; 95% CI: 34.4, 39.4) and only 23.1% (95% CI: 21.0, 25.2) of all respondents recognized this logo.
- The level of knowledge of WRA about IDA was low, as only 12.5% (95% CI: 11.0, 14.0) of women were able to identify at least 2 causes of IDA
- Only 5.9% (95% CI: 4.6, 7.2) of the women could list at least 3 ways of preventing IDA.

vi. *Consumption of foods containing heme iron and of inhibitors of iron absorption*

- Consumption of heme iron-rich foods (91.4%; 95% CI: 89.9, 92.9) and enhancers of iron absorption (97.1%; 95% CI: 96.3, 97.9), at least once the day before the survey, was high.
- In addition, the proportion of women consuming vegetables or fruit daily in the week preceding the survey was high (90.2%; 95% CI: 88.7, 91.7).

- Unfortunately, 94.7% (95%CI: 93.5, 95.8) of WRA also reported consumption of iron absorption inhibitors such as coffee or tea (with or without milk) during or right after their meal the day before the survey.

iv. Conclusions

The survey showed that the aim of the flour fortification program to reduce the prevalence of anemia in WRA by 20%, from 60% to 48% was achieved with the prevalence of anemia among this group being estimated at 34%. Results from this survey do not support a claim that this change can be directly associated with the UDM first grade flour and bread fortification program, however, given the high household availability of either UDM first grade flour and/or grey loaf across the country, the fortification program is probably one of the most significant factors. Unfortunately, the shortage of premix prior to the survey greatly limited the interpretation of survey findings since it meant that only 42% of households had wheat flour with the expected level of iron.

No baseline data were available for folate deficiency, making it difficult to assess any impact of the fortification program or of any other parallel interventions. The survey found that, although the national geometric mean folate concentration was within the normal range, 29% of women were folate deficient, which suggests additional opportunities to improve status need to be explored.

The prevalence of anemia in Uzbekistan is still at the level of a moderate public health problem and iron deficiency and folate deficiency were shown in this survey to be relatively strong predictors of anemia. Depleted iron stores (low ferritin) were found among 48% of women nationally and 29% of women were folate deficient.

Awareness of anemia, iron deficiency and food fortification were all surprisingly low among the female respondents in this survey. In addition, the practice of drinking tea or coffee immediately after or with a meal, which inhibits iron-absoprtion, remained prevalent throughout the country, despite relatively high intakes of heme iron-rich foods and enhancers of iron absorption.

v. Recommendations

Recent legislation for continued fortification of first grade wheat flour with iron, folic acid and other micronutrients should help ensure continued improvement in iron and folate status of the population, thus reducing anemia further. The fortification of first grade UDM wheat flour with a variety of micronutrients, including iron and folic acid, coincided with a substantial decline in the prevalence of anemia in WRA in Uzbekistan. However, the lack of improvement in the prevalence of women with depleted iron stores suggests that complementary interventions to improve iron and folate status may also be beneficial. In addition to strengthening the flour fortification program, the relative impact

of other interventions in different local conditions should be assessed and complementary programs (to flour fortification) targeted appropriately.

It is essential that a higher proportion of UDM flour is fortified to the appropriate level and that the fortification levels are adequately monitored. In Uzbekistan, the UDM first grade flour is often mixed with other flours during the bread making process, diluting the fortification effect, so a more bioavailable form of iron might help improve the biological impact. Later versions of the KAP premix have used more bioavailable sources of iron, such as NaFeEDTA or ferrous sulfate and are an option, which could be considered.

One advantage of the LC-LQAS design was that it allowed for identification of rayons within each oblast that were above or below the national average and program targets for coverage and nutritional status. These were identified and discussed during the hand tabulation workshop, along with recommendations for action to address the issues found[1].

The fortification of first grade UDM wheat flour with a variety of micronutrients, including iron and folic acid, coincided with a substantial decline in the prevalence of anemia in WRA in Uzbekistan. However, the lack of improvement in the prevalence of women with depleted iron stores suggests that women are still not eating enough iron in the diet or are drinking too much tea at meal times and inhibiting iron absorption. Communication messages about the fortification project are not reaching the majority of women, and women's understanding of the causes of IDA is poor. These findings imply that a greater focus on consumer education is required to complement and enhance the impact of interventions such as flour fortification in improving micronutrient status. Consumer education should be prioritized and perhaps included in the school curriculum to educate the next generation, and given at health clinics for women.

[1]The results and recommendations from the workshop are available as a separate document.

I. Background

Uzbekistan is the most populated country of Central Asia sharing a border with Kazakhstan (North), Turkmenistan (South-West), Afghanistan (South), Tajikistan (East), and Kyrgyzstan (North-East). Administratively, the country is split into 12 oblasts, Tashkent city and the Autonomous Republic of Karakalpakstan (Figure 1).

Figure 1: Map of Uzbekistan showing regions and surrounding countries.

Iron-deficiency anemia (IDA) is a significant public health problem in Uzbekistan. In 1996, a Demographic Health Survey (DHS) reported 60.4% of women of reproductive age (WRA) and 60.8% of children 6-59 months of age (pre-SAC) had low concentrations of hemoglobin (hemoglobin <120 g/L and <110 g/L respectively) (1). In 2002, the Health Examination Survey reported that 49.2% of pre-SAC had hemoglobin concentrations below the WHO cut-off; however, there were no data for women (2). Recent data, collected as part of the evaluation of the Program on Prevention and Control of Anemia in Uzbekistan in 2005 from Khoresm and Fergona oblasts and the Republic of Karakalpakstan showed that an estimated 37% of WRA had anemia (3). There are no national data on the prevalence of folate deficiency, but data from four sentinel sites between the years 2004 and 2007 showed that approximately 20 to 50% of non-pregnant women may have anemia and low levels of iron and 24 to 34% may have low concentrations of folate (<10nmol/L)(4).

Bread is a staple food in Uzbekistan and is consumed at each meal[2]; therefore, flour fortification was implemented as a key strategy for addressing anemia. In urban areas, >90% of urban households buy bread. A separate supply chain ensures that industrial urban bakers are supplied with first grade fortified flour for the fortified grey loaves. The pattern of bread consumption is very different in rural areas of Uzbekistan, where people bake bread at home or buy it from small 'tandoor' bakers, making it a more difficult task to provide fortified bread to the rural poor (5). In rural areas, most home-made bread is made from a mix of both first grade (fortified) and premium grade flour (non-fortified) which reduces the amount of fortified flour consumed and hence the micronutrient intake.

In 2003, the Republic of Uzbekistan's National Flour Fortification Program (NFFP) was implemented and financed by government funds, industry and a grant from the Global Alliance for Improved Nutrition (GAIN), and was managed by the World Bank, and the Minstry of Health. Uzbekistan produces four grades of flour: premium (extraction rate 55 – 60%), first (extraction rate up to 72%), second (extraction rate 78 – 83%) and third (extraction rate >83%). Since the first grade flour is consumed by 61% of the population, the NFFP targeted the fortification of 'first grade' flour produced by a large, state-run milling agency, *UzDonMakhsulot* (UDM) and some private mills, and on the 'grey loaf' made from that flour in commercial bakeries (6, 7).

The selected fortificant premix was the *KAP Complex 1*, which was developed by the Kazakhstan Academy of Nutrition and was used in the Asian Development Bank (ADB) regional flour fortification project that was the precursor to the GAIN project (6). The premix contains elemental iron powder made by an electrolytic process; consequently, the premix has twice the level of iron as fortificants made with ferrous sulphate, to compensate for a bioavailability of only 50%. In addition, the fortificant contains folic acid, zinc, thiamin, riboflavin, and niacinamide (4). The KAP premix incorporation rate was 120 g/metric ton of flour, equivalent to 40 mg/kg of iron, and thus providing an average of 22 – 39% (depending on consumption 0.16 – 0.26 kg/day) of the World Health Organisation (WHO) recommended nutrient intake (RNI) of iron (8). The primary objective of the program was to reduce anemia among WRA by 20% (from 60.8% to 48.6% using the 1996 DHS anemia data as a baseline measure) (1).

The program has the following main components:

[2] http://www.roxanatour.com/uzbekistan/tour_travel/uzbek_cuisine.html

(a) Production and distribution of fortified wheat flour

(b) Food quality control and monitoring

(c) Communication and marketing

(d) Program impact evaluation

(e) Project management

The program received technical support from several expert program areas at the Centers for Disease Control and Prevention (CDC)[3] as well as the World Bank, and the Uzbekistan Institute of Hematology and Blood Transfusion.

Although a monitoring and evaluation draft (M&E) plan was developed, which included sentinel sites to monitor the coverage, and the health and nutrition impact of the program, no baseline assessment was conducted [8,9]. The sentinel site system involved randomly sampling 40 households within a selected pilot region (4). However, this methodology had several limitations: only one sentinel pilot location was selected and only 40 WRA were tested at each round of surveillance (4). In 2007, CDC and the World Bank recommended a national Large Country – Lot Quality Assurance Sampling Survey (LC-LQAS), with the inclusion of biological assessment, as an alternative methodology to the sentinel surveillance system for assessing program impact and sustainability at the end of the funding period (31 December 2008).

II. The Large Country-Lot Quality Assurance Sampling (LC-LQAS) Method

LC-LQAS is a method for assessing a program by analyzing the data produced by a small sample using an approach that integrates LQAS and cluster sampling[4] [10]; a multi-level evaluation tool. In the LC-LQAS survey design, the cluster-level sample size is driven by the goal of local-level classification using the cluster data (9). LQAS is a statistical tool used for the classification of the

[3] CDC programs providing support included: the International Micronutrient Malnutrition Prevention and Control Program (IMMPaCt), the National Center for Birth Defects and Developmental Disabilities, the Nutritional Biomarkers Branch and the National Center for Environmental Health.

[4] LQAS was initially developed for industrial quality control, however, during the mid 1980s it was adapted to health programs. In 1991, the World Health Organization (WHO) report on epidemiological and statistical methods for rapid health systems assessment concluded that LQAS was one of the more pracitcal methods available and encouraged its further development to monitor health programs. M. Anker 1991. World Health Statistics Quarterly **44**. Pg 94-97

performance of small geographic or administrative units called supervision areas (SAs) (10). The collection of rayons, cities, and towns within a region served as the SAs for the survey. LQAS is considered to be a practical tool for conducting baseline and end-line surveys as well as for monitoring service provision and health and nutrition needs.

Advantages of the methodology include:

1. Relatively simple sampling procedures and analyses, which can produce findings that can be used immediately by local program managers.

2. LQAS works by subdividing a program catchment area (in the case of Uzbekistan the catchment areas for which coverage estimates can be obtained are the oblast and national level) into smaller areas that deliver the service (in the case of Uzbekistan these Supervision Areas (SAs) are rayons, cities and towns)[11].

3. Data from individual supervision areas (SAs) can be aggregated into a relatively precise estimate of coverage for the larger program catchment area (oblast and national) [11].

II. Survey Objectives and Target Population

The overall objective of the survey was to assess the status of the process (including increased consumer knowledge and awareness) and the impact of the NFFP after 5 years of implementation. More specifically, the sub-objectives were to:

1. Produce information at the local level that could be rapidly interpreted and used to identify priorities and make strategic decisions to improve the implementation of the flour fortification program.
2. Provide aggregate data at national and oblast levels that could be used for refining strategies, reporting and allocation of resources.
3. Introduce LC-LQAS as a tool to strengthen the M&E capacity of the NFFP at all levels of operation.
4. Produce data on the impact of the NFFP on the nutritional status of the women, in particular their iron and folate status.

The targeted population was non-pregnant WRA (15-49 years.

III. Methodology of the Survey

i. Sampling

Uzbekistan is divided into 14 regions: 12 oblasts, the Autonomous Republic Karakalpakstan and Tashkent city. Among the 14 regions in Uzbekistan, there are 162 rayons and 37 cities or towns,

comprising 199 SAs. For the survey, the cities and towns were treated as separate administrative units and were not included in the rayons.

The number of sampled SAs per region was selected such that the maximum confidence interval width for coverage indicators at the oblast level was 20%. To calculate the sample size, population data were obtained directly from the census of the population. To anticipate the degree of clustering in the survey, the design effects were assessed from 28 nutritional and demographic variables in the Uzbekistan 2002 DHS, and the largest design effect, 1.79, was selected to calculate the sample size (see Table X in Annex 3). Oblast-level sample sizes were calculated by using the relationship between the design effect and intra-class correlation, along with the census population estimates, using the methods described in Hedt *et.al* 2008 [10]. The number of WRA sampled per oblast was fixed at 19 to facilitate local level evaluation of the fortification program. To calculate the number of SAs to sample per oblast (n), the following formula was applied:

$$n = N(1+(m-1)\widehat{\rho})\left\{\left[\left(\frac{\ell_{max}N^{*}_{cen}}{1.96}\right)^{2}\left(\frac{(m-1)(1-\widehat{\rho})}{N\overline{M^{2}}}\right)+m\widehat{\rho}\right]\right\}^{-1}$$

where *m* =19 is the number of WRA sampled per SA;
N is the total number of SAs in the oblast;
N^{*}_{cen} the total population in the oblast;
$\bar{\boldsymbol{M}}^{\boldsymbol{2}}$ is the average of the square of the population in each SA;
$\widehat{\boldsymbol{\rho}}$ is an estimate of the intraclass correlation;
l_{max} = 0.2 is the maximum desired length for the confidence interval.

The specific SAs within each region were sampled using simple random sampling without replacement, as in Hedt *et al* [10]. Within a SA, sampling locations were identified by listing the health points (rural medical centers known by the acronym SVP and urban policlinics) and their associated population size. Then, 19 random locations among the SVP/policlinics were selected using probability proportional to size (PPS) sampling. Within these locations, one household was randomly selected using segmentation sampling, and one WRA in the household was interviewed. If no WRA resided at the selected household, the data collectors proceeded to the next closest door. This PPS sampling strategy is self-weighting and approximates simple random sampling within an SA.

ii. Questionnaire

A survey questionnaire was developed to specifically address the project's objectives. There were 2 language versions of the questionnaire: Uzbek and Russian. The majority of respondents answered in Uzbek, however, there were some Russian-speaking respondents, for whom the Russian questionnaires were used. The survey consisted of the following sections:

1) An introduction to the survey

2) Demographic and socio-economic information, including age, education, nationality, marital status and a list of indicators from which to estimate socio-economic status**.**

3) Availability of fortified flour/bread at the household and testing of flour for iron using the iron spot test[5]

4) Purchase and consumption of fortified flour/bread at the household

5) Knowledge of IDA and flour fortification program

6) Iron supplementation

6) History of anemia

7) Diet

8) Reproductive history

9) Blood samples were taken for hemoglobin, which were analysed daily at the end of the field day. The rest of the blood was centrifuged, separated and the serum stored frozen for later analysis for folate, C- reactive protein (CRP) and ferritin concentrations.

vi. Data Collectors and Training

The Director of the Anemia Center compiled a list of field workers for training, which included 35 potential interviewers, and 25 laboratory workers. Two parallel 4-day training sessions were conducted, one for the interviewers and one for the laboratory personnel. The topics covered in LC-LQAS data collection training included:

- Sampling methodology
- LQAS data use
- Familiarisation and practice with the questionnaire
- A pilot study with debriefing and a discussion of lessons learned
- Assigning trained staff to the survey teams.

[5] http://www.a2zproject.org/pdf/Manual_Foods.pdf

The training for laboratory personnel was conducted by a Senior Laboratory Specialist from CDC and included biological sampling procedures, such as blood collection, sample preparation, labeling, and storage. The LQAS Training Participant's Manual was translated into Russian and adapted for the LC-LQAS survey.

The interviewers and supervisors were trained to select the respondents from health registries using systematic random sampling. Exercises on community and household mapping as well as selection of the respondents from the maps were also covered during the training.

The blood collection procedures and the questionnaire were pre-tested in selected non-survey urban and rural locations in Russian or in Uzbek as appropriate. Cognitive testing was done to ascertain that:

- The respondents responded as expected to the way in which the questions were asked
- The respondents understood the terms and specific phrases used in formulating the questions
- The recall questions were appropriate for respondents to answer
- The respondents were motivated, willing to answer to "sensitive" questions and responded with honesty
- The suggested response options work.

and as a result any changes needed were incorporated into the final version of the instrument.

