

## Effect of multi-pronged interventions in reducing low birth weight and maternal anaemia among pregnant women. A community-based interventions research in non-agrarian resource constrained setting of rural Pakistan

Inayat Thaver,<sup>1</sup> Ahsan Maqbool Ahmad,<sup>2</sup> Mariam Ashraf,<sup>3</sup> Syed Kamal Asghar,<sup>4</sup> Muhammad Sarwat Mirza<sup>5</sup>

### Abstract

**Objective:** To investigate the effect on maternal and infant health of iron plus folate and multiple micronutrient supplements, along with deworming and health education session provided to pregnant women in rural, non-agrarian and food-insecure areas.

**Methods:** The quasi-experimental study was conducted in Tharparker and Umerkot districts, Sindh, Pakistan, in 2013-14, and comprised pregnant women in their earlier weeks of pregnancy. The enrolment and follow-up phase entailed 3 visits to each subject. Areas covered by lady health workers were designated as intervention areas, and those with non-LHW population were labelled as non-intervention areas.

**Results:** Of the 1204 subjects, 600(49.8%) were in the intervention group and 604(50.2%) were in the non-intervention group. By the end of the follow-up phase, significantly more women had increased number of meals in the intervention group compared to the non-intervention group ( $p<0.001$ ). There was a significantly higher increase in mean haemoglobin levels and body mass index of women in the intervention arm after 3 and 6 months of interventions ( $p<0.05$ ). Significantly higher mean birth weight was recorded in intervention areas compared to non-intervention areas ( $p<0.05$ ).

**Conclusion:** Community-based provision of multiple micronutrients to women along with deworming, health education and dietary counselling significantly reduced the prevalence of anaemia and reduced the incidence of low birth weight.

**Keywords:** Maternal anaemia, Low birth weight, Multiple micronutrients, Nutrition. (JPMA 70: 2092; 2020)

**DOI:** <https://doi.org/10.47391/JPMA.1108>

### Introduction

Maternal nutritional status has profound effects on foetal growth, development, and subsequent infant birth weight.<sup>1</sup> Low birth weight (LBW), as defined by the World Health Organisation (WHO), is the weight at birth  $<2500g$ , remains a major public health problem globally and is associated with a range of consequences.<sup>2</sup> LBW is not only a major predictor of prenatal mortality and morbidity, but recent studies have found that it also increases the risk for non-communicable diseases, such as diabetes mellitus (DM) and cardiovascular diseases (CVDs) later in life.<sup>3</sup> Overall, it is estimated that 15-20% of all births worldwide are LBW, representing more than 20 million births a year.<sup>3</sup>

In low and middle income countries (LMICs), the intake of micronutrients among women is usually very low,

.....  
<sup>1</sup>Mustashaar Social Development Advisors, Islamabad, <sup>2</sup>Department of Research and Development, Health Services Academy, Islamabad, Pakistan, <sup>3</sup>Department of Community Health, University Kebangsaan Malaysia, Kuala Lumpur, Malaysia, <sup>4</sup>Unicef Sindh, Karachi, <sup>5</sup>Health and Nutrition Development Society, Karachi, Pakistan.

**Correspondence:** Mariam Ashraf Email: [maryamashraf@hotmail.com](mailto:maryamashraf@hotmail.com)

resulting in poor nutritional status.<sup>4</sup> Preferably, it is important to make efforts to improve these low intakes before conception, but increasing intakes during pregnancy may also help improve birth weight and survival chances of newborns.<sup>5</sup> Micronutrient deficiency results from inadequate consumption of meat, fruits and vegetables, and infections can also be a cause.<sup>6</sup> Micronutrients are known to affect birth weight by their interactions with each other, i.e., micronutrient supplementation may improve maternal appetite, leading to increased food consumption, and, thus, reducing morbidity.<sup>5</sup> Prenatal multiple-micronutrients (MMN) supplementation is associated with reduced risk of LBW outcomes and with improved birth weight when compared with iron-folic acid supplementation. There is no significant effect of MMN supplementation on the risk of preterm birth or small-for-gestational-age (SGA) infants.<sup>7</sup>

Additional interventions that affect the nutritional status during pregnancy include dietary measures and public health interventions, such as deworming and health education. Although the risk of being born with LBW is significantly more with moderate preconception

anaemia,<sup>1</sup> it has been noted that in many resource-constrained settings, mothers restrict their dietary intake during pregnancy to have smaller infants in order to lower the risk of delivery complications.<sup>8</sup> Lack of nutrition-related awareness and favourable practices have also been associated with poor dietary practices which are often influenced by dietary taboos and soil-transmitted helminthic infestation.<sup>9</sup> Where access and availability to food is possible, healthy diet is likely to provide protein, energy and micronutrients. However, such foods are not often accessible to marginalised populations, which is why food supplements to such pregnant women is now a standard recommendation.<sup>10,11</sup>

Global evidence recommends use of MMN supplementation, including iron-folate, during pregnancy, providing additional food supplement of more than 700 kcal per day and deworming pregnant women in the second trimester with documented effect of significant reduction in maternal anaemia and LBW among newborns.<sup>12</sup>