Questions related to key indicators (and included in the hand tabulation workshop) are listed in Annex 1 with details of how each indicator was calculated and what assumptions were made

vii. Field work

At the end of the LQAS training, 20 field teams were formed each with one interviewer and one laboratory worker. In total, 10 supervisors were assigned to the field teams, and of these, 7 were involved in direct supervision of the interviewers (3 teams each), and the remaining 3 supervisors supervised the laboratory technicians in the sampling and processing of the biological samples (i.e. centrifugation of the collected blood at the end of the day).

Data collection took place in the period from March 17 to April 21. The schedule of 5-week intensive fieldwork is below:

Table 1: Fieldwork schedule

Date	Oblasts	Number of selected supervision areas	Number of respondents	Number of teams
17 – 20, 22 March	Tashkent city	9	171	9
	Tashkent oblast	10	190	11
24- 29 March	Syrdarya	9	171	7
	Navoi	9	171	7
	Jizak	10	190	6
7 – 12 April	R. of Karakalpakstan	11	209	8
	Khorezm	8	152	5
	Bukhara	10	190	7
14 – 21 April	Namangan	9	171	5
	Fergona	10	190	7
	Andijan	11	209	8
21 – 26 April	Surkhandarya	10	190	7
	Kashkadarya	10	190	7
	Samarkand	10	190	6
	TOTAL	136	2584	

iii. Blood collection

Venous blood (10mL) was drawn from each WRA using a Vacutainer (BD, Russia) and kept in a cool and dark place until the end of each day. A small volume of the whole blood was used to measure the hemoglobin concentration to the nearest 1 g/L using a portable b–hemoglobin photometer (Hb 301 HemoCue™ AB, Angelholm, Sweden). Each HemoCue was checked three times a day using three control liquids (low, medium and high) and was considered acceptable for use only if the reading was within the range specified. Altimeters were used to measure the elevation above the sea level and the information was recorded in the questionnaire and used to adjust hemoglobin concentrations where necessary; although few places in Uzbekistan are above 1000 meters. Hemoglobin concentrations were also adjusted for smoking status. Women with hemoglobin concentrations < 120g/L were defined as anemic [12]. The remaining whole blood was centrifuged for 10 minutes at 3000 rpm, the serum removed and stored cold (+4°C) in two tubes (one tube containing serum for the analysis of folate and one for CRP and ferritin) at local Blood

Transfusion Centers. At the end of each week, the serum was transported to the Hematology and Blood Transfusion Center, Tashkent where it was stored frozen at -70°C until analysis.

iv. Biochemical analysis

Serum CRP concentrations were measured using the Randox full-range immunoturbidometric assay (range of assay: 0.3 –161 mg/L) on a Randox Daytona Analyser (Randox Laboratories Ltd, Crumlin, UK). Three levels of specific protein controls and two high sensitivity CRP controls were run at the beginning and end of the day; intra-assay precision was <3% and inter-assay precision was <6%. A CRP concentration > 5mg/L indicated the presence of inflammation [13].

Serum ferritin concentrations were measured using the Randox immunoturbidometric assay (range of assay: 5.78 – 434 µg/L) also on the Randox Daytona Analyser (Randox Laboratories Ltd, Crumlin, UK). Three levels of specific protein controls were run twice a day; the intra-assay and inter-assay precision were <5%. A ferritin concentration <15 µg/L indicated depleted iron stores [14].

Serum samples were analyzed to determine folate concentrations, using a microbiological assay in the Department of Hematology at the Tashkent Hematology and Blood Transfusion Center. The microbiological assay was based on the methodology used by the Division of Laboratory Sciences, Nutritional Biomarker Branch at the CDC, but with a slight modification because of the limitation of equipment available [15]. As it was not possible to read the plates at 590nm, the plates were read at 492nm. The use of the 492nm wavelength was verified by CDC who found that compared to reading the plates at 592nm, reading at 492nm gave a bias of 1.6% (95% CI: 0.4 – 2.9%; SE 0.63%; n = 98), which was considered to be acceptable.

In brief, the method involved the preparation and growth of *Lactobacillus rhamnosus* 10463 (NCIMB, Aberdeen, UK) in folic acid medium (Bacterius Ltd, Kansas, USA) for 24 hours at 37°C in an incubator. The 24-hour culture (100 – 300 µL) was then put into another 20 mL of growth medium and incubated at 37°C for a further 24 hours; this was repeated again. Different amounts of the active culture were then inoculated in duplicate at different incubation times. The optical density of one of the duplicate cultures was measured at 492nm and the log growth phase (~18 - 20 hours) recorded. The log phase culture was mixed 50/50 with 80% glycerol (sterilized by autoclaving) and the mixture aliquoted in sterile cyrovials (1 mL/vial) and stored at -70°C. Serum pools were prepared as quality control (QC) samples at three levels: high, medium and low and run at least 20 times to establish the acceptable ranges. For external QC, CDC serum pool samples were run on each plate and verified by CDC recurrently throughout the analysis period. Calibrators were prepared from 5-methyltetrahydrofolate (5MeTHF) stock solution (200 µg/mL). The calibrator range was from 0.05–1

nmol/L and 12 standard concentrations (including a blank) were used in duplicate on each calibration plate.

For the assay, 96-well plates were used and into each well containing an unknown or QC sample, 200 µL of folic acid medium inoculated with *L. rhamnosus,* then 50 µL of 0.5 g/dL sodium ascorbate were added. 50 µL of the 1/100 diluted serum QCs and 100µL of the unknown sample were then added to the corresponding wells. The last sample in each plate was always a blank. The plates were sealed very tightly with microplate sealing membrane, inverted several times to mix and incubated for 42-45 hours at 37°C. Calibrator plates and those containing the QCs and unknowns were then read on the microplate reader at 492nm. The reportable range for serum samples is 10-100 nmol/L. Any samples with a serum folate concentration <10nmol/L were considered to be deficient [16].

Ethics

The survey was under the direction of the Ministry of Health hence no ethics permission was required. Inclusion in the survey was dependent on the woman being willing to participate in the survey and giving written informed consent for both the interview and the phlebotomy

Data Analysis

A data hand tabulation and analysis workshop took place from 6 to 8th May 2008 and was used to verify the data and correct the discrepancies. In Annex 1 (Tables 1 and 2), the key indicators tabulated during the workshop, with their measurement and assumptions are listed. The workshop also allowed immediate access to the survey results, and helped to identify the priority areas for further intervention (reported elsewhere). The participants were the Director of the Anemia Center, the Project Monitoring and Evaluation Officer, interviewers, supervisors, and laboratory specialists. The Project Manager took part on the last-day when priorities were set. All 2584 questionnaires were brought to the workshop location and sorted by SA. The workshop participants' hand tabulated the project indicators by rayon and oblast level to see which SAs were below average coverage. At the end of the workshop the participants came up with presentations of priorities in each oblast (presented elsewhere).

Subsequent to the workshop, all data were singly entered into an EXCEL spreadsheet. The survey data were then analyzed at the oblast and national level using Stata v12 (StataCorp LP© Lakeway Drive, College Station, Texas, USA). Large sample linearized variance estimates were used to

calculate confidence intervals (CI). Survey weights were defined as the inverse probability of a sampled individual being included in the survey. To quantify socioeconomic status (SES), number of durable household goods available in the household was used (17). It was assumed that data were missing completely at random; however, missing data were rare, and this assumption should subsequently have minimal impact on the results.

CIs for the national and oblast-level estimates were set at 95% and constructed using a t-distribution. In contingency table analyses assessing the relationship between categorical covariates, a design-based Pearson Chi-square test was used, which corrected the Chi-square statistic and based inference on the F-distribution to account for the survey design [18]. In order to assess the relationship between the binary outcomes of interest and the covariates, which constitute a mixture of continuous, ordinal, and discrete covariates, a weighted logistic regression model with linearized robust variance estimates was used to adjust for the survey design. All hypothesis tests were two-sided and were performed at the 0.05 level of significance.

Results

i. *Some of the difficulties/limitations to data collection*

a. The process of sampling was often complex and time-consuming in urban areas and sometimes in rural areas. In some places the health registries were deemed outdated and incomplete and it was necessary to use maps. The work of data collectors was facilitated by the fact that many policlinics had maps of their catchment area.
b. The local health care personnel were much more willing to help in rural areas compared to urban settings.
c. In rural areas, the teams had no refusals to take part in the survey but in urban areas the number of refusals was very high. However, there was a difference between "refusal" and "absence of an eligible respondent at home". If the woman was absent, an appointment was made to return and interview the eligible woman. But often there were refusals from women in urban areas who were at home at the time of intervewer's visit and the main reasons for not taking part were unwillingness to give blood or lack of time. When the interviewers asked the nurses or physicians from the local policlinics/SVPs to accompany them, this helped to improve consent rates.
d. In Tashkent city there was one policlinic that served the population from two rayons (Mirobod and Sergeli), which caused some confusion. Therefore for future surveys, it is recommended to note the boundaries of SAs, even when selecting the respondents from one policlinic.
e. In rural areas, the distances between rural health points for the same SA was long, thus, transportation often required a significant amount of time.
f. Lack of electricity in the remote rayons was another problem in rural areas.

Results are presented as weighted percentages, as indicated. Where applicable, result tables include reference to the relevant questionnaire number. Additional information about calculation of the indicator and any assumptions made are presented in Annex 1 along with details of how each indicator was calculated.

ii. *Demographics*

In the final survey, 136 SAs out of the total 199 SAs were sampled. Consequently, the total sample size for the survey was 2584 women. The majority of respondents were between 20 and 39 years old, married, educated to secondary level, of Uzbek nationality, and lived in rural areas. The

distribution of the survey respondents by age, education level, nationality, and marital status is shown in Table 2.

Table 2: Percentage of respondents by age groups

Variable	Sub-groups	Percent (CI)
Age group	15-19	6.8 (5.8, 8.0)
	20-29	37.8 (35.6, 40.0)
	30-39	37.2 (35.0, 39.4)
	40-49	18.2 (16.5, 20.1)
Education	Less than secondary	9.7 (8.3, 11.2)
	Secondary	61.8 (59.3, 64.3)
	College	20.1 (18.3, 22.1)
	Higher	8.4 (6.9, 10.2)
Nationality	Uzbek	87.9 (85.9, 89.7)
	Tajik	4.7 (3.5, 6.2)
	Kazakh	2.0 (1.5, 2.6)
	Karakalpak	2.0 (1.4, 2.7)
	Other (Russian, Tatar, Turkmen, Kyrgyz)	3.5 (2.6, 4.8)
Marital status	Single	15.3 (13.7, 17.0)
	Married	80.8 (78.9, 82.5)
	Widowed	1.3 (0.1, 2.0)
	Divorced/Separated	2.6 (2.0, 3.4)

In addition, at the time of the survey 66.7% of women were not working outside the home.

SES and urban/rural location were highly correlated, with higher SES in more urban locations. According to the results, 24.9% of respondents were of low SES, 61.6% were middle and 13.5% were of high SES. Most of the population lived in a rural location, especially those in the lower SES group, as represented in Table 3.

Table 3: Proportion in lower, middle and high socio-economic groups in the rural areas.

Socioeconomic Status	% Rural (CI)
Low SES	94.2 (91.0, 96.3)
Middle SES	79.6 (73.6, 84.5)
High SES	47.2 (38.5, 56.1)

iii. *Availability of Fortified Bread/Flour at the Household*

Data on availability of any wheat flour and UDM first grade bread/flour in the household across the country are summarized in Table 4. As shown in the table, the overall weighted proportion of households where any wheat flour was available was 97%, with the lowest percentage in Tashkent city (85%) and the highest in Bukhara (100%).

The percentage of households with UDM first grade flour varied widely across the oblasts with the lowest proportion in Tashkent city (2%) and the highest proportion in Navoi oblasts (82%). The overall weighted average coverage of UDM first grade flour at the household at the time of the survey was 60% (Table 4).

There was a statistically significant association between SES and availability of UDM first grade flour in the household (p = 0.0002). UDM first grade flour was available in 67.9% of households (CI: 62.6, 72.8) in the lowest SES group, 59.4% (CI: 55.8, 62.9) in the middle group and 50.3% (CI: 43.7, 56.8) in the highest group had first grade flour. The effect of SES was attenuated by residency (urban/rural), as shown in Table 4 (logistic regression of factors associated with having UDM first grade flour), but the effect of SES remained statistically significant (p = 0.027). In urban areas, UDM first grade flour was available in 46.2% (CI: 37.2, 55.4) of households compared to 63.8% (CI: 60.3, 67.1) in rural areas (p-value = 0.001).

Table 4: Availability of any wheat flour and UDM (UDM) first grade flour at the household.

Oblast	Availability of any wheat flour at the households (Q201)			Availability of UDM first grade flour at the households (Q202)		
	Numerator/ Denominator	Weighted coverage estimate %	CI (±)	Numerator/Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	146/171	87.5	6.2	4/146	2.2	2.4

Tashkent oblast	184/190	97.2	3.1	61/184	33.0	14.5
Syrdarya	165/171	97.3	2.8	96/165	59.7	8.0
Samarkand	180/190	94.3	4.8	113/180	66.3	10.1
Surkhandarya	185/190	97.5	2.5	134/185	75.8	8.6
Navoi	169/171	98.2	3.0	146/169	81.9	7.2
Namangan	170/171	99.3	1.5	122/170	71.6	9.2
Jizak	187/190	98.7	1.8	101/187	54.0	8.8
Kashkadarya	180/190	93.9	4.8	146/180	81.2	7.1
Fergona	187/190	98.9	1.6	116/187	63.1	9.6
Khorezm	151/152	99.4	1.4	85/151	54.6	10.3
R. Karakalpakstan	206/209	99.2	1.1	122/206	53.5	10.3
Andijan	203/209	97.2	2.8	156/203	76.4	8.5
Bukhara	190/190	100.0	0.0	113/190	63.4	8.8
Total (country)	2503/2584	96.6	0.9	1516/2503	59.8	3.0

The relationship between question (Q) 202 (Table 4), and other predictors was examined. A multivariate logistic regression was used, adjusted for the survey design, which examined the impact on availability of UDM first grade flour at the household of the following factors: age, education, SES, urban/rural location, knowledge that UDM is fortified (Q 408i; Table 5), whether the woman bakes her own bread, anemia history, and iron use history. Education was not statistically significant in univariate or multivariate analyses, so it was dropped from the regression model. Age was not statistically significant, but it was left in the model as it might be an important confounder in a quadratic relationship between outcome and age, but there was no evidence of such a relationship. A regression table displaying the results is below in Table 5:

Table 5: Logistic regression on the impact of listed covariates on having UDM first grade flour in the household.

Covariate	Univariate Odds ratio (CI)	Multivariate Odds ratio (CI)

Age	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)
Anemia History (vs. no history)	0.81 (0.67, 0.98)	0.77 (0.61, 0.97)
Iron use (vs. no use ever)		
More than 2 years ago	1.17 (0.93, 1.48)	1.20 (0.92, 1.57)
Within last 2 years	1.30 (1.01, 1.68)	1.34 (1.00, 1.79)
UDM knowledge	1.34 (1.11, 1.61)	1.32 (1.08, 1.61)
Bake bread	4.35 (2.91, 6.52)	3.51 (2.25, 5.46)
Among rural:		
Middle (vs. low) SES	0.74 (0.57, 0.95)	0.76 (0.59, .99)
High (vs. low) SES	1.21 (0.80, 1.85)	1.33 (0.86, 2.07)
Among urban:		
Middle (vs. low) SES	0.47 (0.19, 1.19)	0.41 (0.16, 1.04)
High (vs. low) SES	0.18 (0.07, 0.47)	0.16 (0.06, 0.42)
By SES:		
Low SES - Urban (vs. rural)	1.19 (0.45, 3.13)	2.16 (0.79, 5.90)
Middle SES - Urban (vs. rural)	0.76 (0.48, 1.21)	1.15 (0.69, 1.91)
High SES - Urban (vs. rural)	0.17 (0.09, 0.32)	0.27 (0.14, 0.50)

The following trends were clear from the regression analyses. Women who had an anemia history were slightly less likely to have UDM first grade flour. Women who have taken iron supplements in the past 2 years are slightly more likely to have UDM first grade flour. Knowledge that UDM first grade flour is fortified was associated with an increased likelihood of having the flour in the household. The strongest predictor of having UDM flour was whether or not a woman bakes her own bread (multi-variate odds ratio (OR) 3.51 [CI 2.25, 5.46]). The relationship between SES, urban/rural location, and having this type of flour is somewhat complex, but makes sense in context. Among rural women, there was no strong evidence of an association between SES and having UDM first grade flour in the household. Among urban women, increasing SES is associated with a large decrease in UDM first grade flour in the household (recall that greyloaf is more popular in urban locations and among higher SES women).

Examining the data from another perspective, among the lower and middle SES classes, there were no statistically significant differences in having first grade UDM flour between urban and rural locations. On the other hand, among high SES women, urban women are much less likely to have the UDM flour (OR 0.17, CI 0.09, 0.32; Table 5).

iv. *Iron spot test*

The weighted results of the iron spot test showed that among 2503 households where any wheat flour was available, 41.6% (CI: 39.2, 43.9) of all flour tested was fortified. Fortification rates varied by oblast ($p < 0.001$) with the highest estimates of 73.5% (CI: 65.5, 80.2) in Bukhara and the lowest in Syrdarya oblast (10.1%; 95%CI: 5.6, 17.6) and Tashkent city (11.4%; 95%CI: 7.2, 17.6) (Table 6).

v. *Labelling of flour*

The aim of this indicator was to assess the number of households where flour was available and labelled as "fortified" on the package. It was, however, difficult to obtain sufficient data to provide a reliable result for this indicator due to the high proportion of households where flour was either without packaging or where it had been repackaged at the household after purchase. The resulting low denominator numbers at the oblast level meant that data at this level was not reliable, therefore only the national findings can be used: out of all households with flour in its original packaging (n = 455), the percentage of households with the label "fortified" on the flour package was 25%.

Table 6: Availability of fortified flour at the household according to the iron spot test.

Oblast	Availability of fortified flour at the households according to the iron spot test (Q204)		
	Numerator /Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	19/146	11.4	6.3
Tashkent oblast	40/184	20.8	6.9
Syrdarya	14/165	10.1	6.9
Samarkand	48/180	28.6	10.2
Surkhandarya	65/185	37.6	9.9

Navoi	68/169	38.4	9.7
Namangan	85/170	50.2	10.6
Jizak	78/187	40.2	9.6
Kashkadarya	86/180	46.2	7.9
Fergona	71/187	36.9	7.7
Khorezm	52/151	35.2	9.5
R. Karakalpakstan	78/206	41.5	9.9
Andijan	76/203	35.0	8.9
Bukhara	116/190	73.5	7.4
Total (country)	**896/2503**	**41.6**	**2.3**

Regression analysis of factors associated with the availability of fortified flour in the household (based on the outcome of the iron spot test) found that the presence of fortified flour was higher in rural locations 45.4% (CI: 42.9, 48.1) than in urban locations 27.5% (CI: 22.1, 33.7; $p < 0.001$). When this association with location was taken into account, there was no significant association with household availability of fortified flour and SES.

vi. *Coverage of grey loaf*

The country-level weighted mean coverage of the grey loaf was 11.5% and, in general, the prevalence of households having a grey loaf in the household at the time of the survey were comparable across the oblasts and ranged from 0.5% in Surkhandarya to 7% in Navoi, with the exception of 2 oblasts; Tashkent city and Tashkent oblast where 72% and 38% of respondents respectively showed a grey loaf to the interviewers (Table 7). A similar situation for the day preceding the survey was described, and again Tashkent city (68%) and Tashkent oblast (42%) were the exceptions reporting much higher coverage.

Table 7: Availability of the grey loaf at households during and the day before the survey

Oblast	Availability of the grey loaf at households during the survey (Q207)			Availability of the grey loaf at households the day before the survey (Q315)		
	Numerator /Denominator	Weighted coverage estimate %	CI (±)	Numerator /Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	125/171	72.1	8.3	118/171	68.4	8.7
Tashkent oblast	67/190	38.5	13.9	72/190	41.6	12.7
Syrdarya	7/171	4.0	3.7	12/171	6.6	4.5
Samarkand	8/190	4.5	4.7	10/190	5.8	5.2
Surkhandarya	1/190	0.5	1.1	0/190	0.0	0.0
Navoi	9/171	6.6	5.5	9/171	7.3	5.8
Namangan	3/171	1.8	2.3	4/171	2.6	3.0
Jizak	2/190	0.6	1.0	2/190	0.6	1.0
Kashkadarya	7/190	3.7	3.4	8/190	4.8	4.0
Fergona	6/190	3.6	4.0	13/190	6.6	4.9
Khorezm	9/152	6.2	5.5	9/152	6.3	5.6
R. Karakalpakstan	3/209	1.8	2.4	5/209	2.3	2.5
Andijan	4/209	0.9	1.2	6/209	2.1	2.6
Bukhara	6/190	2.3	2.2	7/190	2.6	2.4
Total (country)	257/2584	11.5	1.8	275/2584	12.3	1.8

vii. *Distribution of flour by SES,location, education, nationality and marital status*

The majority of women included in the survey fell into the middle SES group (61.6%). Women of lower SES had UDM first grade flour in their households more frequently ($p < 0.0001$, design based Pearson Chi2 test; Table 7). In contrast, the higher SES group was associated with more frequently

purchasing “non-first grade flour” ($p < 0.0001$; Table 8). Specifically, non-first grade flour meant any type of flour that was not specified into another grouping and not first grade.

Examining the impact of location, rural women were more likely to have UDM flour in the household, compared to urban women ($p < 0.001$, Pearson Chi2 test). Specifically, 63.8% (CI: 60.3, 67.1) of rural women had UDM flour in the household, whereas 46.2% (CI: 37.3, 55.4) of urban women had UDM flour in the household. Due to the high collinearity between SES and location, we used a logistic regression model to examine the impact of SES within location. Among rural women, the odds ratio for having UDM flour for the middle versus low SES group is 0.735 (CI: 0.569, 0.950); and 1.213 (CI: 0.798, 1.846) for the high versus low SES group. Among urban women, the odds ratio for having UDM flour for the middle versus low SES group is 0.469 (CI: 0.185, 1.189); and for the high versus low SES group 0.175 (CI: 0.066, 0.466). Hence, there is a clear trend that, among urban women, UDM flour is less common among higher SES women.

Table 8: Distribution of types of the flour available at the households during the survey by level of socio-economic status (SES). Prevalence (CI).

	UDM first grade flour	First grade flour privately-owned mills	First grade flour non-branded mills	Kazakstan first grade flour	First grade flour unknown source	Non-first grade flour
Low SES (n=643)	63.3 (57.8, 68.6)	9.8 (7.1,13.4)	*1.8 (0.9, 3.5)*	5.6 (3.6, 8.7)	*0.5 (0.2, 1.7)*	16.7 (13.4, 20.6)
Middle SES (n=1592)	52.4 (49.0, 55.9)	6.7 (5.3, 8.3)	1.5 (1.0, 2.4)	12.1 (9.9, 14.7)	*0.5 (0.3, 1.0)*	23.4 (20.8, 26.2)
High SES (n=349)	40.0 (33.2, 47.3)	*2.1 (1.1, 3.9)*	*0.4 (0.1, 1.2)*	15.2 (10.5, 21.5)	*0.4 (0.0, 1.5)*	36.9 (31.2, 42.9)
Total (n=2584)	53.2 (50.2, 56.3)	6.8 (5.5, 8.3)	1.4 (1.0, 2.1)	11.0 (9.2, 13.1)	*0.5 (0.3, 0.9)*	23.8 (21.6, 26.0)

Figures in italics indicates numbers are too small (<10 cases) to draw any conclusion or to include in any additional analysis.

The availability of UDM first grade flour was lower at households of women with higher education (54.5%) compared to women with less than secondary education (62.5%), secondary (60%) or college education (63%) during the survey.

Respondents of Kazakh nationality were the most likely to have UDM first grade flour (76%, n = 86) but there was little difference in prevalence between nationalities. The lowest prevalence of first grade flour (51%, n = 45) was found in housholds of respondents of other non-specified nationalities.

viii. *Purchase and Consumption of Fortified Flour/Bread at the Household*

The weighted mean national coverage estimate of households where at least 50% of total flour purchased during the year before the survey was UDM first grade flour, was 58.2% (Table 9). Using a Pearson Chi2 test adjusted for the survey design, there was a significant difference in those reporting that UDM flour made up at least 50% of all flour purchased over the past year by oblast ($p < 0.0001$). Even after omitting Tashkent Oblast and Tashkent City, who use greyloaf more frequently, the result remains statistically significant ($p = 0.0024$).

Using a Pearson Chi2 test adjusted for the survey design, and excluding Tashkent City and Tashkent oblast, the weighted coverage estimate of households who purchased UDM grey loaf during the year before as 50% or more of the annual amount of bread, did not vary notably by oblast ($p = 0.24$). Using the same test and including all oblasts, there was a significant difference in those reporting that greyloaf made up at least 50% of all bread purchased over the past year ($p < 0.0001$). This result is driven by higher levels of grey loaf purchase in Tashkent Oblast and Tashkent City when compared with the rest of Uzbekistan.

Table 9: Purchase of UDM first grade flour and the grey loaf by oblasts

Oblast	UDM first grade flour made up ≥50% of the flour purchased during the year before the survey (Q306)			Grey loaf made up ≥ 50% of the bread purchased during the year before the survey (Q312)		
	Numerator /Denominator	Weighted coverage estimate %	CI (±)	Numerator /Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	12/167	6.0	4.9	115/171	67.2	8.9
Tashkent oblast	76/190	40.1	16.5	55/190	29.8	9.6
Syrdarya	112/171	65.8	9.5	12/171	7.6	5.0
Samarkand	135/190	71.0	8.9	6/190	3.1	2.9
Surkhandarya	138/189	75.8	7.9	1/185	1.1	2.5

Navoi	152/171	86.1	7.6	4/166	3.8	4.6
Namangan	98/170	57.8	11.4	5/168	3.3	3.1
Jizak	102/185	56.3	9.9	3/185	1.8	2.5
Kashkadarya	105/189	55.3	10.2	3/190	1.2	1.7
Fergona	108/189	58.0	13.9	7/184	4.8	4.4
Khorezm	98/151	63.5	12.1	5/143	4.1	4.9
R. Karakalpakstan	140/208	64.7	11.2	3/206	1.9	2.5
Andijan	132/209	62.8	12.0	8/209	3.7	3.9
Bukhara	130/190	70.9	8.5	3/189	0.9	1.3
Total (country)	1538/2569	58.2	3.0	230/2547	10.4	1.5

When results in Table 9 were analysed by the categories of SES, age, nationality, and marital status, the following within category results were found:

SES: in the low SES group 64.8% (59.8, 69.5) of women reported that at least 50% of the flour purchases for the household over the past year was UDM first grade flour, in the middle and high SES groups this was 57.9% (54.3, 61.4) and 48.7% (41.9, 55.6), respectively. Annual purchase of UDM first grade flour was significantly different by SES (p = 0.0004).

Education: a similar proportion of respondents with no education 69.2% (61.8, 75.6), secondary education 57.4% (53.7, 61.0) and college education 60.2% (54.7, 65.5), but a slightly lower proportion 47.2% (39.2, 55.3) of respondents with higher education, reported that annual purchase of UDM first grade flour was 50% or more of all the flour purchased. Annual purchase of UDM first grade flour was significantly different by educational status (p = 0.0004).

Nationality: 71.4% (55.2, 83.5) of Kazakh, 71.5% (57.4, 82.3) of Karakalpak, 58.1% (54.8, 61.2) of Uzbek, 59.2% (46.7, 70.5) of Tajik and 46.3% (33.0, 60.1) of other nationalities (Russian, Tatar, Turkmen, Kyrgyz) reported that annual purchase of UDM first grade flour was 50% or more of all the flour purchased. Annual purchase of UDM first grade flour was not significantly different by nationality group (p = 0.08).

Marital status: 79.2% (CI: 60.8, 90.4) of widowed women reported that at least 50% of the flour purchases for the household over the past year was UDM first grade flour, which was higher than that reported by single women, 60.5% (54.3, 66.3); married women 57.5% (CI:

54.2, 60.7) and divorced or separated women, 58.2% (CI: 43.2, 70.7). The CI for widowed women was wide due to the small number of widows in the dataset and consequently there was not a statistically significant difference in UDM purchasing by marital status (p = 0.12).

ix. *Proportion of UDM first grade flour purchased*

40.9% of women reported that UDM first grade flour was purchased to provide > 90% of their household's flour needs during the year preceding the survey. In contrast, respondents from only 3.8% of households reported that the grey loaf was purchased > 90% of the time (Table 10).

Table 10: Proportional distribution of UDM first grade flour/grey loaf purchase

Proportion of UDM flour/bread purchased in the year preceding the survey among other types of flour/bread (%)	% (number) of households reported purchase of UDM first grade flour	% (number) households reported purchase of grey loaf
> 90	40.9 (1050)	3.8 (97)
70 – 90	9.2 (237)	2.7 (69)
50 – 69	9.8 (251)	2.5 (64)
30 – 49	8.1 (209)	3.8 (96)
10 – 29	8.4 (215)	4.2 (107)
< 10	23.6 (607)	83 (2114)
Total	100 (2569)	100 (2547)

x. *Reasons for not purchasing UDM first grade flour*

Respondents were asked the main reasons why they did not purchase UDM first grade flour and poor quality and availability of home-made flour were the top two reasons given (Table 11). Among the 313 respondents (38.1%), who mentioned poor quality as the main reason not to purchase local first grade flour, the highest proportions lived in Tashkent city (40%) and Tashkent oblast (27%), where it was more usual to buy ready-made grey loaves. Availability of home-made *lepeshka* (bread) was the over-whelming reason given as to why respondents did not buy the grey loaf (64.9% of respondents) (Table 10). The range of responses giving this as the main reason for non-purchase of the grey loaf ranged between 1.9% (0, 6.3) in Tashkent City to 84.7% (78.4, 91.0) in

Kashkadarya and 84.1% (75.2, 92.9) in Namangan. Using a Pearson Chi-squared test accounting for survey design this difference in reasons given by oblast was significant (p <0.001).

Availability of home-made flour was mentioned as the main reason for not purchasing UDM first grade flour by a small percentage (< 14%) of respondents in nine of the oblasts: Republic Karakalpakstan, Jizak, Khorezm, Kashkadarya, Namangan, Fergona, Andijan, Bukhara and Surkhandarya. The proportion of women who indicated poor access to local first grade UDM flour was highest in Namangan, Samarkand, and Andijan. In other oblasts the denominator was too low to draw any meaningful conclusions.

Table 11: Main reasons for UDM first grade flour or the grey loaf not to be purchased

Reasons for UDM first grade flour or grey loaf not being purchased	Main reason for not purchasing UDM first grade flour	Main reason for not purchasing the grey loaf
	% Households	% Households
Poor quality	38.1	8.5
Availability of home-made flour/bread	36.9	64.9
Access	14.8	19.0
Price	2.1	-
Taste	1.2	4.0
Don't know/No answer	6.9	3.6
Total	100(822)	100 (2221)

xi. *Consumption of grey loaf or bread home-baked from UDM first grade flour*

Table 12 shows that consumption of the grey loaf or bread which was home-baked from UDM first grade flour the day before the survey was similar across oblasts with the lowest percentage in Tashkent city (74%) and the highest in Namangan and Kashkadarya (94%). National and oblast-level consumption of the grey loaf or bread which was home-baked from UDM first grade flour during the week preceding the survey was similar to consumption the day before the survey.

Table 12: Consumption of grey loaf or bread which was home-baked from UDM first grade flour

Oblast	Consumption of grey loaf or bread which was home-baked from UDM first grade flour, the day before the survey (Q 704(1))			Consumption of grey loaf or bread which was home-baked from UDM first grade flour, every day during the week before the survey (Q 704(2))		
	Numerator /Denominator	Weighted estimate %	CI (±)	Numerator/Denominator	Weighted estimate %	CI (±)
Tashkent city	124/171	74.0	8.6	112/143	78.8	8.7
Tashkent oblast	138/190	76.2	11.2	123/162	80.1	11.5
Syrdarya	132/171	76.5	9.0	130/161	80.7	9.3
Samarkand	160/190	82.0	8.3	155/181	83.8	8.2
Surkhandarya	163/190	86.0	7.3	156/183	85.5	7.5
Navoi	162/171	92.1	5.8	156/165	91.8	6.1
Namangan	161/171	93.4	5.2	157/166	93.9	5.3
Jizak	160/190	83.8	8.1	147/175	83.4	8.7
Kashkadarya	179/190	93.7	4.4	176/184	95.4	4.0
Fergona	151/190	78.0	7.8	141/178	78.0	7.5
Khorezm	124/152	81.2	10.0	120/148	80.7	10.3
R. Karakalpakstan	178/209	81.9	10.0	176/206	82.6	9.5
Andijan	172/209	80.8	7.6	171/202	83.7	8.4
Bukhara	162/190	87.2	6.2	158/181	88.8	5.8
Total (country)	2166/2584	82.9	2.0	2078/2435	84.6	2.0

According to the findings, the median weight of grey loaf or bread home-baked from UDM first grade flour consumed per household member per day is 230 g, this is shown per oblast in Table 13.