Pakistan is the sixth most populous country in the world,<sup>13</sup> with women of reproductive age group (15-49 years) constituting almost one quarter of the total population. The rapid increase in population constrains economic gains, stretches the already overburdened healthcare provision mechanisms and is adversely affecting the country's maternal and child health (MCH) indicators. Pakistan has a maternal mortality ratio of 276 maternal deaths per 100,000 live births and is categorised as a high-risk country for women's morbidity and mortality with reference to sexual and reproductive health.<sup>14</sup> The neonatal mortality is 42 per thousand live births and infant mortality is 71 deaths per 1,000 live births, and every year around 216,000 newborns die before they reach their first month of age. Furthermore, it is estimated that nearly one million children die before the age of five, representing an under-five mortality of 87 deaths per 1,000 live births. Women living in rural areas are at double the risk of dying during the maternal period compared to their counterparts in urban areas, with nearly 26,000 maternal deaths attributed to pregnancy and birth-related causes in the country annually.<sup>15</sup> Additionally, there are nearly 8 million children aged less than five years who are malnourished, while LBW is estimated to be the underlying factor in 60-80% of the disease burden in the country for this age group.<sup>16</sup> The maternal mortality rate in the province of Sindh is higher than the national figures and is currently estimated to be 314 deaths per 100,000 live births, which depicts a less favourable picture of maternal health in the province compared to other parts of the country. The situation is

empirically linked to adverse situation of the healthcare delivery system, with evidence suggesting that national- and community-level interventions are not reaching women living in under-served and marginalised areas in Pakistan.<sup>17</sup>

The current study was planned to assess interventions for reducing LBW with inbuilt components of an integrated approach and targeting both areas covered by lady health workers (LHWs) and those not covered by their services in rural Sindh.

## Subjects and Methods

The quasi-experimental study was conducted in Tharparker and Umerkot districts, Sindh, Pakistan, in 2013-14. The study areas represent two of the most rural, underdeveloped and highly food-insecure districts in southern Sindh. These two districts were anticipated to have a high prevalence of malnutrition due to their non-agrarian terrain. After approval from the National Bio-Ethics Committee of the Pakistan Medical and Research Council (PMRC), Islamabad, pregnant women in their earlier weeks of pregnancy were enrolled. The two segments were from LHW-covered intervention areas, and the non-LHW population in non-intervention areas.

The intervention and non-intervention segments of the population were identified through a baseline survey conducted during the initial phases of the project. There were 4 tehsils (a geographical administrative sub-district level unit) in Tharparker and Umerkot districts each. Half of these tehsils per district, 2 each from Tharparker and Umerkot, were randomly selected during the baseline survey. The same population was selected for the current study. A catchment population of about 4,000 of the LHW-covered population was involved from each basic health unit (BHU), translating into a total of 16,000 per tehsil as 4 BHUs were selected per tehsil, and 32,000 per district across the 2 tehsils in a district. Across both districts, hence, a total population of 64,000 was involved in this phase of the study.

Considering the annual population growth rate of 2% (i.e. 20 per 1000)<sup>18</sup> and the death and migration rates in Pakistan, it was anticipated that there would be approximately 30 pregnancies registered with one LHW per year. Assuming a nearly universal registration mechanism within the primary healthcare (PHC) system by the community based LHWs, it was expected that 2-3 new pregnancies would be registered within the PHC per month per LHW. The first two months of the interventions formed the enrolment phase of the project. In this phase, it was estimated that a total of 8-12 pregnancies would be identified per LHW and, hence, 32-48 women per selected

BHU population per month. This was anticipated to reflect a total of 160-240 pregnancies per month across each district for the LHW-covered segment of the population. Resultantly, it was estimated that 320-480 pregnancies would be identified across both districts per month, and a total of 640-960 pregnancies in the enrolment phase of the follow-up research for the LHW-covered areas.

The same magnitude of population (64,000 people) was involved for the non-LHW-covered areas within each district. These populations were identified through the baseline survey methodology across both the districts respectively. Thus, similar to the estimations for the LHW-covered areas, a total of 640-960 pregnancies were expected to be enrolled for this non-LHW covered segment of the population.

Furthermore, considering a natural attrition of loss to follow-up of 10% in the study population, it was estimated that 575-864 women in each segment of the population would complete the follow-up phase. Hence, it was estimate that 1,150-1,728 pregnancies and birth outcomes would be analysed to ascertain the effect of project interventions across both population segments and districts.

As per the given estimations, during the enrolment phase, a total of 600 pregnant women were enrolled across the LHW-covered areas and 604 pregnant women were enrolled in non-LHW-covered areas.