Table 13: Median weight of grey loaf or bread home-baked from UDM first grade flour consumed per household member per day

Oblast	Median (kg)
Republic Karakalpakstan	0.26
Tashkent region	0.21
Bukhara region	0.26
Syrdarya region	0.26
Jizak region	0.16
Navoiy region	0.28
Khorezm region	0.23
Tashkent city region	0.20
Fergona region	0.18
Samarkand region	0.24
Andijan region	0.17
Kashkadarya region	0.24
Namangan region	0.20
Surkhandarya region	0.25
Total (country n = 2584)	0.23

xii. *Knowledge about Fortification and Fortified Flour*

As illustrated in Table 14, 55% of WRA had heard of fortified food but there were differences in knowledge across oblasts with lowest in Surkhandarya oblast (40%) to the highest in Tashkent City (64%). Knowledge about which foods are fortified was demonstrated by 47% of respondents overall with the largest percentage in Fergona oblast (56%). From the programmatic point-of-view, for this indicator, only responses indicating knowledge about the local UDM first grade flour and the grey loaf were considered acceptable.

Table 14: Awareness about food fortification

Oblast	Ever heard about fortified food (Q 406)			Knowledge that grey loaf and/or UDM first grade flour is fortified		
	Numerato /Denominator	Weighted coverage estimate %	CI (±)	Numerator/ Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	111/171	64.1	11.1	73/171	43.9	9.7
Tashkent oblast	120/190	62.5	8.0	90/190	46.7	9.4
Syrdarya	95/171	60.7	9.9	61/171	38.2	11.0
Samarkand	104/190	54.5	8.3	86/190	45.4	8.7
Surkhandarya	73/190	40.4	8.5	79/190	43.0	8.6
Navoi	74/171	48.2	10.1	79/171	52.3	9.9
Namangan	96/171	57.6	10.1	94/171	55.1	9.9
Jizak	94/190	51.3	9.5	75/190	40.9	9.5
Kashkadarya	87/190	45.8	8.5	89/190	47.9	8.9
Fergona	107/190	55.5	10.2	109/190	56.2	11.9
Khorezm	93/152	61.8	10.0	79/152	52.8	9.1
R. Karakalpakstan	112/209	52.0	8.5	86/209	40.2	9.1
Andijan	105/209	49.1	8.6	85/209	38.0	8.0
Bukhara	117/190	61.9	9.0	96/190	51.8	10.9
Total (country)	1388/2584	54.5	2.3	1181/2584	47.0	2.4

Women were asked which minerals and vitamins are added as fortificants to the local first grade flour and to the grey loaf, 31% of respondents mentioned iron but there were differences across oblasts with the lowest frequency of this response in Tashkent city (22.6%) and highest in Fergona (41.5%) being aware of forticants. A question was asked about the benefits of the consumption of fortified flour and bread, however only 3.7% of the respondents in the country could give the correct answer with small variations across oblasts, i.e. no correct response in the Republic of Karakalpakstan and only 7% of correct responses in Syrdarya (Table 15).

Table 15: Knowledge on fortification with iron and benefits of consumption of fortified flour/bread

Oblast	Knowledge of fortification of UDM first grade flour or grey loaf with iron (Q409)			Knowledge on the benefits of consumption of fortified flour/bread (Q410)		
	Numerator /Denominator	Weighted coverage estimate %	CI (±)	Numerator /Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	37/171	22.6	8.3	7/171	5.5	5.3
Tashkent oblast	53/190	28.7	7.1	6/190	2.9	2.9
Syrdarya	43/171	28.3	10.1	12/171	7.6	5.3
Samarkand	64/190	34.1	8.9	4/190	3.4	4.7
Surkhandarya	60/190	33.2	8.4	9/190	6.1	4.4
Navoi	39/171	23.8	8.4	2/171	2.3	3.7
Namangan	62/171	35.9	9.0	2/171	1.2	2.0
Jizak	59/190	30.1	8.7	7/190	3.8	3.7
Kashkadarya	62/190	35.0	9.2	7/190	4.1	3.4
Fergona	80/190	41.5	9.8	6/190	3.1	2.7
Khorezm	59/152	38.9	9.0	4/152	2.7	3.3
R. Karakalpakstan	60/209	28.7	8.3	0/209	0.0	0.0
Andijan	53/209	23.8	7.4	10/209	4.3	3.2
Bukhara	66/190	35.0	9.7	10/190	5.3	4.1
Total (country)	797/2584	32.1	2.2	86/2584	3.7	0.9

Knowledge that the grey loaf and/or UDM first grade flour are fortified with iron was associated with a higher likelihood that at least > 50% of all flour purchased over the past year was UDM first grade flour ($p < 0.001$ adjusted, $p < 0.001$ unadjusted) and with a higher likelihood of currently have UDM first grade flour in the household ($p = 0.002$ adjusted, $p = 0.004$ unadjusted). On the other hand, knowledge that the grey loaf and/or UDM first grade flour are fortified with iron was associated with a lower likelihood that at least 50% of all bread purchased over the past year was was grey loaf ($p = 0.02$ adjusted, $p = 0.063$) and with a lower likelihood that there was currently grey loaf in the house

(p = 0.03 adjusted, p = 0.23). Those who were older, had a history of anemia, had previously taken iron supplements, had higher SES, and were more educated were more likely to know that UDM first grade flour is fortified. This is somewhat interesting, given that those with lower SES and less education are more likely to purchase UDM. Those with a history of anemia were actually less likely to have UDM first grade flour in their house at the time of the survey.

Knowledge of the benefits of fortification were not associated with any of the biochemical measures: ferritin, folate or hemoglobin (data presented later) in both unadjusted analyses and in analyses adjusted for age, SES, education, anemia history, and urban/rural in the model. Education (unadjusted: p = 0.002, adjusted for confounders p = 0.02) and SES (unadjusted: p< 0.00; adjusted for confounders p = 0.01) were significantly positively associated with knowledge of the benefits of consuming fortified bread.

Awareness that fortified flour can be distinguished from other flours by the package label, was demonstrated by only 12% of respondents with 6% of correct responses in Andijan and 19% in Fergona and Navoi (Table 16).

Table 16: Knowledge on how fortified flour can be distinguished from ordinary flour

Oblast	Knowledge on how fortified flour can be distinguished from ordinary flour (Q 411)		
	Numerator/ Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	15/171	9.2	5.3
Tashkent oblast	17/190	9.4	6.1
Syrdarya	13/171	8.5	5.5
Samarkand	14/190	7.0	6.3
Surkhandarya	24/190	14.2	5.9
Navoi	29/171	19.3	8.1
Namangan	27/171	14.6	6.3
Jizak	20/190	9.3	4.8
Kashkadarya	32/190	18.3	6.2
Fergona	38/190	19.2	7.2
Khorezm	24/152	15.5	7.7

R. Karakalpakstan	28/209	13.0	6.0
Andijan	15/209	6.0	3.9
Bukhara	19/190	10.1	6.7
Total (country)	315/2584	12.2	1.6

xiii. *Non-polvon" health food label*

Nationally, 36.9% of respondents had ever seen the "non-polvon" (healthy food) logo (Table 15). By oblast, just over half of respondents in Khorezm but only 21.3% in Samarkand had ever seen the logo. When asked if they recognized the 'non-polvon' logo, the result was disappointing as only 23.1% of WRA could say they recognized it.

Table 17: Knowledge of "healthy food" logo

Oblast	Ever seen the "non-polvon" logo (Q412)			Recognize the "non-polvon" logo (Q413)		
	Numerator/ Denominator	Weighted coverage estimate %	CI (±)	Numerator/ Denominator	Weighted coverage estimate%	CI (±)
Tashkent city	45/171	27.1	8.7	21/171	14.2	7.1
Tashkent oblast	70/190	36.3	10.0	44/190	22.4	7.7
Syrdarya	45/171	28.4	8.4	20/171	11.4	5.9
Samarkand	43/190	21.3	8.9	28/190	13.9	6.3
Surkhandarya	57/190	31.7	7.6	40/190	23.1	7.8
Navoi	68/171	44.1	9.9	39/171	23.0	8.3
Namangan	76/171	44.2	10.6	47/171	27.4	8.2
Jizak	80/190	43.5	8.6	47/190	23.1	7.7
Kashkadarya	73/190	39.0	8.8	46/190	24.4	7.4
Fergona	93/190	47.3	11.7	73/190	36.5	12.8
Khorezm	77/152	51.1	9.8	56/152	37.3	9.4

R. Karakalpakstan	94/209	43.9	10.2	56/209	25.5	8.6
Andijan	62/209	31.8	8.8	33/209	15.9	6.2
Bukhara	83/190	43.6	10.3	44/190	22.9	9.1
Total (country)	966/2584	36.9	2.5	594/2584	23.1	2.1

xiv. *Dietary Intake (Selected Consumption Frequency Questions)*

Consumption patterns for foods rich in heme iron and foods promoting iron absorption are reported in Tables 18 and 19. Over 90% of women had eaten some form of meat, fish or eggs on the proceeding day and stated that they had eaten such foods at least twice in the previous week (Table 18). There was some variation by oblast with lowest consumption in Surkhandarya (77.4%). There is no quantitative data for 'other foods' rich in heme iron, however this indicator (other foods' rich in heme iron) is highly correlated with SES. Additionally, only 3.8% of respondents did not eat one of these foods at least twice in the last week, so there is little power to detect an effect.

Table 18: Consumption of food rich with hem iron

Oblast	Ate chicken/other types of poultry, meat, fish or eggs at least once yesterday (Q701(1))			Ate chicken/other types of poultry, meat, fish or eggs at least twice in the last week (Q 701(2))		
	Numerator/ Denominator	Weighted coverage estimate %	CI (±)	Numerator/ Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	164/171	95.5	4.2	164/171	96.1	3.8
Tashkent oblast	179/190	94.4	4.3	183/190	96.3	3.3
Syrdarya	157/171	93.7	4.4	161/171	94.9	4.1
Samarkand	169/190	88.7	7.7	176/190	93.0	5.8
Surkhandarya	145/190	77.4	8.0	166/190	87.1	6.6
Navoi	166/171	97.0	3.8	168/171	97.8	3.3
Namangan	155/171	91.0	5.3	165/171	96.4	3.3
Jizak	171/190	88.5	7.0	182/190	95.6	3.6
Kashkadarya	165/190	86.4	7.0	184/190	97.1	2.6

Fergona	180/190	95.5	3.4	186/190	98.4	2.2
Khorezm	147/152	96.4	3.8	152/152	100.0	0.0
R. Karakalpakstan	187/209	89.3	5.0	205/209	98.9	1.5
Andijan	194/209	94.1	3.9	205/209	98.5	1.9
Bukhara	185/190	96.5	3.5	190/190	100.0	0.0
Total (country)	2364/2584	91.4	1.4	2487/2584	96.2	1.0

The percentage of respondents, who reported consumption of green leaves, other vegetables or fruits during the meal, at least once in a day preceding the survey, was higher than the consumption of meat and fish, as 97.1% of women nationally stated that they had eaten fruits and vegetables, with little variation by oblast (Table 19). Similarly, 90.2% of respondents reported eating green leaves, vegetables or fruits during the meal every day during the last week and there was little variation by oblast.

Table 19: Consumption of fruits and vegetables and iron absorption enhancers

Oblast	Eating green leaves, vegetables or fruits during the meal at least once yesterday (Q702(1))			Eating green leaves, vegetables or fruits during the meal every day during the last week (Q702(2))		
	Numerator/ Denominator	Weighted coverage estimate %	CI (±)	Numerator/ Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	164/171	95.9	4.2	149/171	88.6	6.2
Tashkent oblast	183/190	95.7	3.8	172/190	88.4	6.3
Syrdarya	161/171	95.5	3.8	140/171	84.3	8.5
Samarkand	180/190	96.2	3.4	155/190	83.3	7.3
Surkhandarya	189/190	99.5	1.2	177/190	93.6	5.1
Navoi	166/171	96.7	3.5	156/171	88.2	6.9
Namangan	171/171	100.0	0.0	168/171	98.1	2.7
Jizak	182/190	96.6	2.9	173/190	91.5	5.4

Kashkadarya	182/190	97.9	2.3	176/190	94.5	4.2
Fergona	184/190	97.4	3.3	170/190	89.7	6.9
Khorezm	152/152	100.0	0.0	142/152	92.9	5.4
R. Karakalpakstan	188/209	92.6	4.3	181/209	88.8	5.1
Andijan	202/209	96.9	2.8	190/209	93.3	4.4
Bukhara	185/190	97.5	2.7	164/190	87.3	5.9
Total (country)	2489/2584	97.1	0.8	2313/2584	90.2	1.5

In contrast, consumption of inhibitors of iron absorption during the meal or right after the meal was high (Table 20). Only 5% of respondents in the country reported not drinking coffee, coffee with milk, tea or tea with milk during the meal or right after the meal during the day before the survey. This practice was in fact their normal behavior as a similar proportion stated they had drunk tea or coffee during or after meals during the previous week.

Table 20: Non-consumption of inhibitors of iron absorption

Oblast	Did not drink coffee/coffee with milk, tea or tea with milk during the meal or right after the meal yesterday (Q 703(1))			Did not drink coffee/coffee with milk, tea or tea with milk during the meal or right after the meal during the last week (Q 703(2))		
	Numerator/ Denominator	Weighted coverage estimate %	CI (±)	Numerator/ Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	7/171	4.8	4.2	6/171	3.6	3.6
Tashkent oblast	3/190	1.0	1.7	3/190	1.0	1.7
Syrdarya	4/171	2.8	3.3	4/171	2.8	3.3
Samarkand	10/190	4.2	3.9	10/190	4.2	4.0
Surkhandarya	11/190	5.6	4.1	11/190	5.6	4.1
Navoi	14/171	10.9	7.0	11/171	8.4	6.2
Namangan	8/171	5.1	4.3	7/171	4.4	4.0
Jizak	7/190	2.4	2.3	7/190	2.4	2.3

Kashkadarya	13/190	6.3	4.6	11/190	5.6	4.3
Fergona	25/190	12.6	7.8	22/190	11.1	6.5
Khorezm	6/152	3.8	3.9	6/152	3.8	3.9
R. Karakalpakstan	23/209	8.7	4.7	22/209	8.2	4.5
Andijan	2/209	0.7	1.2	2/209	0.7	1.2
Bukhara	10/190	6.4	5.2	6/190	4.4	4.3
Total (country)	143/2584	5.3	1.2	128/2584	4.7	1.0

xv. *Knowledge of Iron Deficiency Anemia (IDA) and Flour Fortification*

Table 21 demonstrates that the proportion of women who could mention at least two causes of IDA was low and varied from the lowest in Navoi oblast (4.6%) to the highest in Syrdarya (19.1%) and that, nationally, only 12.5% of WRA had some knowledge. The percentage of respondents who could mention at least three of the most-at-risk populations for IDA ranged from 8.0% in Andijan oblast to 27.3% in Kashkadarya oblast with a national average of 17.4%. Knowledge of the causes of IDA was associated with a higher likelihood of purchasing the grey loaf at least 50% of the time over the past year ($p < 0.001$ unadjusted, $p = 0.02$ adjusted) and with currently having grey loaf in house ($p < 0.001$ unadjusted, $p = 0.02$ adjusted). Confounders included in the model were age, SES, education, anemia history, and urban/rural location.

Knowledge of at-risk populations was not associated with the likelihood of purchasing either grey loaf or UDM first grade flour.