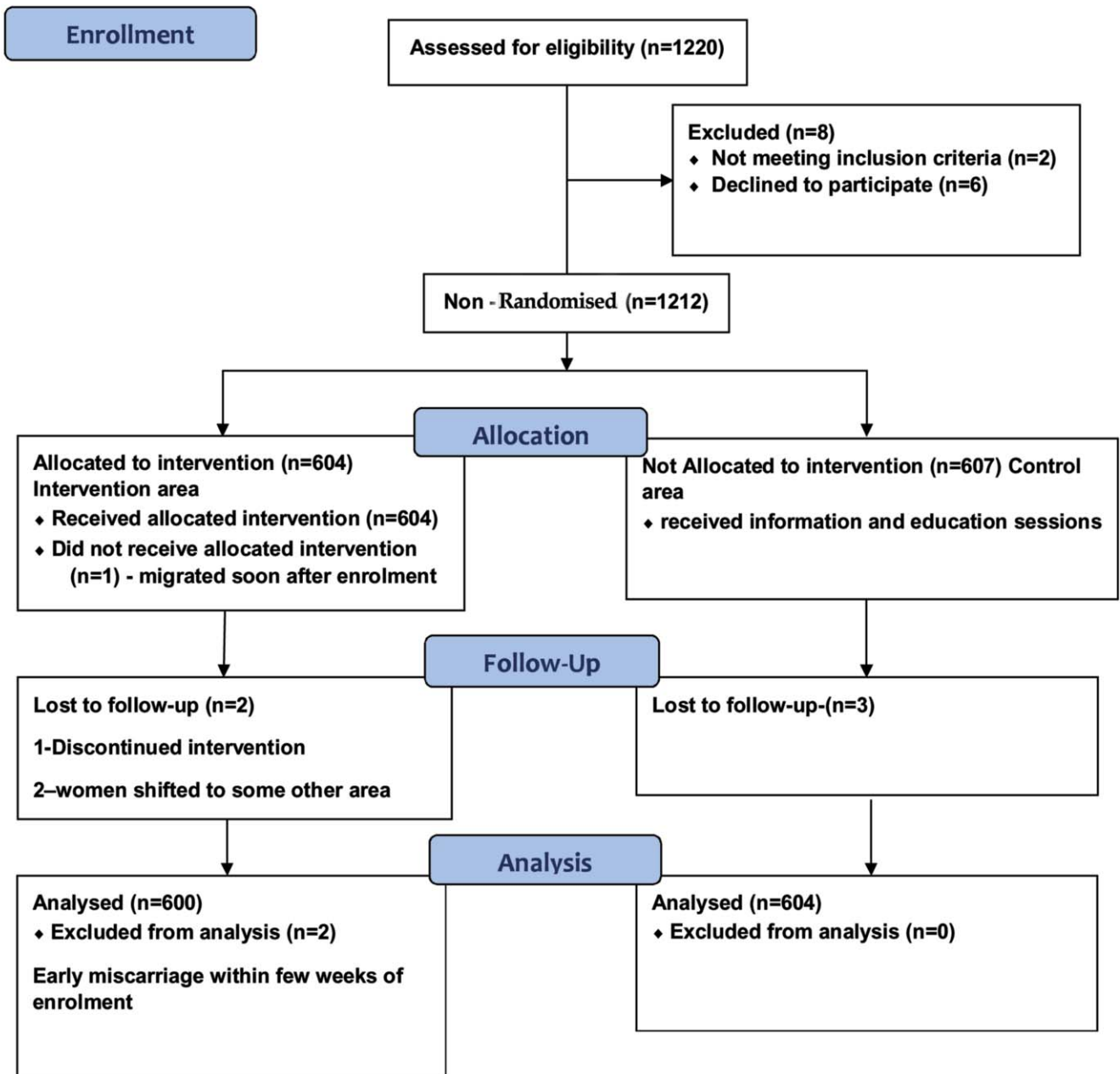
In the intervention area prior to initiation of enrolment, the selected LHWs were trained with the facilitation of the District National Programme of Family Planning and Primary Healthcare (FPPHC), on identification and enrolment of pregnant women, criteria of enrolment, recording of consent, enrolment form, on measurement of haemoglobin (Hb), weight, and height, individual counselling and session conduction with support of the Information, Education and Counselling (IEC) material. The women in the first trimester of pregnancy were identified by the trained LHWs. After identification of those pregnant women who were in their first trimester of gestation, a written consent form was filled for every pregnant woman who agreed to participate in the study. Additionally, the enrolment form was filled for every woman to get basic information about her demographic and socioeconomic status (SES), dietary habits, history of pregnancies, and health-seeking behaviour etc. At the time of enrolment, LHWs measured and recorded weight, height and Hb of the subjects. Then they distributed MMN tablets for 30 days to them with counselling about its benefits and method of intake. Total 100-105 tablets, for one tablet per day consumption in three months (92

days), were given to each subject.

Similarly, in non-intervention area, district project teams identified community facilitators (CFs) with the support of local communities. The CFs were trained about the process of identification of pregnant women, criteria of inclusion, consent and information process. As soon as the CFs identified and informed district project teams about the presence of pregnant women, the project team reached the area, sought consent, filled the enrolment form, measured and recorded the weight, height and Hb level of the subject. During enrolment, they were also requested to keep in touch with the CFs as they would be followed up till delivery.

The process of identification and enrolment continued by the LHWs through home visits to each household every month. Similarly, the process continued in the non-intervention area by the CFs and district project team by frequent visits to each village every month, keeping close communication with the CFs. The process which was initially envisaged to last 2 months, continued for 4 months to achieve the requisite sample size in both segments of the study.

The intervention group received MMN supplements, including iron and folate; deworming during the second trimester; and health and nutrition education sessions for the subjects and their families. The control group received health education only. In the intervention group, pregnant women in their first trimester were accessed at their households, and, where possible, at the health facility level, while during the subsequent trimesters, as applicable depending on the weeks of gestation that they had been enrolled, to estimate the Hb levels. Follow-up for eliciting birth outcomes in the intervention group was conducted regularly through contact with LHWs. A mechanism was defined in the control area for the registration of the pregnant women and testing Hb at the time of enrolment and then during the late third trimester, including the weighing of the newborn's weight after delivery. This follow-up was done around the time of the expected date of delivery (EDD) which was calculated at the time of enrolment (Figure-1). To enhance the efficiency of this surveillance, linkages were established with the local traditional birth attendants (TBAs) and other skilled care providers in the catchment population. The LHWs conducted monthly follow-up home visits to each enrolled pregnant woman to replenish MMN tablets and provided counselling on any related problem. LHWs also conducted women group meetings monthly with the help of counselling material developed for the study. Those health education sessions were about maternal nutrition, health and hygiene,



**Figure-1:** Flow diagram for the intervention phase of the project.

breastfeeding, use of iodised salt, deworming etc. The sessions were attended by enrolled pregnant women, adolescents and young girls, and all married women of all families.