Table 21: Knowledge of causes and most-at-risk population for IDA

Oblast	Knowledge of at least 2 causes of IDA (Q402)			Knowledge of at least 3 most-at-risk population for IDA (Q403)		
	Numerator /Denominator	Weighted coverage estimate %	CI (±)	Numerator /Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	32/171	17.2	7.5	31/171	18.1	7.4
Tashkent oblast	34/190	17.6	7.9	35/190	19.5	8.6
Syrdarya	28/171	19.1	8.5	19/171	13.0	6.8
Samarkand	27/190	17.0	6.8	30/190	16.1	6.9

Surkhandarya	22/190	10.9	5.2	38/190	18.7	6.4
Navoi	8/171	4.6	4.1	17/171	8.6	5.3
Namangan	27/171	14.7	6.0	24/171	13.3	5.9
Jizak	14/190	8.0	4.8	25/190	13.1	6.0
Kashkadarya	16/190	9.1	4.8	48/190	27.3	8.3
Fergona	15/190	7.9	4.3	46/190	25.9	11.5
Khorezm	18/152	11.2	6.1	30/152	19.3	8.4
R. Karakalpakstan	14/209	6.3	3.8	24/209	12.5	6.4
Andijan	19/209	9.4	5.2	18/209	8.0	4.3
Bukhara	38/190	17.4	7.3	33/190	15.5	6.9
Total (country)	312/2584	12.5	1.5	418/2584	17.4	2.0

Nationally, 42% of women correctly mentioned at least 3 signs and consequences of IDA. The lowest percentage was in Navoi oblast (30.0%) and the highest in Namangan oblast (52.5%; Table 22). Only 5.9% of respondents nationally demonstrated adequate knowledge of ways to prevent IDA (by mentioning at least 3 accepted ways to prevent IDA).

Knowledge indicators were not associated with the biochemical measures of ferritin, folate or hemoglobin in either the unadjusted and adjusted regression analyses where confounders in the model were age, SES, education, anemia history, and residency.

Table 22: Knowledge of signs and consequences of anemia and how to avoid IDA

Oblast	Knowledge of at least 3 signs and consequences of anemia (Q 404)			Knowledge of at least 3 ways to prevent IDA (Q 405)		
	Numerator /Denominator	Weighted estimate %	CI (±)	Numerator/ Denominator	Weighted estimate %	CI (±)
Tashkent city	69/171	40.9	8.0	12/171	7.4	4.9
Tashkent oblast	81/190	42.3	9.9	9/190	5.5	3.9
Syrdarya	66/171	41.4	9.3	8/171	6.1	4.9
Samarkand	89/190	43.4	9.3	12/190	6.9	5.7

Surkhandarya	76/190	38.6	7.3	15/190	8.0	4.4
Navoi	48/171	30.0	7.8	4/171	2.6	3.1
Namangan	88/171	52.5	8.0	6/171	3.5	3.3
Jizak	84/190	38.8	8.3	14/190	6.9	4.5
Kashkadarya	74/190	40.1	7.2	10/190	5.4	4.0
Fergona	74/190	38.5	7.3	8/190	4.4	4.2
Khorezm	77/152	50.8	8.2	1/152	0.8	2.0
R. Karakalpakstan	76/209	37.7	8.3	11/209	5.7	4.1
Andijan	77/209	37.2	6.7	14/209	9.4	7.4
Bukhara	98/190	51.1	9.1	14/190	7.5	4.8
Total (country)	1077/2584	41.9	2.4	138/2584	5.9	1.3

xvi. *Biomarkers*

Hemoglobin

The overall national weighted geometric mean for hemoglobin concentration was 121.6 g/L, which is above the WHO cut-off defining anemia (<120g/L; [12]). However, the mean hemoglobin concentration in two oblasts, Surkhandarya and the Republic of Karakalpakstan did fall below the WHO cut-off (114.3g/L and 117.5g/L, respectively) indicating that anemia was a problem in these oblasts (Table 23). Overall, 34.4% (CI: 32.0, 36.7), (weighted coverage estimate) of WRA had concentrations of hemoglobin <120g/L and were considered to be anemic. Using the WHO criteria, this level of prevalence indicates that anemia was a moderate public health problem in the county as a whole [17] (Table 24). There was marginal evidence that the prevalence of anemia varied within the regions of the country (p=0.07). Surkhandarya oblast and the Republic of Karakalpakstan had the highest prevalences of anemia, estimated at 45.6% (CI 34.5, 57.2) and 44.2% (CI 36.6, 52.1), respectively. Prevalences of over 40% indicate that anemia was a severe public health problem for these two oblasts. Analysis of the prevalence of anemia by oblast was done using the binary indicator (low hemoglobin), and continuous measures. For continuous measures, assuming normality and using an F-test adjusting for survey design, there were significant differences by oblast for hemoglobin (p = 0.006). However, the continuous data were treated as normally distributed within oblasts, but as the distributions of the biochemical markers are skewed this assumption may not hold. Repeating the analysis using log-transformed data, the Pearson Chi-2, accounting for survey design, there were still significant differences by oblast for hemoglobin, (p =

0.01). The sample size for the anemia data is 2580; samples from 4 WRA were lost due to coagulation.

Table 23: Geometric mean hemoglobin (Hb) concentrations

Oblast	Hb concentrations (g/L)		
	n	Weighted estimate	CI
Tashkent city	171	124.2	120.1, 128.4
Tashkent oblast	190	122.3	118.3, 126.4
Syrdarya	171	120.8	117.6, 124.1
Samarkand	190	123.4	118.4, 128.5
Surkhandarya	190	114.3	107.9, 121.1
Navoi	171	122.0	117.4, 126.8
Namangan	171	122.6	119.8, 125.5
Jizak	190	126.1	123.1, 129.3
Kashkadarya	190	121.4	118.5, 124.4
Fergona	190	124.0	118.8, 129.5
Khorezm	152	120.3	115.8, 124.9
R. Karakalpakstan	209	117.5	114.2, 120.8
Andijan	209	121.8	119.1, 124.6
Bukhara	190	120.1	117.7, 122.6
Total (country)	2580	121.6	120.4, 122.7

Lower and upper limits for CI shown because CI for geometric mean is not symmetric.

Table 24: Prevalence of anemia (Hb<120g/l) in WRA by oblast

Oblast	Numerator/Denominator	Weighted coverage estimate %	CI (±)
Tashkent city	47/170	26.9	8.6
Tashkent oblast	65/189	33.9	8.0
Syrdarya	59/171	30.0	9.0
Samarkand	57/189	28.7	8.5
Surkhandarya	85/190	45.6	13.2
Navoi	52/171	29.4	8.9
Namangan	51/171	29.0	8.8
Jizak	56/190	27.4	7.9
Kashkadarya	63/190	34.9	8.4
Fergona	57/189	27.5	9.1
Khorezm	50/152	32.9	9.7
R. Karakalpakstan	92/209	44.2	8.5
Andijan	65/209	32.2	7.5
Bukhara	67/190	33.0	8.4
Total (country)	866/2580	34.4	2.3

Data were also analyzed by severity of anemia by oblast (Table 25). Of those WRA with hemoglobin < 120g/L, the majorty had mild anemia (29%), 4.3% had moderate and a minority (1%) had severe anemia. Since only 111 and 25 WRA had moderate and severe anemia, respectively, it was not possible to assess differences in prevalence by oblast.

Table 25: Proportion of women with different stages of anemia by oblast

	Anemia status (range g/L) and prevalence (%) (CI)			
OBLASTS	Normal (Non-anemic) (120 – 170.9 g/L)	Mild anemia (91 -119.9 g/L)	Moderate anemia* (70-90.9 g/L)	Severe anemia* (≤ 69 g/L)
Tashkent city	71.6 (63.4, 78.6)	24.5 (18.0, 32.4)	*2.5 (1.0, 6.2)*	*1.4 (0.3, 5.9)*
Tashkent oblast	65.1 (57.3, 72.2)	30.9 (23.6, 39.4)	*4.0 (1.6, 9.7)*	*0*
Syrdarya	66.4 (57.7, 74.0)	29.4 (22.4, 37.4)	*3.5 (1.4, 8.3)*	*0.8 (0.2, 3.4)*
Samarkand	67.7 (59.5, 75.0)	28.1 (20.7, 36.8)	*4.0 (1.6, 9.5)*	*0.3 (0.0, 2.2)*
Surkhandarya	54.4 (42.8, 65.5)	35.3 (26.9, 44.8)	*7.4 (3.8, 14.2)*	*2.8 (0.8, 9.2)*
Navoi	68.2 (59.9, 75.5)	23.8 (17.3, 31.7)	*6.6 (3.4, 12.5)*	*1.4 (0.3, 6.8)*
Namangan	68.1 (59.8, 75.5)	28.1 (21.3, 36.2)	*3.1 (1.4, 6.8)*	*0.7 (0.0, 4.6)*
Jizak	70.6 (62.9, 77.3)	27.2 (20.9, 34.6)	*2.2 (0.9, 5.0)*	*0*
Kashkadarya	62.7 (54.4, 70.2)	32.0 (24.9, 40.1)	*3.6 (1.7, 7.4)*	*1.7 (0.6, 5.1)*
Fergona	72.2 (63.5, 79.5)	24.1 (17.3, 32.4)	*2.9 (1.2, 6.7)*	*1.0 (0.2, 3.4)*
Khorezm	65.4 (56.7, 73.1)	25.5 (18.3, 34.4)	*7.4 (4.3, 12.5)*	*1.7 (0.4, 6.4)*
R. Karakalpakstan	55.8 (47.8, 63.4)	38.5 (31.2, 46.3)	*4.7 (2.5, 8.6)*	*1.1 (0.3, 3.9)*
Andijan	65.0 (58.1, 71.4)	28.9 (23.0, 35.7)	*5.8 (2.9, 11.1)*	*0.3 (0.0, 1.3)*
Bukhara	63.2 (55.1, 70.6)	32.8 (25.4, 41.1)	*3.2 (1.5, 6.6)*	*0.9 (0.2,3.9)*
Total (country)	65.6 (63.2, 67.9)	29.2 (27.0,31.5)	*4.3 (3.4, 5.4)*	*1.0 (0.6, 1.5)*

** Figures given in italics because sample size too small to infer any differences between oblasts.*

Given the low number of WRA in the survey who were aged 15-19 (n = 176) and the relatively small number of WRA with moderate or severe anemia, it was not possible to analyse the severity of anemia by age.

Overall, almost 100% of women had some level of education (Table 2) of which 90.5% reached at least secondary education, Using a Peasron Chi-2 test adjusting for the survey design, there were no statistically significant differences in severity of anemia by educational status (p=0.72). In women

who were unqualified and did manual work there was a slightly higher proportion with anemia (41%) compared to women who did not work during the year preceding the survey (33%; ns). Prevalence of anemia in all categories of work was similar; i.e. women who had a professional, technical or management occupation (33%), women performing administrative work (31%), women working in trade or other services (33%), women working in qualified manual work (36%) or agriculture (30%). There were no significant differences in the prevalence of anemia among these groups. SES was also not associated with hemoglobin concentrations.

There were no statistically significant differences in severity of anemia by marital status (p= 0.06), however the p-value for marital status was almost statistically significant, possibly driven by the observed lower anemia rates in single, never-married women.

The proportion of WRA who were anemic was higher in respondents of Karakalpak nationality (49%) compared to the respondents of Uzbek (32.5%) Tajik (37%) Kazakh (39%) or other nationalities (30%). Statistical significance was determined using a Pearson Chi 2 test, adjusting for the survey design and showed significant difference between nationalities for low hemoglobin (p=0.021). This difference was driven to a large degree by higher deficiency rates in the Karakals compared to the other nationalities.

There was an association between stage of anemia and awareness of a history of anemia (p = 0.005). Those with a history of anemia had generally lower hemoglobin levels than those without a history of anemia (Table 26).

Table 26: Proportion of women with different stages of anemia by history of anemia.

	Anemia prevalence % (CI)			
History of Anemia	Normal (non-anemic) 120 – 179 g/L	Mild 91 –119 g/L	Moderate 70–90 g/L	Severe* ≤69 g/L
No	69.0 (65.2, 72.5)	27.7 (24.3, 31.3)	3.0 (1.9, 4.6)	*0.4 (0.2, 1.1)*
Yes	63.2 (60.3, 66.1)	30.2 (27.6, 33.0)	5.2 (4.1, 6.7)	*1.3 (0.8, 2.3)*
Overall	65.6 (63.2, 67.9)	29.2 (27.0, 31.5)	4.3 (3.4, 5.4)	*1.0 (0.6, 1.5)*

** Figures given in italics because total sample size for severe anemia small, only 25 WRA.*

The proportion of women with an adequate level of hemoglobin who were or were not consuming UDM first grade flour or the grey loaf is presented in Table 27. Overall, there were no substantial

difference in the prevalence of normal hemoglobin levels between WRA who had or did not have fortified flour/bread in their household.

Table 27: Proportion of women consuming UDM first grade flour or g rey loaf who have normal hemoglobin concentration (≥120g/L)

	Proportion WRA with hemoglobin concentration ≥ 120g/L %(CI)	
Oblast	No flour or greyloaf in house	Flour or greyloaf in house
Tashkent city	71.0 (52.3, 84.5)	74.0 (62.8, 82.7)
Tashkent oblast	62.2 (48.9, 73.9)	68.5 (56.5, 78.4)
Syrdarya	72.0 (57.1, 83.3)	68.6 (56.5, 78.6)
Samarkand	73.0 (59.4, 83.3)	70.4 (58.9, 79.7)
Surkhandarya	64.0 (42.7, 80.9)	51.1 (36.0, 66.1)
Navoi	69.3 (43.0, 87.1)	70.8 (60.4, 79.4)
Namangan	71.9 (53.8, 84.9)	70.6 (59.2, 79.9)
Jizak	79.7 (67.6, 88.1)	66.4 (53.7, 77.1)
Kashkadarya	67.9 (48.9, 82.4)	64.2 (54.4, 73.0)
Fergona	73.4 (57.9, 84.7)	72.0 (60.9, 80.9)
Khorezm	58.3 (42.9, 72.3)	73.8 (58.7, 84.9)
R. Karakalpakstan	54.3 (40.5, 67.5)	58.6 (49.9, 66.8)
Andijan	59.3 (43.3, 73.5)	70.8 (60.9, 79.0)
Bukhara	72.8 (59.0, 83.3)	63.9 (52.8, 73.8)
Total (country)	67.4 (63.7, 70.9)	67.7 (64.8, 70.5)

Severity of anemia did not significantly differ between WRA living in households where UDM first grade flour was purchased more than 50% of the time over the past year (66% non-anemic, 27.8% mild anemia, 6.2% moderate or severely anemic) compared with those living in households where it was purchased less than 50% of the time over the past year (65% non-anemic, 31.0.8% mild anemia, 4.0% moderate or severely anemic) (p = 0.08).

There is insufficient evidence from regression analysis to conclude that consuming chicken, other types of poultry, meat, fish or eggs was associated with any biochemical indicator; hemoglobin, ferritin or folate. There would have been more power to detect a significant difference if more women had not eaten these foods however, in the survey sample these foods were commonly available and therefore not a driver of population differences in the biochemical indicators.

Analyses were performed both without and with adjusting for relevant confounders (e.g. fortification, age, SES). Without adjusting for confounders, the association between low hemoglobin and the consumption of these relatively heme-rich foods was not significant (p = 0.07). The prevalence of low hemoglobin in those who ate these heme iron-rich foods was 32.4% (CI: 30.1, 34.8), compared to 31.6% (CI: 21.8, 43.3) in those who did not.

CRP and inflammation

The presence of inflammation was indicated by CRP concentrations >5mg/L and in all oblasts the mean CRP concentration was less than the cut-off hence the prevalence of inflammation in the women was very low (Table 28; [13]). The distribution of the CRP data was skewed. Using a Pearson Chi-2 test and accounting for survey design, differences between oblasts for high CRP were not statistically significant (p = 0.68).

Table 28: Mean CRP concentrations (mg/L) and prevalence of abnormal CRP concentrations (>5mg/L) by oblast and overall in Uzbekistan.

Oblast	Geometric mean CRP concentrations (mg/L)			Prevalence of CRP concentrations >5mg/L		
	n	Weighted estimate %	CI *	Numerator /Denominator	Weighted estimate %	CI (±)
Tashkent city	171	1.4	1.1,1.7	5/171	3.1	3.5
Tashkent oblast	190	1.5	1.3,1.7	9/190	5.3	4.1
Syrdarya	171	0.7	0.6,0.9	9/171	6.5	5.0
Samarkand	189	1.0	0.8,1.2	4/189	2.9	3.6
Surkhandarya	190	0.7	0.6,0.9	7/190	4.6	4.5
Navoi	171	0.7	0.6,0.8	5/171	3.3	4.0
Namangan	170	0.8	0.7,1.0	2/170	1.2	2.0
Jizak	190	0.7	0.6,0.9	3/190	0.9	1.4
Kashkadarya	190	0.8	0.7,1.0	9/190	4.7	3.7

Fergona	190	1.6	1.4,1.8	9/190	5.0	3.4
Khorezm	152	1.3	1.2,1.5	5/152	3.2	3.3
R. Karakalpakstan	209	2.2	1.9,2.4	13/209	5.7	3.8
Andijan	208	0.9	0.7,1.2	8/208	4.4	3.5
Bukhara	190	0.9	0.7,1.1	8/190	4.8	4.2
Total (country)	2581	1.1	1.0,1.1	96/2581	4.0	0.9

* Lower and upper limits for CI shown because CI for geometric mean is not symmetric.

Ferritin

Although there was little inflammation in the women, as measured by CRP concentrations, the correction of ferritin concentrations for the presence of inflammation, using the calculated factors from the meta-analysis of Thurnham et al [13] was carried out. Mean ferritin concentrations unadjusted and adjusted are given in Table 29. In all oblasts and nationally, the mean corrected and uncorrected ferritin concentrations were all >12 µg/L, the WHO cutoff for depleted iron stores [17].

Table 29: Geometric mean ferritin concentrations (uncorrected and corrected for inflammation) by oblast

Oblast	Geometric mean serum ferritin unadjusted concentrations (µg/L)			Geometric mean serum ferritin concentrations adjusted for inflammation* (µg/L)		
	n	Weighted Estimate %	CI**	N	Weighted Estimate %	CI **
Tashkent city	171	18.2	15.3, 21.5	171	18.0	15.2, 21.4
Tashkent oblast	190	14.1	12.4, 16.0	190	13.9	12.2, 15.8
Syrdarya	171	14.7	12.5, 17.3	171	14.4	12.3, 17.0
Samarkand	189	21.4	17.1, 26.9	189	21.3	17.0, 26.6
Surkhandarya	190	20.5	17.6, 23.9	190	20.3	17.4, 23.5
Navoi	171	18.8	15.4, 22.9	171	18.6	15.3, 22.6
Namangan	170	23.2	19.9, 27.0	170	23.1	19.8, 26.9
Jizak	190	15.1	12.9, 17.7	190	15.1	12.8, 17.7
Kashkadarya	190	19.2	16.0, 23.0	190	19.0	15.8, 22.7
Fergona	190	15.2	12.8, 18.1	190	15.0	12.7, 17.8

Khorezm	152	14.4	12.0, 17.2	152	14.2	11.9, 17.1
R. Karakalpakstan	209	11.9	10.3, 13.8	209	11.7	10.1, 13.6
Andijan	209	18.5	16.1, 21.2	209	18.3	15.9, 21.0
Bukhara	190	14.5	12.3, 17.2	190	14.4	12.1, 17.0
Total (country)	2582	17.3	16.5, 18.1	2582	17.1	16.4, 17.9

*Ferritin concentrations associated with elevated CRP concentrations were adjusted according to the meta-analysis of Thurnham et al 2010.

** Lower and upper limits for CI shown because CI for geometric mean is not symmetric.

The estimated overall corrected geometric mean ferritin concentration was 17.1 µg/L (CI: 16.4, 17.9) (the geometric mean was used because the distribution of ferritin concentrations was highly right skewed). Binary analysis using log-transformed data was done because ferritin data were skewed. Using the Pearson Chi-2, accounting for survey design, significant differences were found by oblast for ferritin adjusted for CRP ($p < 0.0001$).

Table 30: Prevalence of women of reproductive age who had depleted iron stores

Oblast	Depleted iron stores % serum ferritin <12 ug/L		
	Numerator/ Denominator	Weighted estimate %	CI (±)
Tashkent city	76/171	44.9	9.2
Tashkent oblast	110/190	58.0	9.4
Syrdarya	89/171	52.9	9.8
Samarkand	76/189	36.7	10.1
Surkhandarya	75/190	40.1	8.9
Navoi	81/171	46.0	9.7
Namangan	55/170	31.8	7.9
Jizak	98/190	51.6	8.5
Kashkadarya	79/190	43.6	9.2
Fergona	110/190	54.4	9.4
Khorezm	84/152	56.7	10.4

R. Karakalpakstan	144/209	63.9	10.2
Andijan	90/209	43.7	8.0
Bukhara	110/190	56.9	9.5
Total (country)	1277/2582	47.5	2.4

There was evidence that the prevalence of depleted iron stores varied by oblast ($p < 0.0001$), with the highest estimated prevalence in the Republic of Karakalpakstan (63.9%; CI: 53.7, 74.1) and the lowest in Namangan (31.8%; CI: 24.0, 39.6). Additionally, there is evidence that iron depletion varied by nationality ($p = 0.002$), the highest prevalence (71.0%,CI: 60.1, 79.9) found within the Karakalpakstans.

Using a Pearson Chi2 test adjusted for the survey design, there were statistically significant differences in prevalence of depleted iron stores by oblast ($p < 0.0001$).

Table 31: Iron depletion by stage of anemia

Anemia Stage	% Low ferritin (<12 ug/L) (CI)
Normal >120 g/L	37.4 (34.6, 40.3)
Mild 91-120 g/L	65.7 (61.5, 69.8)
Moderate 70-90 g/L	73.5 (62.8, 82.1)
Severe* ≤ 69 g/L	*74.1 (49.6, 89.3)*
p-value: low iron stores by stage of anemia	< 0.0001.

** Figures given in italics because total sample size for severe anemia is small, only 25 WRA.*

Of WRA who had anemia, 67.3% also had depleted iron stores (CI: 63.2, 71.3). As expected, the prevalence of depleted iron stores was significantly higher in those with anemia (Table 31) ($p < 0.001$).

As mentioned above, there is insufficient evidence from regression analysis to conclude that consuming chicken, other types of poultry, meat, fish or eggs was associated with any biochemical indicator; hemoglobin, ferritin or folate. Without adjusting for confounders, the association between low ferritin and consumption of these relatively heme-rich foods was not significant ($p = 0.07$).

Table 32 shows the prevalence of low ferritin by SES, age, education, and UDM first grade flour purchase history. None of these factors were significantly associated with low ferritin concentration.

Table 32: Proportion of WRA with low ferritin concentrations by different factors

		Low ferritin (<12 µg/L) % (CI)	p value*
Marital Status	Single	43.3 (38.1, 48.6)	0.2
	Married	48.6 (46.0, 51.3)	
	Widowed	34.0 (18.8, 53.5)	
	Divorced	43.9 (30.7, 58.0)	
SES	Low	44.1 (39.6, 48.7)	0.1
	Moderate	49.4 (46.5, 52.3)	
	High	45.4 (39.4, 51.5)	
Education	Less than secondary	47.9 (40.3, 55.5)	0.07
	Secondary	46.5 (43.5, 49.4)	
	College	53.0 (48.2, 57.8)	
	Higher	41.5 (33.5, 50.0)	
Proportion of flour purchased over the past year that was UDM first grade	< 50%	48.6 (44.9, 52.3)	0.5
	> 50%	47.0 (43.9, 50.0)	
	Total	47.5 (45.1, 49.9)	

* p value for Pearson Chi-2 test, adjusting for survey design, for differences in low ferritin concentration.

Folate

Nationally the mean folate concentration was greater than the cut-off (10nmol/L; [16]) and, although there were variations by oblast, the mean folate value for all oblasts was above the cut-off. The prevalence of folate deficiency (values <10 nmol/L) was 29% nationally (Table 33), with an enormous range by oblast from 3% deficiency in Bukhara to 45% in Navoi. Using a Pearson Chi2 test adjusted for the survey design, the prevalence of folate deficiency was found to differ

significantly across oblasts (p < 0.0001). Folate data were skewed therefore log-transformed continuous data and the Pearson Chi-2 test, accounting for survey design, was conducted and significant differences were still found by oblast for folate (p < 0.0001).

Table 33: Geometric mean folate concentrations and prevalence of low folate concentrations (<10nmol/L) in women of reproductive age

Oblast	Folate concentrations (nmol/L)			Prevalence of folate concentrations <10nmol/L		
	n	Weighted estimate	CI (±)*	Numerator/ Denominator	Weighted estimate	CI (±)
Tashkent city	170	13.9	12.7, 15.2	25/170	14.1	6.9
Tashkent oblast	186	11.1	10.3, 12.0	58/186	29.9	8.2
Syrdarya	170	11.1	10.1, 12.2	45/170	24.1	7.8
Samarkand	190	12.8	11.6, 14.1	55/190	26.8	8.1
Surkhandarya	190	11.2	10.5, 12.0	67/190	37.1	8.9
Navoi	169	10.3	9.6, 11.1	75/169	45.3	10.1
Namangan	168	9.9	9.4, 10.4	77/168	44.4	8.8
Jizak	189	10.3	9.7, 11.0	81/189	41.0	9.0
Kashkadarya	190	11.2	10.4, 12.2	54/190	27.4	7.8
Fergona	189	9.8	9.3, 10.3	103/189	53.9	8.4
Khorezm	151	13.4	11.9, 15.1	25/151	16.8	7.1
R. Karakalpakstan	206	12.3	11.2, 13.5	44/206	21.1	6.8
Andijan	207	12.9	11.8, 14.1	29/207	15.2	5.7
Bukhara	188	18.7	17.7, 19.8	7/188	3.4	3.1
Total (country)	2563	11.9	11.7, 12.2	745/2563	28.8	2.0

* Lower and upper limits for CI shown because CI for geometric mean is not symmetric.

Table 34 describes the association between low folate status and stage of anemia. Of WRA with anemia, 45.9% also had low folate levels, (CI: 42.1, 49.6). Among WRA who did not have anemia, 20.6% had low folate levels (CI: 18.6, 23.1). As expected from these data, the rate of low folate levels is significantly higher in those with anemia (p < 0.001).

Table 34: Low folate by stage of anemia

Anemia Stage	Low folate (<10nmol/L) (CI)
Normal >120 g/L	20.6 (18.4, 23.0)
Mild 91-120 g/L	36.8 (33.1, 40.7)
Moderate 70-90 g/L	88.8 (80.3, 93.9)
Severe ≤ 69 g/L	93.4 (78.1, 98.3)
p-value: low folate prevalence by anemia stage	< 0.0001

An increase in SES is associated with a decrease in low folate (p =0.03: Wald test from Logistic regression). Proportions with low folate by SES group are: low SES 32.6% (CI: 28.3, 37.1), moderate SES 28.9% (CI: 26.4, 31.5) and high SES 23.0% (CI: 18.3, 28.4). Compared to the lowest SES group, the odds of low folate are 0.83 times lower (CI - 0.65, 1.06) in the middle group, and 0.61 times lower (I - 0.43, 0.87) in the high SES group. Coefficients are similar between multivariate and simple logistic regression, suggesting no confounding by age or education.

Using a Pearson Chi 2 test, adjusting for the survey design, there is a statistically significant difference between nationalities for low folate (p= 0.04). However, using the same test there was no significant variation in the proportion of women with low folate concetrations by marital status (p = 0.1), age (p= 0.8) or education (p = 0.4). The proportion of women with low folate concentrations did not significantly differ between those who had purchased UDM first grade flour more than or less than 50% of the time over the past year (p = 0.1).

As mentioned above, there is insufficient evidence from regression analysis to conclude that consuming chicken, other types of poultry, meat, fish or eggs was associated with any biochemical indicator; hemoglobin, ferritin or folate. Without adjusting for confounders, the association between low folate and consumption of these relatively heme-rich foods was not significant (p = 0.07).

The prevalence of low folate among WRA who had eaten these foods the day before the survey was 28.5% (CI: 26.4, 30.6), compared to 39.1% (CI: 28.0, 51.6) in those who did not. The small sample size for WRA who had not eaten these foods the day before limted the power to detect a significant difference.

Iron tablets

WRA who had taken iron tablets in the last 2 years had higher rates of iron deficiency, lower hemoglobin, lower folate and lower ferritin. Those with any history of taking iron also had higher iron deficiency rates, lower hemoglobin, and lower ferritin than those who never took iron. Apart from low ferritin, this result holds even when controlled for history of anemia in the regression equation but linking association and causation is difficult.

xvii. *Associatons between the biomarkers and fortified flour in the household*

Using the data from Tables 3 and 5, three categories were defined:

a. Did not have any type of adequately fortified flour in the household according to the iron spot test
b. UDM flour was in the household but it was not sufficiently fortified according to iron spot test
c. Fortified flour was in household according to iron spot test.

The data was analysed in two ways (i) looking for associations in the entire sample, and (ii) removing Tashkent City and Tashkent Oblast from the analysis, because these oblasts tend to purchase grey loaf and not bake their own bread, which could distort the association between first grade flour and the biochemical measures. In all of these analyses, without adjusting for other covariates, there was no association between availability of UDM first grade flour and any of the biochemical measures. Adjusting for confounding by women's age, motherhood, education, smoking status, or history of anemia did not change the results. There was evidence of effect modification by education of the relationship between flour and hemoglobin. For those with primary education or less (only 221 women), there was a significant difference between anemia prevalence among those with (40.0%) and without fortified flour (73.1%) whether we excluded or included Tashkent City and Tashkent Oblast ($p = 0.03$).

While there is a strong possibility of confounding, WRA who had grey loaf in the household the day before the survey had a significantly lower prevalence of folate deficiency than WRA from households without grey loaf, 29.8% (27.7, 31.9) versus 22.6% (17.4, 28.8), $p=0.03$. Controlling for anemia, motherhood, iron consumption, smoking, age, and education did not substantially alter the results. However, after adding SES and urban/rural into the regression equation, the difference was no longer statistically significant, suggesting differences in folate deficiency could be driven by other differences associated with SES and/or location, which in turn are associated with availability of grey loaf in the household (there is collinearity between SES and grey loaf purchasing).

Restricting the analysis to only Tashkent City and Tashkent Oblast, where a higher proportion of the population buy the grey loaf, reduced the statistical power substantially, therefore, none of the

results were statistically significant, but the direction of the effect was consistently towards an association between grey loaf in the household and lower prevalence of folate deficiency.

Incorporating many confounders into the model and controlling for the effect modification by residency, the grey loaf was not significantly associated with the biochemical markers, however it was probable that there was some effect modification by iron use or anemia history on the data as well.

VI. Discussion

Anemia has been recognized as a significant public health problem in Uzbekistan. In 1996, 60.4% of women of reproductive age and 60.8% of children of 6-59 months had low concentrations of hemoglobin [1]. A number of interventions, including fortification of wheat flour with iron and other micronutrients have been implemented by the Government, with the support of international partners. Other interventions include: oral supplementation of high risk groups with iron and folate; promotion of improved and diversified diets; control of infection (helminths; malaria where the highest risks are those on the borders with Tajikistan and Afghanistan); linkage of anemia control efforts to related public health services; and explicit inclusion of supportive strategies of communication, monitoring and research.

Bread is a staple in Uzbekistan and is generally consumed at each meal; results from this survey indicate a median fortified bread consumption of 230 g/household member/day with a general trend for lower SES households to consume more than higher SES households. Therefore, fortification of flour with iron, folic acid and other micronutrients was expected to result in significant decreases in the prevalence of iron and folate deficiency and anemia. The NFFP targeted ‘first grade’ UDM flour, which is more frequently consumed by lower SES households, and the ‘grey loaf’, made from this flour in commercial bakeries and more frequently consumed by the urban population, as the best vehicles for fortification.

National flour production data showed that over 90% of total flour produced for part of the year 2006 to 2007 was UDM first grade fortified flour, which represented about 30% of the total flour consumption needs of the population (personal communication). It was reported in the GAIN project proposal documents that >90% of urban households buy, rather than home-bake, their bread therefore a specific supply chain was established to ensure that industrial urban bakers are supplied with fortified flour for the grey loaves. The pattern of bread consumption is very different in rural areas of Uzbekistan where people bake bread at home or buy it from small ‘tandoor’ bakers (possible using locally milled flour), and at the start of the project this raised concerns about the limited reach to the rural poor. In rural areas, most home-made bread is made from a mix of both first grade (fortified) and premium grade flour (non-fortified) and so the fortification effect is ‘diluted’.