LHWs and district teams were trained on procedures and techniques of eligibility criteria and enrolment and follow-up procedures along with training on conducting weight, height and Hb measurements. These trainings were conducted on a two-tier basis, with the first set of

training extended to master trainers, while the master trainers and district teams imparted the same procedures and techniques in cascade training to the selected LHWs and project field staff. Hand-outs and reading material in local language were also provided to LHWs and district teams as they could refer that material in case of any problem. Hb assessment was done on a digital machine (Hemocue Hb 201 plus System) that measured Hb level within seconds. Weight was measured through electronic weighing scale (SECA) while the height of the subjects

was taken through a stadiometer (SECA). Weight and Hb readings were taken four times for each pregnant woman. Height was taken once at the time of enrolment. The first reading was taken at enrolment, the second reading was taken on same calendar date after three months in the second trimester, a third reading was taken on the same date after three months in the third trimester, and the fourth reading was taken within 72 hours of delivery. The measurements were conducted by LHWs in the intervention area, and by Health and Nutrition Development Society (HANDS) district teams with facilitation of CFs in control area.

LHWs provided MMN tablets to each subject along with counselling about dietary intake and information on MMN replenishment date. Contact numbers of research team members were shared with all the participating women for contacting the field team members in case of any problem/side effects from MMNs. To ensure intake of MMNs, the methodology was used similar to the World Health Organisation's (WHO) recommended Direct Observation Treatment Strategy (DOTS) in tuberculosis (TB) treatment.<sup>19</sup> In this approach, the mother-in-law or an elderly woman in the house were made responsible to visually observe the enrolled pregnant women consuming MMN daily. Furthermore, LHWs visited households on a weekly/fortnightly basis and sometimes with lady health supervisors (LHSs) and HANDS district teams to monitor supplement intake. HANDS senior management team also conducted monitoring visits on a monthly basis to meet the enrolled women to check supplement intake, provision and consumption of MMNs, counselling by LHWs etc. Visit notes and checklists were also filled and on-job sessions and coaching were done by LHSs and district teams for further improvement.

Data computerisation was done through EPI-Info version 6.04. A study-specific data entry program was designed in EPI-Info by the researchers. Value range checks, skip patterns, must-entry field checks and related quality assurance measures were part of the data computerisation process.

Once data entry was completed, the dataset was imported into SPSS 20 for data cleaning and analysis. Frequencies and summary measures for continuous and categorical variables were derived to conduct logical cleaning of the computerised data. The finalised dataset was then used to conduct quantitative analysis to generate descriptive and inferential statistics through univariable and multivariate regression analyses. Means and standard deviations (SDs) were used to summarise the continuous variables, while frequencies and percentages were used to summarily present information

of categorical variables. Uni-variable, bivariate and multivariate logistic regression modelling were conducted through purposeful and backward deletion modelling techniques to derive a parsimonious model of predictors for LBW.

## Results

From the total of 1204 subjects, 600 (49.8%) were in the intervention group and 604 (50.2%) were in the non-intervention group. Of the intervention group, 312 (52%) subjects and 300 (50%) in the non-intervention subjects belonged to Tharparkar district, while the remaining half came from Umerkot (Table-1). Mean age of the participants across the two segments was not significantly different ( $p > 0.05$ ). With respect to formal education, a significantly higher proportion of subjects in intervention areas 116 (19%) had formal education compared to non-intervention area 38 (6%) with a  $p$ -value  $< 0.05$ . However, they were comparable in terms of economic status as gauged through the proxy indicator of the number of rooms in the house ( $p > 0.05$ ). The previous history of stillbirth was not significantly different ( $p < 0.60$ ). None of the subjects reported a history of LBW, but abortion was reported which was comparable across the intervention and non-intervention areas (Table-1).

Nearly all women in both segments were consuming 2-3 meals per day prior to the current pregnancy. LHW areas

**Table-1:** Characteristics of follow-up participants.

Variables	LHW covered area	Non-LHW covered area	P-value
	Intervention group n (%) N=604	Control group n (%) N=600	
<b>Districts</b>			
Umerkot	288 (48.0)	300 (49.7)	0.60
Tharparkar	312 (52.0)	304 (50.3)	
<b>Formal Schooling*</b>			
Yes	116 (19.2)	38 (6.3)	0.001
No	488 (80.8)	569 (93.7)	
<b>Number of rooms in a Household*</b>			
1	261 (43.2)	220 (36.2)	0.06
2-3	278 (46.0)	338 (54.2)	
>3	65 (10.8)	58 (9.6)	
Age (years) Mean $\pm$ SD	28.1 $\pm$ 5.6	28.6 $\pm$ 5.8	0.14
<b>History of LBW</b>			
No	600 (100)	604 (100)	-
<b>History of stillbirth</b>			
Yes	1 (0.2)	2 (0.3)	0.60
No	599 (99.8)	602 (99.7)	
<b>History of Abortion</b>			
Yes	36 (6.0)	24 (4.0)	0.11
No	564 (94.0)	580 (96.0)	

\*N=604 intervention arm and 607 in non-intervention arm

SD: Standard deviation.

**Table-2:** Dietary and physical activity during current pregnancy.

Variables	Intervention group n (%) 604 (100)	Control group n (%) 607 (100)	P-value
<b>Number of meals per day before pregnancy</b>			0.001
1	6 (1.0)	2 (0.3)	
2	397 (65.7)	478 (78.7)	
3	199 (32.9)	124 (20.4)	
4	2 (0.3)	3 (0.5)	
<b>Supplement use before pregnancy</b>			0.001
Yes	105 (17.4)	41 (6.8)	
No	499 (82.6)	566 (93.2)	
<b>Modify diet in pregnancy</b>			0.02
Yes	236 (39.1)	277 (45.6)	
No	368 (60.9)	330 (54.4)	
<b>Modification in diet</b>			0.00
Increased number of meals	132 (56.7)	112 (41.3)	
Modified contents of meals	72 (30.9)	109 (40.2)	
Addition of supplement	11 (4.7)	0 (0.0)	
Other	18 (7.7)	50 (18.5)	
<b>Physical activity during pregnancy</b>			0.001
Changed	175 (29.0)	314 (51.7)	
Not changed	429 (71.0)	293 (48.3)	
<b>What changes in physical activity</b>			0.001
Take more rest	31 (17.7)	114 (36.4)	
Reduced Household chores	51 (29.1)	90 (28.8)	
No outside/field work	92 (52.6)	106 (33.9)	
Went to parents for rest/did not do any work	1 (0.6)	3 (0.9)	

**Table-3:** Follow-up visits.

Variables	Intervention group Mean±SD	Control group Mean±SD	P-value
Pregnancy duration at 1st visit	22.2±2.3	22.4±1.2	0.09
Pregnancy duration at 2nd visit	34.1±2.3	34.3±1.9	0.06
Pregnancy duration at 3rd visit	36.8±0.4	36.7±0.4	0.20

SD: Standard deviation.

596 (98.6%), and non-LHW areas 602 (99.1%). Nearly one-sixth of the women in the intervention areas 105(17.6%) were using supplements (vitamins and/or iron-folate) before the pregnancy, while this proportion was significantly lesser 41(6.8%) in non-LHW areas (p-value <0.00).

The number of women who had modified their diet during the current pregnancy was significant (Table-2). A significantly higher proportion of women increased the number of meals in LHW areas compared to women in non-LHW areas (p<0.001).

Modified physical activity was significant in the two study arms (p<0.05). Provision of the interventions by the

**Table-4:** Outcome of pregnancy.

Variables	Intervention group n (%)	Control group n (%)	P-value
<b>Outcome of pregnancy</b>			
Full term live birth	560 (93.3)	584 (96.7)	
Premature live birth	3 (0.5)	2 (0.3)	
Still birth	4 (0.7)	2 (0.3)	0.06
Abortion	33 (5.5)	15 (2.5)	
Multiple births	0 (0.0)	1 (0.2)	

**Table-5:** Natal experience.

Variables	Intervention group n (%)	Control group n (%)	P-value
<b>Who conducted the delivery</b>			
SBA	4 (0.7)	11 (1.8)	
Doctor	85 (14.2)	97 (16.1)	
LHV	43 (7.2)	52 (8.5)	
Nurse	1 (0.2)	3 (0.5)	0.01
Dai	434 (72.3)	426 (70.6)	
Other	33 (5.5)	15 (2.5)	
<b>Type of delivery</b>			
Simple Vaginal Delivery	563 (93.8)	581(96.2)	
Caesar section	4 (0.7)	7 (0.2)	0.03
Forceps	0 (0.0)	1 (0.2)	
Other	33 (5.5)	15 (2.5)	
<b>Place of delivery</b>			
Home	469 (78.2)	455 (75.3)	0.24
Health facility	131 (21.8)	149 (24.7)	
<b>Material used for cord cutting</b>			
Disposable blade	567 (100.0)	526 (89.3)	0.00
Used blade	0 (0.0)	63 (10.7)	

SBA: Skilled Birth Attendant; LHV: Lady Health Visitor.

project staff to the participants reflected encouraging results with nearly all 600 (99%) of the enrolled women in intervention areas receiving deworming tablets during the second trimester. In this regard, all the women enrolled in the intervention group were found to have received MMN supplements during the first-second trimester 604(100%) and the vast majority 575 (95%) during the second-third trimester. All the women and their family members had received counselling on pregnancy care.

As per the WHO protocols, one MMN tablet was to be consumed by the participants. In this regard, the project staff provided the women participants with monthly supplies of 35 MMN tablets. Good adherence was observed for taking the MMN tablets with 592 (98%) of women taking the daily required dose.

**Table-6:** Early neonatal care.

Variables	Intervention group n (%)	Control group n (%)	P-value
<b>Initiation of feeding (hours)</b>			
1 hour	428 (76.0)	479 (81.6)	0.00
2 hours	132 (23.4)	102 (17.4)	
≥ 3 hours	3 (0.5)	6 (1.0)	
<b>Traditional Pre lacteal Feed (Gutti) given</b>			
Yes	16 (2.8)	192 (32.7)	0.00
No	547 (97.2)	395 (67.3)	
<b>Was baby vaccinated</b>			
Yes	556 (98.8)	378 (64.4)	0.00
No	7 (1.3)	209 (35.6)	