UDM first grade flour is thought to be of poor quality and the perception is that those who can afford the more expensive Kazakh flour will purchase it, however, this survey found that in rural areas there was no significant relationship between SES and having UDM first grade flour in the household. There was, however, a significant difference in urban areas, where women of lower SES were more likely to have UDM first grade flour in the household, whereas women of higher SES were were more likely to have other flour, especially non-fortified Kazakhstan flour, which is thought to be of better quality. In contrast, in the semi-autonomous Republic of Karakalpakstan, the high

rate of poverty meant that households were thought to be largely consuming flour that they produce and mill themselves (non-fortified). However, results from this survey show that household availability of UDM first grade flour in the Republic of Karakalpakstan, although less than the national average was just over 50%. Differences between this area and the rest of Uzbekistan were noted in the higher anemia rates and prevalence of depleted iron stores amongst the WRA, but there is not enough data to establish that lack of access to fortified flour is the cause of the poorer iron status among this population.

The data indicated that 97% of WRA had some form of wheat flour in their household at the time of the survey and 60% of households said they had UDM first grade flour. In some cases respondents were not able to identify the type of the flour at their households, as often the flour is purchased in packages without labels, thus, reporting of the type of flour might not have been correct for some households. An iron spot test was done on the flour, when it was available at the house and, based on the results from this qualitative test, only 41.6% (CI: 39.2, 43.9) of the flour was adequately fortified. The low percentage might have been due to a sharp drop in fortified first grade flour milled due to a shortage of fortificant early in 2008. Premix supplies were available again in June 2008, but it was not until later in 2008 that production once again reached >90% of total UDM first grade flour milled [5]. Nevertheless, the program target of 30% WRA regularly consuming fortified wheat flour was achieved. However, there was substantial variability by oblast in the percentage of adequately fortified flour samples (tested using the iron spot kit) by oblast (ranging from 10.4% to 62.9% of households), which remained after controlling for all covariates e.g. age, SES, and urban/rural location. While UDM has flour mills in all oblasts, the availability of premix, as well as the quality of the fortification process, may vary across mills. The end-of-project evaluation carried out in 2009, subsequent to the survey and the premix shortage, found that only 46% of iron spot tests at mills showed adequate fortification suggesting that more monitoring and subsequent correction of the fortification process would be necessary at mill level. As stated earlier, the flour/bread consumption pattern for WRA living in the urban and rural areas was different. In Tashkent City and Tashkent Oblast the grey loaf was more often purchased when compared to households in the rest of the oblasts. It was not possible to assess the adequacy of the grey loaf fortification, as there is no simple field qualitative test for bread fortification, but it is probable that the flour used in grey loaf is from the same mills, suggesting that the fortification pattern would be similar.

One of the main survey findings was that the prevalence of anemia in Uzbekistan had fallen from 60% in 1996 [1] to 32.4% (2008 survey), which represents a significant improvement and surpasses the target set by the program of a 20% reduction in anemia (no baseline survey was conducted so the most recent available data were from 1996). It is not possible to attribute this change to the flour fortification program alone, since, as mentioned above, a) the household availability of adequately fortified flour was only 42% during the survey, and b) a number of anemia prevention and control

interventions were being implemented by the Ministry of Health alongside flour fortification. In fact, about two-thirds of WRA who were regularly consuming UDM first grade flour (homebaked bread) or the grey loaf had adequate hemoglobin concentrations, however additional analysis found no association between availability of first grade flour and hemoglobin concentrations, even after adjusting for confounders. However, given the high bread consumption, flour and bread fortification could be expected to be one of the most significant contributing factors and it may be that results would have been different if there hadn't been a shortage of premix for 2-3 months before the survey start.

Despite the decrease in prevalence, anemia is still at a level considered to be a moderate public health problem nationally [17]. Overall, anemia prevalence was not significantly affected by marital status, age, education, occupation, or SES but had a tendency to be lower, not significantly, in certain sub-groups, e.g. younger (15-19 years) and single women. Those with a medical history of anemia generally had significantly lower hemoglobin concentrations than those without. In Surkhandarya oblast and the Republic of Karalpakstan, anemia was still a severe public health problem, which indicates that these oblasts need further attention to understand and address the underlying causes of anemia there. In terms of the expected contribution of flour fortification to reduce anemia levels in these regions, households in Surkhandarya had relatively high availability of UDM first grade flour (75.8%), when compared with availability in the Republic of Karalpakstan (53.5%); however, the percentage of all household wheat flour samples that tested positive for iron was similar between the two areas (37.6% and 41.5% respectively) and certainly much higher than in Syrdarya Oblast where only 10.4% of samples tested positive for iron and anemia was a moderate public health problem (30%).

Data collected by UNICEF/ Ministry of Health/Kazakh Academy in 2005 in three oblasts, including the Republic of Karalpakstan, Khorezm and Fergona found the prevalence of anemia to be 45.9%, 38.9% and 27.9% respectively [3]. The current data indicates a slight decrease from these levels, to: 41.4%, 32.9% and 27.5% respectively, with a similar, slightly lower, prevalence of mild and moderate anemia compared to the 2005 studies. Different methodologies mean that it is not possible to comment on the significance of the small differences. The low number of WRA with severe anemia meant it was also not possible to deteremine any change in the prevalence of severe anemia between 2005 and 2008.

The 2008 survey found that WRA with moderate and severe anemia were more likely to report regularly purchasing fortified flour than those with mild anemia or normal hemoglobin levels, which is the reverse of what might be expected. The survey identified some other, positive, diet-related practices that could help reduce anemia prevalence. The diet of most women respondents was reported to be high in iron-rich foods and enhancers of iron absoprtion, such as meat, fish or poultry and green leaves, vegetables and fruit. About 90% of women interviewed said that they eat these

foods regularly. These findings are supported by data on food frequency from the 2002 Health and Examination Survey, that found red meat was eaten by women on average 5 times per week, but there were rural (3.9 days)/urban (7 days) differences [2], as there were with the consumption of dark green vegetables, which were eaten 7 days/week in urban and 4.7 days/week in rural areas; fresh fruit was eaten daily in both locations. On the negative side, women in the 2008 survey reported drinking tea or coffee with most meals, thus probably reducing the bioavailability of dietary iron. So, as for elsewhere, the relationship between diet and anemia prevalence in Uzbekistan is complex and flour fortification plays only a part.

Inflammation was low among the women surveyed (4%) and, consequently, adjustment of ferritin concentrations for the presence of inflammation using the meta-analysis of Thurnham et al [16] made little difference to the geometric mean for ferritin. Ferritin concentrations were above the WHO cutoff (>12 µg/L; [14]) nationally and by oblast. There was no association between availaibility of UDM first grade flour and ferritin concentrations, even after adjusting for confounders. Depleted iron stores were found in 48% of women and there was a significant difference in iron-depleted stores by oblast. Considering the relationship between low ferritin concentrations and anemia, 67% of those with anemia also had depleted iron stores, whereas only 38% of those without anemia had depleted iron stores and there was a significant association between stage of anemia and depleted iron stores, i.e. those with severe anemia had the highest prevalence of low ferritin concentrations.

Folate concentrations overall were above the WHO cutoff of 10 nmol/L [16]. There was no association between availability of UDM first grade fortified flour and folate concentrations even after adjusting for confounders. However, there was a significantly lower prevalence of folate deficiency in those who had a grey loaf in the household the previous day to the survey, however, when SES and/or urban/rural residency were taken into account the association was no longer significant. The result makes sense as the majority who purchase the grey loaf were in the urban areas of Tashkent City and Tashkent Oblast. It is not possible to determine whether the higher consumption of grey loaf in these higher SES and/or urban areas is influencing folate status, or whether urban location and/or higher SES is associated with better folate due to other factors. Unfortunately, it was also not possible to assess whether folate concentrations had changed since the start of the fortification program, because there was no baseline data. As for iron and anemia, the shortage of premix prior to the survey and resulting lower than normal coverage availability of fortified flour also made it difficult to infer associations from the available data. However, the fact that low folate was not associated with whether more or less than 50% of household flour purchased over the past year was UDM first grade flour, indicates that factors other than folic acid-fortifiation of UDM first grade flour, may also have an influence.

Overall 29% of women were folate deficient, but there was a significant difference by oblast. From the data in this survey, it is not possible to determine which factors are most strongly associated

with these differences, however, as above, it is possible that other lifestyle factors and access to interventions, such as the government-supported weekly iron-folic acid supplementation programme, may contribute to these differences.

There was a significant association between stage of anemia and folate concentrations, and of those with anemia, 46% also had low folate concentrations. This relationship with stage of anemia was a slightly stronger predictor of anemia severity than ferritin, even though there were more anemic women with depleted iron stores than folate deficiency.

The questionnaire tested the knowledge of the women about fortified foods and the fortification project in particular, and the results were disappointing. Only 37% had seen the healthy food logo (non-polvon logo), and even fewer understood what the logo represented. A similar proportion were aware that UDM first grade flour was fortified but only 4% understood the benefits of eating fortified flour and bread, which points to some major limitations in project impact. A focus on measuring whether target groups have seen the logo says little about how they link the logo to fortified food or how it might affect food purchasing or consumption habits. Thus while 35% of respondents in Uzbekistan said they had seen the flour fortification logo, only 12% knew how to distinguish fortified flour from ordinary flour.

As part of the communication section, knowledge of anemia was also tested and 42% of women interviewed knew the signs and consequences of IDA but only 13% knew the causes of IDA and only 9% knew how to avoid IDA.

The findings described above imply that the communication messages for fortification need to move from logo recognition to some level of consumer nutrition education to raise awareness and better understanding of the impact of household purchasing choices.

VIII. Conclusions

The NFFP aim of reducing the prevalence of anemia in WRA age by 20%, from 60% to 48%, was achieved, and in fact surpassed, as the 2008 impact survey estimated the prevalence to be 34%. This decline in anemia prevalence coincided with the fortification of first grade UDM wheat flour with a variety of micronutrients, including iron and folic acid. This change cannot be related soley to the UDM first grade flour and bread fortification project, although it is probably one of the most significant factors. However, the lack of improvement in the prevalence of women with depleted iron stores suggests that women are still not eating enough iron in the diet or are drinking too much tea at meal times and inhibiting iron absorption.

Unfortunately, it was not possible to assess whether another key performance indicator, folate deficiency, had deceased during the same period of time because there was no baseline data for folate status. However, although the national geometric mean folate concentration was within the normal range, 29% of women were folate deficient, which suggests additional opportunities to improve status need to be explored.

Fortification of first grade wheat flour with iron, folic acid and other micronutrients has now been made mandatory in Uzbekistan (see below). This intiative should help ensure continued improvement in iron and folate status of the population. However, the lack of association found in this survey between anemia, iron and folate status with consumption of fortified wheat flour, suggests that complementary interventions to improve iron and folate status may also be beneficial. This is reinforced by the different prevalence patterns for anemia, iron deficiency and low folate by oblast, unrelated to the high (83% of households) consumption of either UDM first grade flour and/or grey loaf, which did not differ significantly across the country. The findings indicate that other causal factors may need to be addressed at the local level. This is especially with regard to folate status, which also varied significantly with urban/rural location and SES.

The Uzbekistan Ministry of Health passed a mandate for the country's first-grade wheat flour to be fortified on January 1, 2011. The aim is to "strengthen the health of the population." Salt iodization and other public health interventions were also included in the order, including fortifying cottonseed oil with vitamin A. The number of flour mills in Uzbekistan is increasing and with the new law in place hopefully the coverage of adequately fortified flour is now higher than 42% found in 2008.

IX. Recommendations

Recent legislation for continued fortification of first grade wheat flour with iron, folic acid and other micronutrients should help ensure continued improvement in iron and folate status of the population, thus reducing anemia further. In addition to strengthening the flour fortification program, the relative impact of other interventions in different local conditions should be assessed and complementary programs (to flour fortification) targeted appropriately.

It is essential that a higher proportion of UDM flour is fortified to the appropriate level and that the fortification levels are adequately monitored. In Uzbekistan, the UDM first grade flour is often mixed with other flours during the bread making process, diluting the fortification effect, so a more bioavailable form of iron might help improve the biological impact. Later versions of the KAP premix have used more bioavailable sources of iron, such as NaFeEDTA or ferrous sulfate and are an option, which could be considered.

One advantage of the LC-LQAS design was that it allowed for identification of rayons within each oblast that were above or below the national average and program targets for coverage and nutritional status. These were identified and discussed during the hand tabulation workshop, along with recommendations for action to address the issues found[6].

The lack of improvement in the prevalence of women with depleted iron stores suggests that women are still not eating enough iron in the diet or are drinking too much tea at meal times and inhibiting iron absorption. Communication messages about the fortification project are not reaching the majority of women, and women's understanding of the causes of IDA is poor. These findings imply that a greater focus on consumer education is required to complement and enhance the impact of interventions such as flour fortification in improving micronutrient status. Consumer education should be prioritized and perhaps included in the school curriculum to educate the next generation, and given at health clinics for women.

[6]The results and recommendations from the workshop are available as a separate document.

X. References

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Annex 1

Indicators

Table 1 includes the key survey indicators, with measurements and assumptions, tabulated during hand-tabulation workshop.

Table 1: Key indicators (hand-tabulated), way of construction and assumptions

Q. ref	Indicator	Numerator	Denominator[7]	Assumptions
201	Percentage of households (HH) currently having wheat flour	Number of HH, where there was wheat flour during the survey	Number of HH with availability of any flour at the time of the survey.	An estimate of availability of flour at the household
202	Percentage of HH currently having UDM first grade flour (according to the respondent)	Number of HH, where there was UDM first grade flour during the survey	Total number of HH surveyed	Uzbek first grade flour is the flour that is to be fortified as part of the project
205	Percentage of HH that have flour labeled as “fortified” on the package (when available)	Number of HH, where there was flour labeled as “fortified” on the package	Number of HH, where there was flour in original package	The package will be examined to assess whether there is a label mentioning that the product is fortified
207	Percentage of HH that currently have a grey loaf	Number of HH, where there was a grey loaf during the survey	Total number of HH surveyed	Grey loaf is made with Uzbek subsidized first grade flour as an ingredient. While there may be other flour types (and additives to enhance yield) combinations currently in

[7] For all indicators, only those respondents, who responded to the particular question, were included into denominators.