**Table-7:** Anaemia, haemoglobin (Hb) and health status and low birth weight (LBW).

Variables	Intervention group Mean±SD	Control group Mean±SD	P-value
Haemoglobin level (gm./dl) at enrolment	10.1±1.8	10.5±1.8	0.00
Haemoglobin level (gm./dl) at 1st visit	11.3±1.5	10.8±1.7	0.00
Haemoglobin level ( gm./dl ) at 2nd visit	12.1±1.4	11.2±2.2	0.00
Haemoglobin level ( gm./dl ) at 3rd visit	11.1±1.4	10.2±1.6	0.00
Height at enrolment (m <sup>2</sup> )	2.3±0.2	2.3±0.2	0.16
Weight (kg) at enrolment	45.4±6.7	45.2±6.9	0.64
Weight (kg) at 1st visit	48.3±6.6	47.7±6.8	0.13
Weight (kg) at 2nd visit	52.9±6.6	52.0±7.1	0.00
Weight (kg) at 3rd visit	48.2±6.7	47.0±6.8	0.00
Body mass index ( Kg/m <sup>2</sup> ) at enrolment	19.5±3.3	19.4±2.7	0.79
Body mass index ( Kg/m <sup>2</sup> ) at 1st visit	15.8±2.1	15.6±2.1	0.12
Body mass index ( Kg/m <sup>2</sup> ) at 2nd visit	17.3±2.1	16.9±2.2	0.01
Body mass index (Kg/m <sup>2</sup> ) at 3rd visit	15.8±2.2	15.4±2.1	0.00
Birth weight (kg)	2.8±0.30	2.5±0.31	0.00

SD: Standard deviation.

These women also reported a mean 4.5 counselling sessions attended/received by LHWs during the follow-up phase as recorded during the 1st and 2nd follow-up visit results. Abdominal discomfort was the only side effect reported by the subjects, with nearly one-tenth 62 (10.3%) of them experiencing such a side effect during the first three months of follow-up, while the said proportion was much lower 19 (3.2%) during the subsequent three months. All of the women, who reported to have experienced this side effect, sought advice from the LHWs during household visits in the follow-up phase. As per the protocol and training of LHWs in this project, the women received advice on taking MMN with juice and not with plain water.

Each follow-up visit as per the study protocol was 11-13 weeks apart. The mean duration of pregnancy was

**Table-8:** Predictors of Low Birth Weight (LBW).

Characteristic	Adj OR	95% CI		P-value
		Lower	Upper	
Age	1.03	0.99	1.07	0.07
Weight at enrolment	0.90	0.87	0.93	0.00
Hb at enrolment	0.85	0.75	0.96	0.01
Hb differential (1st-3rd follow-up)	0.47	0.33	0.66	0.00
BMI differential (1st-3rd follow-up)	0.61	0.42	0.89	0.01
<b>Intervention arm</b>				
Intervention group	0.02	0.01	0.04	0.00
Control group	1			
<b>Pre- Lacteal feed (Ghutti) given</b>				
Yes	1			
No	0.05	0.03	0.10	0.00

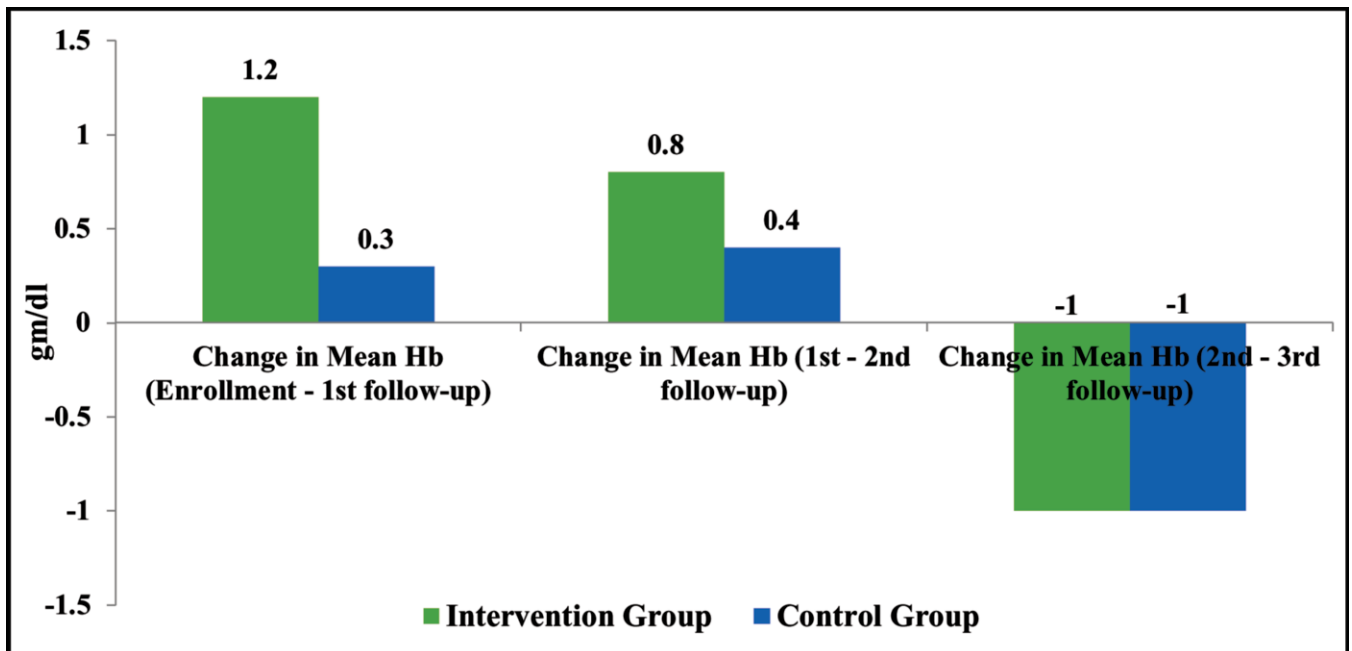
OR: Odds ratio; CI: Confidence interval; Hb: Haemoglobin; BMI: Body mass index.

comparable across both segments of the research for all the three follow-ups (Table-3).