				the market, it is estimated that the main ingredient is Uzbek first grade flour. It is assumed that if this ingredient is fortified, the grey loaf will be also fortified.
315	Percentage of HH having a grey loaf yesterday	Number of HH with the respondents reported availability of a grey loaf in the day preceding the survey	Total number of HH surveyed	-
306	Percentage of HH where at least 50% of the flour purchased during the year preceding the survey was UDM first grade flour	Number of HH with the respondents, who mentioned that at least 50% of the flour purchased during the year preceding the survey was UDM first grade flour	Total number of HH surveyed	It was estimated that UDM provided about 50% of the flour in the market. Therefore, at least 50% of UDM first grade flour of total annual flour was taken as realistic measure of fortified flour purchase (10)
312	Percentage of HH where at least 50% of the bread purchased during the year preceding the survey was Grey loaf	Number of HH with the respondents, who mentioned that at least 50% of the Grey loaf purchased during the year preceding the survey was Grey loaf	Total number of HH surveyed	-
704(1)	Percentage of WRA, said they ate grey loaf or bread, which was home-baked from UDM	Number of WRA who said they ate yesterday grey loaf or bread, which was	Total number of WRA	It is assumed that grey loaf is made from UDM first grade flour; it is also assumed that UDM first grade flour is fortified. Thus,

	first grade flour yesterday	home-baked from UDM first grade flour		this indicator is a proximate measure of fortified bread consumption.
402	Percentage of WRA, who know the causes of IDA	Number of WRA, who mentioned at least 2 main causes of IDA	Total number of WRA surveyed	-
403	Percentage of WRA, who know the most-at-risk population for IDA	Number of WRA, who mentioned at least 3 most-at-risk population groups for IDA	Total number of WRA surveyed	-
404	Percentage of WRA, who know the signs and consequences of anemia	Number of WRA, who mentioned at least 3 signs or consequences of anemia	Total number of WRA surveyed	-
405	Percentage of WRA, who know how to avoid IDA	Number of WRA, who mentioned at least 3 ways of IDA prevention	Total number of WRA surveyed	-
406	Percentage of WRA, who have heard of fortified food	Number of WRA, who heard of fortified food	Total number of WRA surveyed	-
408	Percentage of WRA, who know which food is fortified	Number of WRA, who mentioned UDM First grade flour or Grey loaf as fortified food	Total number of WRA surveyed	-
409	Percentage of WRA, who know that UDM first grade flour or Grey	Number of WRA, who mentioned that UDM first grade flour	Total number of WRA surveyed	-

	loaf is fortified with iron	or Grey loaf is fortified with iron		
410	Percentage of WRA, who know the benefits of consumption of fortified flour/bread	Number of WRA, who mentioned at least 3 benefits of consumption of fortified flour/bread	Total number of WRA surveyed	-
411	Percentage of WRA, who know how fortified flour can be distinguished from ordinary flour	Number of WRA, who stated that fortified flour can be distinguished from ordinary only by label	Total number of WRA surveyed	-
412	Percentage of WRA, who said they have seen the “non-polvon” logo	Number of WRA, who said they have seen the “non-polvon” logo	Total number of WRA surveyed	-
413	Percentage of WRA, who recognized the “non-polvon” logo	Number of WRA, who recognized the “non-polvon” logo	Total number of WRA surveyed	-
701(1)	Percentage of WRA, who said they ate chicken, other types of poultry or meat, fish or eggs at least once yesterday	Number of WRA, who reported eating chicken, other types of poultry or meat, fish or eggs at least once in the day preceding the survey	Total number of WRA surveyed	Poultry, meat, fish and eggs are the main sources of heme iron, with much higher absorption than from other sources of iron. Consumption of these products can prevent IDA, while low intake is a risk factor for IDA (11, 12)
701(2)	Percentage of WRA, who said they ate chicken,	Number of WRA, who said they ate chicken, other types	Total number of WRA surveyed	-

	other types of poultry or meat, fish or eggs at least twice in the last week	of poultry or meat, fish or eggs at least twice in the week preceding the survey		
702(1)	Percentage of WRA, who said they ate green leaves, vegetables or fruits during the meal at least once yesterday	Number of WRA, who said they ate green leaves, vegetables or fruits during the meal at least once in the day preceding the survey	Total number of WRA surveyed	Green leaves, vegetables and fruits are main enhancers of iron absorption. Consumption of these food with meal decreases the risk of IDA (11, 12)
702(2)	Percentage of WRA, who said they ate green leaves, vegetables or fruits during the meal every day in the last week	Number of WRA, who said they ate green leaves, vegetables or fruits during the meal every day in the week preceding the survey	Total number of WRA surveyed	-
703 (1)	Percentage of WRA, who said they did not drink any coffee/coffee with milk, tea or tea with milk during the meal or right after the meal yesterday	Number of WRA, who said they did not drink any coffee/coffee with milk, tea or tea with milk during the meal or right after the meal in the day preceding the survey	Total number of WRA surveyed	Coffee, coffee with milk, tea or tea with milk are the most commonly used iron absorption inhibitors. Consumption of these drinks with meal is a risk factor for IDA (11, 12)
703 (2)	Percentage of WRA who did not drink any coffee/coffee with milk, tea or tea with milk during the	Number of WRA, who said they did not drink any coffee/coffee with milk, tea or tea with milk during the meal	Total number of WRA surveyed	

	meal or right after the meal during the last week	in the week preceding the survey		
901	Percentage of WRA with low level of hemoglobin	Number of women with hemoglobin level below 12g/l	Total number of women, who gave blood	

Only those indicators were tabulated during hand-tabulation workshop, for which there were justified correct answers. As a result the priorities were identified only for these indicators. Later, these indicators were recalculated to control for mistakes in data hand tabulation and some priorities were re-set. The remaining indicators, which are presented in the Table 2, were analyzed and interpreted during computer data analysis.

Table 2: Additional indicators, construction and assumptions

Q. ref.	Indicator	Numerator	Denominator	Assumptions
204	Percentage of HH currently having any flour that is fortified according to the iron spot test	Number of HH possessing any flour at the time of the survey that was found fortified as a result of spot test	Number of HH with availability of any flour at the time of the survey	
“305”/(30x”314”)+”309”x600/(7x”314”)	Amount of fortified flour and fortified bread per each household member per day[8] (median for this indicator should be calculated)			UDM first grade flour and grey loaf are proxy for fortified flour and bread
321 и 322	Proportion of women who bake bread at home last time using UDM first grade flour	Number of women who used UDM first grade flour when baked bread at home last time	Number of women who baked bread at home	
322	Median proportion of UDM first grade flour in mixture with other types of flour according to the women who baked bread at home last time using UDM first grade flour			
704 (2)	Percentage of non-pregnant WRA consuming fortified flour/bread every day of the week preceding the survey (and median number of days).	Number of women consuming fortified flour/bread every day during the week preceding the survey	Total number of WRA surveyed	

[8] Fortified flour here means Uzdomak. first grade flour; fortified bread means Grey loaf here.

704 (2) – every day in the last week 901 ≥12g/dl (120g/l) 902 ≥ 15μg/l 903 ≥ 3 ng/ml 904 < 5mg/L	Percentage of non-pregnant WRA consuming fortified flour/bread with adequate level of hemoglobin, serum ferritin, and serum folate concentrations.	Number of women consuming fortified flour/bread every day and having adequate hemoglobin, serum ferritin and folate concentrations	Number of women consuming fortified flour/bread	
903 ≥ 3 μg/l	Percentage of non-pregnant WRA with adequate level of folate in blood.	Number of women with adequate serum folate concentration	Total number of women who gave blood	

Annex 2

Targets

The targets for the next survey were discussed and decided with the project team as presented in **Table 36**.

Table 36: Baselines and Targets for hand-tabulated indicators

#	Indicator	Baseline	Target (2011)
201	Percentage of HH currently having wheat flour	93%	-
202	Percentage of HH currently having UDM" first grade flour (according to the respondent)	56%	70%
204	Percentage of HH currently having fortified flour (according to the spot test)	40%	
207	Percentage of HH that currently have a grey loaf	11%	15%
315	Percentage of HH having a grey loaf yesterday	12%	15%
306	Percentage of HH where at least 50% of the flour purchased during the year preceding the survey was "UDM" first grade flour	56%	70%
312	Percentage of HH where at least 50% of the bread purchased during the year preceding the survey was the grey loaf	10%	15%
704 (1)	Percentage of WRA who said they ate the grey loaf or bread home-baked from "UDM" first grade flour yesterday,	81%	70%
704 (2)	Percentage of WRA who said they ate grey loaf or bread home-baked from "UDM" first grade flour, every day in the week before the survey	70%	
402	Percentage of WRA who know the causes of IDA	12.5%	15%
403	Percentage of WRA who know the most-at-risk population for IDA	16.5%	25%
404	Percentage of WRA who know the signs and consequences of anemia	43%	60%
405	Percentage of WRA who know how to avoid IDA	6%	20%

406	Percentage of WRA who have heard of fortified food	59%	75%
408	Percentage of WRA who know which food is fortified	45%	65%
409	Percentage of WRA who know that “UDM” first grade flour or grey loaf is fortified with iron	30.5%	35%
410	Percentage of WRA who know the benefits of consumption of fortified flour/bread	5%	20%
411	Percentage of WRA who know how fortified flour can be distinguished from ordinary flour	12%	20%
412	Percentage of WRA who said they have seen the “non-polvon” logo	35%	50%
413	Percentage of WRA who recognized the “non-polvon” logo	23%	50%
701(1)	Percentage of WRA who said they ate chicken, other types of poultry or meat, fish or eggs at least once yesterday	88%	-
701(2)	Percentage of WRA who said they ate chicken, other types of poultry or meat, fish or eggs at least twice in the last week	93%	-
702 (1)	Percentage of WRA who said they ate green leaves, vegetables or fruits during the meal at least once yesterday	93%	-
702 (2)	Percentage of WRA who said they ate green leaves, vegetables or fruits during the meal every day in the last week	86%	-
703 (1)	Percentage of WRA who said they did not drink any coffee/coffee with milk, tea or tea with milk during the meal or right after the meal yesterday	5%	15%
703 (2)	Percentage of WRA who did not drink any coffee/coffee with milk, tea or tea with milk during the meal or right after the meal during the last week	5%	15%
901	Percentage of WRA with low level of hemoglobin	33.5%	30%

Annex 3

LC-LQAS survey sample design for Uzbekistan 2008 flour fortification impact survey.

The first step in designing the LC-LQAS survey was to select the SA sample sizes. Sample sizes within each SA were determined using standard LQAS design principles. Specifically, within each SA, the aim was to classify coverage of a priority indicator in the survey and choose the sample size such that there is a small risk of misclassifying districts as achieving high coverage when they actually have very low coverage.

The size of the sample collected in each SA was determined by the minimum sample required to apply LQAS decision rules with acceptable error.

To evaluate the flour fortification program at the SA level (rayon), an LQAS sample size of 19 was selected. The logic was based on the explanation of LQAS principles presented by Valadez et al, 2002 [7] and Valadez 2002 [9].

In summary, the logic is as follows: If an SA has a true coverage equal to a given coverage target, say, 80% (p_u), or exceeds the target, and the LQAS survey was repeated a very large number of times, it would be incorrectly concluded that the SA had low coverage at most 10% (α) of the time. In an SA with true coverage equal to 50% (p_l) or has even lower coverage, if the LQAS survey was repeated a very large number of times, it would be incorrectly concluded that coverage was high no more than 10% (β) of the time. Using a sample size of 19, other coverage indicators are classified with the same classification errors, in so far as $p_u - p_l = 30\%$. The decision rules corresponding to an LQAS sample size of 19 can be found in [9].

The number of SAs to be sampled, n, was dependent on six parameters: (1) the number of samples collected in each SA, m; (2) the total number of SAs in a catchment area, N; (3) the total population in the catchment area (usually based on a national census), N^*_{cen}; (4) the average of the square of the populations in each SAs, M^2; (5) an estimate of the intraclass correlation $\hat{\rho}$; and (6) the maximum desired length for the confidence interval, ℓ_{max}, which in this case, has a value of 0.2.

$$n = N(1+(m-1)\hat{\rho})\left\{\left[\left(\frac{\ell_{max}N^*_{cen}}{1.96}\right)^2\left(\frac{(m-1)(1-\hat{\rho})}{N\overline{M^2}}\right)+m\hat{\rho}\right]\right\}^{-1}$$

Three of the parameters, namely, the number of SAs, the total population size, and the average of the square of the populations in each SA, were obtained directly from the census of the population. As already stated the LQAS sample size used here was 19. An estimate of the intraclass correlation, $\hat{\rho}$, was the only unknown quantity.

An estimate of the intraclass correlation coefficient (ICC), $\hat{\rho}$, was required to use the above formula to calculate the number of SAs to include in the sampling frame. Overestimating the intraclass correlation

would lead to larger samples than necessary to meet the imposed constraints, and unnecessarily inflate the costs of the survey. Using too small a value of $\hat{\rho}$ would result in failing to constrain the length of the confidence interval to 20%. ICC estimates based on design effects were used as described by Fenn and her team who used the DHS [10]. The intraclass correlation was related to the design effect of this survey, using the relationship DE = 1 + ($\bar{m}_{DHS}$ − 1) $\hat{\rho}$, where $\bar{m}_{DHS}$ is the average cluster sample size for the DHS. By solving for ICC, or $\hat{\rho}$, the following equation results and was used for the estimation, $\hat{\rho}$ = (DE − 1)/($\bar{m}_{DHS}$ − 1).

The DHS estimate may result in multiple recommendations for the ICC, one for each indicator, region and stratum. The median of these ICC served as a first recommendation for the sample size formula. The median should be used in most circumstances, as both precision and cost are both important issues.

Survey weights were defined as the inverse probability of a sampled individual being included in the survey

For the LC-LQAS survey, the survey weights were:

w_{ijk} = P(individual k in SA j in oblast i included in the survey)

= P(SA j in oblast i included in survey)*P(individual k in SA j in oblast i included in survey)

$= \frac{m_i}{M_i}\frac{n_j}{N_j}$

where m_i is the number of sampled SAs in oblast i, M_i is the total number of SAs in oblast i, n_j is the number of sampled women in SA j (19 if there are no missing data), and N_j is the population size in SA j. We assume individuals within SAs were sampled using simple random sampling.

If an indicator contained missing data, then n_j was defined as the number of non-missing observations in SA j. Henceforth, it was assumed that data were missing completely at random. Since missing data was rare, it was anticipated that this assumption would have a minimal impact on the results.

Table X: National level, Uzbekistan, DHS, 2002

	National	Urban area, Uzbekistan, DHS, 2002	Rural	Western	Eastern	Tashkent city, Uzbekistan, DHS, 2002	Central Region, Uzbekistan, DHS, 2002	East-Central Region, Uzbekistan, DHS, 2002			
Variable	**Design effect**	**Design effect**	**Design effect**	**Design effect**	**Design effect**	**Design effect**	**Design effect**	**Design effect**	**Average**	**Lower Quartile**	**Upper Quartile**
Primary/incomplete secondary education	1.211	1.296	1.159	0.977	1.173	1.282	1.062	1.034	1.166	1.055	1.22875
Secondary	1.563	1.499	1.598	1.664	1.453	1.328	1.523	1.167	1.511	1.42175	1.57175
College	1.484	1.368	1.541	1.622	1.479	1.243	1.308	1.354	1.4235	1.3425	1.49825
Higher	1.57	1.647	1.503	1.536	1.724	1.747	1.403	1.244	1.553	1.478	1.66625
Never was married	1.101	1.209	1.035	0.859	0.981	1.009	1.058	1.094	1.0465	1.002	1.09575
Married, living with partner	1.104	1.204	1.035	1.056	0.896	1.358	1.186	0.914	1.08	1.00475	1.1905
Married before age 18	1.221	1.151	1.263	1.031	1.253	0.944	1.177	0.952	1.164	1.01125	1.229
Births	1.013	1.058	0.985	0.882	0.833	1.053	1.164	0.728	0.999	0.86975	1.05425
Children alive	1.043	1.055	1.029	0.82	0.873	1.058	1.219	0.709	1.036	0.85975	1.05575
Children delivered by women of 40-49	1.325	1.467	1.461	0.952	1.159	1.318	1.499	0.976	1.3215	1.11325	1.4625
Used any contraception method	0.962	0.869	1.016	1.441	0.828	1.314	0.596	0.916	0.939	0.85875	1.0905
Currently using any contraception method	1.117	1.03	1.172	1.564	0.874	1.042	0.928	1.198	1.0795	1.0045	1.1785
Currently using any modern contraception method	1.145	1.066	1.181	1.522	1.03	1.088	0.991	1.183	1.1165	1.057	1.1815
Currently using any traditional method	1.155	1.127	1.157	1.158	1.379	1.325	1.002	0.836	1.156	1.09575	1.19975
Currently using IDU	1.138	0.983	1.223	1.439	0.955	1.115	1.069	1.128	1.1215	1.0475	1.15925
Currently using condom	1.072	1.03	1.134	1.15	1.112	1.268	1.247	0.774	1.123	1.0615	1.17425
Currently using LAM	1.383	1.324	1.388	1.463	1.115	1.105	1.284	1.382	1.353	1.24175	1.38425
Currently using withdrawal	1.153	1.351	1.007	1.156	1.457	1.055	0.913	0.818	1.104	0.9835	1.20475
Index of body mass less than 18.5	1.408	1.418	1.386	0.977	1.543	1.055	1.354	1.02	1.37	1.04625	1.4105
Index of body mass more than 25.0	1.322	1.122	1.448	1.354	1.57	1.15	1.188	0.897	1.255	1.143	1.3775
Hypertension	1.33	1.339	1.324	0.892	1.531	1.532	0.794	1.311	1.327	1.20625	1.387
Smoking	1.549	1.628	1.009	1.166	1.073	1.131	1.821	1.102	1.1485	1.09475	1.56875
Knowledge of ways of TB transmission	1.565	1.792	1.435	1.45	1.419	1.395	1.481	1.397	1.4425	1.4135	1.502
Teeth problems in the last 12 months	1.482	1.496	1.44	1.489	1.489	1.731	1.036	1.567	1.489	1.4715	1.51375
Symptoms of STI in the last 12 months	1.254	1.367	1.169	1.082	1.263	1.728	1.184	0.947	1.219	1.14725	1.289
Knowledge that condom use will prevent HIV	1.636	1.87	1.446	1.433	1.431	1.263	1.484	1.504	1.465	1.4325	1.537
Knowledge that limiting partners will prevent HIV	1.553	1.631	1.529	1.969	1.685	1.108	1.151	1.287	1.541	1.253	1.6445
Prevalence of anemia in children	1.414	1.654	1.284	0.994	1.235	1.271	1.298	1.28	1.282	1.262	1.327
All Variables									1.21	1.055	1.436