Pregnancy outcomes were elicited during the last follow-up visit by the LHWs and research team members (Table-4). The occurrence of adverse pregnancy outcomes in the intervention group was nearly double to that observed in the non-intervention group, but the difference was not significant ( $p < 0.06$ ).

The birth attendance pattern was significantly different across the study arms, with a significantly higher proportion of women being delivered by skilled attendants in the non-intervention areas compared to the intervention areas ( $p < 0.05$ ). The proportion of health facility-based births was slightly higher in non-intervention areas, but the difference was not significant ( $p < 0.24$ ). A significantly higher proportion of birth attendants in the intervention areas conducted the favourable practice of using a disposable blade for cord cutting compared to the non-LHW-covered areas (Table-5). A significantly ( $p < 0.05$ ), higher proportion of women 560 (99.4%) initiated early breastfeeding within the first 2 hours of birth in the intervention areas compared to the non-intervention areas 581(99%). A significantly higher proportion of women in the non-intervention areas were performing the unfavourable practice of giving 'ghutti' to the newborn compared to those in the intervention arm ( $p < 0.001$ ) (Table-6). Favourable neonatal care practices were observed in the LHW-covered areas compared to the non-intervention areas for getting Expanded Programme on Immunisation (EPI) vaccination done; 556(98.8%) in LHW areas compared to 378(64.4%) in the non-intervention areas (Table-6).

At the time of enrolment, (Table-7) the two segments of the study were comparable with reference to mean body



**Figure-2:** Change in mean haemoglobin (Hb) levels (gm/dl) across the follow-up period.

weight, height and body mass index (BMI) ( $p > 0.05$ ). Hb level, however, was lower in the intervention areas compared to the non-intervention areas ( $p < 0.001$ ). Across all the three follow-ups, the mean Hb level in the intervention area was significantly higher than the control group (Table-7)

It was observed that the change in mean haemoglobin levels in the intervention arm between enrolment and 1st follow-up (i.e. after 3 months of intervention) was 1.2 gm/dl as compared to only 0.3 mg/dl in the non-intervention arm of the study (Figure-2). The mathematical gain in Hb levels in the intervention group was 11.9% compared to 2.9% in the control group ( $p < 0.001$ ). The same pattern was observed for BMI which showed significantly higher gain across the intervention arm compared to the non-intervention arm after 3 months and 6 months of intervention ( $p < 0.05$ ).

The birth weight reflected the effect of project interventions, with newborns in the intervention group having a statistically significantly higher mean birth weight compared to the control group (Table-7). When adjusted for age of the woman, the predictors that increased the risk of having LBW as the pregnancy outcome included having a lower body weight at enrolment; having a lower Hb at enrolment; having a smaller differential in Hb level between the 1st and 3rd follow-up; having a smaller differential in BMI between

the 1st and 3rd follow-up; and belonging to the non-intervention arm.

Among these, the strongest predictor was receiving of project interventions that predisposed the participants to a protective effect of 0.02 times the risk of having LBW compared to non-LHW areas. In this regard, per unit (kg) increase in weight at the time of baseline reduced the risk of LBW by 0.90 times. A higher Hb level at baseline, a higher Hb gain and BMI levels reduced the risk of LBW (Table-8).

## Discussion

The current study documented adequate adherence by the subjects to the proscribed intervention protocols. This method was found to be effective in another study which showed that using participatory women's groups as a community engagement strategy, including home visits, led to a large improvement in newborn survival within the existing health system structures.<sup>20</sup>

The findings of the current study can be used to establish that community-based provision of MMNs to women along with deworming, health education/dietary counselling, enhancing knowledge of women and their family members, and making efforts to improve compliance with MMN therapy significantly reduces the prevalence of anaemia and resultantly reduces the incidence of LBW. These findings are similar to various randomised controlled trails (RCTs) and observational

studies carried out in various parts of the world.<sup>11,21</sup> Another study reported that pregnant women who received MMN supplementation had a lower incidence of LBW, SGA babies, and stillbirths than pregnant women who received only iron with or without folic acid (4). A systematic review<sup>22</sup> indicated that prenatal MMN supplementation was associated with a significantly reduced risk of LBW and with improved birth weight when compared with iron-folic acid supplementation. Another review also provided evidence that the use of MMN could lead to prevention of maternal complications and reduction in other adverse pregnancy outcomes, such as SGA births, LBW, stillbirths, and perinatal and neonatal mortality.<sup>23</sup> The effects of MMN are not only limited to pregnancy and its outcomes, but also affect the early development phase of life. An RCT carried out in Nepal, involving poor population, showed that the effects of MMN supplementation on the foetus persisted into childhood, with a better increase in both weight and body size.<sup>24</sup>

The current study identified possible confounders and has certain limitations as well. Firstly, there is possible selection bias as the sample was not randomised and women were identified through community-based providers which may affect the generalisability of the findings. Secondly, there is a possibility that in the non-intervention group, women may have taken some form of supplements during pregnancy which may have affected the results.

Despite the limitations, the current study, to the best of our knowledge, is one of the first ones done in Pakistan on the effect of MMNs along with a set of composite community-based interventions on the incidence of LBW in one of the remotest and highly food-insecure regions of not just the country, but of the entire South Asia region. Furthermore, the findings provide a lot of promise for achieving even better health and nutrition outcomes in other parts of the country which are more urbanised, fare better in terms of services and are more food-secure.

## Conclusion

Community-based provision of MMN supplements to women along with deworming, health education and dietary counselling significantly reduced the prevalence of anaemia and reduced the incidence of LBW.

**Disclaimer:** None.

**Conflict of Interest:** None.

**Source of Funding:** The United Nations Children's Fund (UNICEF) Sindh.

**Trial Registration:** The trial was retrospectively registered with the Australia New Zealand Clinical Trials Registry (ANZCTR). ACTRN: ACTRN12616001449426.

Web address of trial:

<http://www.ANZCTR.org.au/ACTRN12616001449426.aspx>

Date registered: 17/10/2016 4:43:11 PM.

## References

1. Cheng ER, Park H, Wisk LE, Mandell KC, Wakeel F, Litzelman K, et al. Examining the link between women's exposure to stressful life events prior to conception and infant and toddler health: the role of birth weight. *J Epidemiol Community Health*. 2016;70:245-52.
2. Weise A. WHA Global Nutrition Targets 2025: Stunting Policy Brief. [Online] [Cited 2016 January 12]. Available from: URL: [http://www.who.int/nutrition/topics/globaltargets\\_stunting\\_policybrief.pdf](http://www.who.int/nutrition/topics/globaltargets_stunting_policybrief.pdf)
3. Howson CP, Kinney MV, McDougall L, Lawn JE. Born too soon: preterm birth matters. *Reprod Health*. 2013; 10:S1.
4. Smith V. Multiple-micronutrient supplementation for women during pregnancy. *Pract Midwife*. 2014; 17:36-8.
5. Pojda J, Kelley L. Low Birth weight – Nutrition policy discussion paper No. 18, United Nations Administrative Committee on Coordination Sub-Committee on Nutrition 2000. [Online] [Cited 2016 January 21]. Available from URL: [https://www.unscn.org/layout/modules/resources/files/Policy\\_paper\\_No\\_18.pdf](https://www.unscn.org/layout/modules/resources/files/Policy_paper_No_18.pdf).
6. Lindsay H Allen. Multiple micronutrients in pregnancy and lactation: an overview. *Am J Clin Nutr*. 2005; 81:1206S-125S.
7. Prakesh S Shah, Arne Ohlsson. Effects of prenatal multimicronutrient supplementation on pregnancy outcomes: a meta-analysis. *CMAJ*. 2009; 180:E99-108.
8. Ladipo OA. Nutrition in pregnancy: Mineral and vitamin supplements. *Am J Clin Nutr*. 2000; 72:280-90.
9. Gyorkos TW, Gilbert NL. Blood Drain: Soil-Transmitted Helminths and Anemia in Pregnant Women. *PLoS Negl Trop Dis*. 2014; 8:7-8.
10. Darnton-hill I, Mkpuru UC. Micronutrients in Pregnancy in Low- and Middle-Income Countries. *Nutrients*. 2015; 7:1744-68.
11. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *Lancet*. 2013; 382:452-77.
12. P Kæstel, H Friis. Effects of prenatal multimicronutrient supplements on birth weight and perinatal mortality: a randomised, controlled trial in Guinea-Bissau. *Eur J Clin Nutr* 2005;59:1081-9 .
13. UNDP in Pakistan. [Online] [Cited 2015 Nov 13]. Available from URL: <http://www.pk.undp.org/content/pakistan/en/home/countryinfo.html>
14. Highlights Pakistan Economic Survey 2010-11. Economic Adviser's Wing, Finance Division, Government of Pakistan, Islamabad.
15. UNICEF state of the world's children [Online] 2011 [Cited 2016 Jan 13]. Available from URL: <http://www.unicef.org/sowc2011/statistics.php>
16. UNICEF. Progress for Children A Report Card on Water and Sanitation. New York:UNICEF ;2006, pp 36.
17. Mumtaz Z, Salway S, Bhatti A, Shanner L, Zaman S, Laing L, et al. Improving maternal health in Pakistan: Toward a deeper understanding of the social determinants of poor women's access to maternal health services. *Am J Public Health*. 2014;104: S17-24.
18. United Nations Population Division. World Population Prospects: [Online] [Cited 2018 May 13]. Available from URL: <https://data.worldbank.org/indicator/SP.POP.GROW?locations>

- =PK.
19. World Health Organization. What is DOTS? A Guide to Understanding the WHO-recommended TB Control Strategy Known as DOTS. *Prev Control*. 1999;2:1-39.
  20. Prost A, Colbourn T, Seward N, Azad K, Coomarasamy A, Copas A, et al. Women's groups practising participatory learning and action to improve maternal and newborn health in low-resource settings: a systematic review and meta-analysis. *Lancet*. 2013; 381:1736-46.
  21. Zerfu TA, Ayele HT. Micronutrients and pregnancy ; effect of supplementation on pregnancy and pregnancy outcomes : a systematic review. *Nutrition J*. 2013; 12:1-5.
  22. Shah PS, Ohlsson A. Effects of prenatal multimicronutrient supplementation on pregnancy outcomes: a meta-analysis. *CMAJ*. 2009; 180:E99-108.
  23. Haider BA, Yakoob MY, Bhutta ZA. Effect of multiple micronutrient supplementation during pregnancy on maternal and birth outcomes.[Online] [Cited 2017 January 12]. Available from: URL: <http://www.ncbi.nlm.nih.gov/pubmed/21501436>.
  24. Vaidya A, Saville N, Shrestha BP, de L Costello AM, Manandhar DS, Osrin D. Effects of antenatal multiple micronutrient supplementation on children's weight and size at 2 years of age in Nepal: follow-up of a double-blind randomised controlled trial. *Lancet*. 2008; 371:492-9.
-