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A MULTIVARIATE AND COMPARATIVE ANALYSIS OF DETERMINANTS AND RISK FACTORS INFLUENCING IRON AND CALCIUM SUPPLEMENTATION PRACTICES AMONG PREGNANT WOMEN IN LAYYAH DISTRICT, PAKISTAN

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Abstract

Background: *The nutritional status of mothers has the greatest influence on fetal health and well-being to reduce morbidity. Anaemia is prevented by micronutrients such as iron, calcium and other micronourishment help in fetal growth and also reduce hypertension complication. Though global guidelines have been laid, deficiencies are still very common in underdeveloped economies such as Pakistan. Poor health literacy, socio-economic constraints in rural areas such as Layyah, and less frequent ANC utilization and uptake are the barriers to supplementation.*

Objectives: *To identify the knowledge, attitudes and practices (KAP) about iron and calcium supplementation among pregnant women and to evaluate socio-cultural, economic and health system factors influencing adherence in Layyah district, Punjab, Pakistan.*

Methodology: *quantitative, cross sectional descriptive study in selected rural/urban union councils of Layyah shall be conducted. This will involve collecting data from about 300 pregnant women attending BHUs, Rural Health Centers, District Headquarters Hospital through multistage sampling. Data will be gathered through face-to-face interviews by using a pre-tested questionnaire, which will cover socio-demographics, KAP, adherence and counselling experiences. Data will be analyzed using SPSS by descriptive and inferential statistics.*

Results: *Micronutrient consumption by pregnant women is less than 31.3%, indicating a serious public health problem. Maternal literacy and frequent attendance to ANC visits are key facilitators and stockout of supplements and gastrointestinal intolerance are key barriers.*

Conclusion: *The summary of findings will lead to evidence-based suggestions and recommendations to be taken into account to improve maternal nutrition interventions, optimize supply chains, enhance family-led counselling and strengthen the role of grassroots community efforts in Layyah district.*

1. INTRODUCTION

Gestation is a period of immense physiological stress, causing marked changes occurring in the mother to pathways involving metabolism and homeostasis, which ultimately influence the outcome of the fetus, maternal health and long-term child development [1]. Appropriate nutrition before and during pregnancy results in adaptive and physiologic changes, optimal fetal growth and avoidance of adverse outcomes [2]. The biological stability is largely dependent on available macronutrients and micronutrients. Essential minerals, such as iron and calcium, facilitate essential hematological, skeletal, metabolic and cardiovascular activities, and the systems demand even more as trimesters progress. Iron has critical importance for hemoglobin synthesis, transport, cellular metabolism and the immune system, and there are additional iron requirements for the growth and development of the placenta and fetal tissues, as well as increased maternal blood volume during late gestation [3]. Iron-deficiency anemia ensues if dietary intake is inadequate, leading to chronic intrauterine hypoxic stress and increasing the chance of preterm delivery, with its associated low birth weight and mortality [4]. Though the World Health Organization (WHO) and UNICEF recommendations include routine iron-folic acids and calcium supplementation [9] compliance is low, especially in Africa and in South Asia. In a study of adherence across 25 countries in sub-Saharan Africa, 51.7% of people reported that they adhered to these recommendations, and that level of adherence correlated with education and wealth of households and with the power behind decisions and household actions [5]. The data shows greater decreases: Even in Tigray, Ethiopia, only 37.2% of urban and 28.9% of rural residents had abstained, underscoring significant urban and rural inequalities, low health literacy, and structural issues; in Malawi, 37% of the population had abstained [6,7].

Calcium also is essential for fetal skeletal mineralization, maternal bone, neuromuscular activity and for controlling blood pressure. Fetal bones will take up as much as 250 mg of calcium a day in late gestation, which places a strain on maternal metabolic axes. These are significant factors for neonatal death and are well correlated with poor calcium regulation during pregnancy, especially pre-eclampsia and pregnancy induced hypertension (PIH) [8]. When appropriately supplemented, these risks can be reduced, particularly in areas where food is a chronic scarcity.

In Pakistan, these include some national programs that provide supplements through the Lady Health Worker scheme [10]. Despite the clinical availability, however, a need for implementation and community uptake exists. This can be seen clearly in the Layyah district of South Punjab which is an agrarian area characterized by poverty, illiteracy of females and early marriage. Barriers in supplementing Layyah do not only stem from socio-economic factors such as distance to health facilities and high transport costs, but also from cultural issues concerning the roles of mothers-in-law and husbands in the decision-making process: women's voice is not heard as regard dietary choices and health, and their participation in it is strongly limited [11]. In addition, somatic fears and myths propagate to deep beliefs among women that iron will stimulate fetal development and cause distress during birth and/or to induce heat, and that calcium is too hard a medicine and not a supplement they are required to take. Early deficiency is silent, women may cease supplementation when they enter into the acute phase of deficiency, vaginal clinical counselling also being undertaken, and focuses for a short duration [12].

Comparisons to other countries illustrate that it't enough to distribute, unless you are successful. This spatio-temporal clustering is particularly identified in Ethiopia; individual Public Health programs will need to target these specific hotspot areas for their specific resources [13]. Mathematically, economic growth does not automatically reduce micronutrient vulnerabilities, even in a high-income country, such as in Singapore where micronutrient vulnerabilities due to cultural factors and parity

issues continue [14]. On the flip side, programmes in Bangladesh demonstrate that teaching mothers their diet knowledge and involving husbands actively enhances supplementation uptake [15, 16].

Finally, there is the current research which may be concerned only with cover metrics and not with the actual consumption behaviours. In order to create a gap between policy and actual practice in Layyah district, public health strategies should go beyond the mere distribution of the policy. However, it is urgent to adopt a wide-ranging analysis of practices and procedures, with a scientific basis, the measurement of local attitudes, the deconstruction of local myths and an operational analysis to guarantee sustainable practices of maternal health and improve outcomes for mothers and newborns.

Objective: To evaluate the knowledge, attitude and practices on iron and calcium supplementation among the pregnant women in Layyah district.

2. MATERIAL AND METHODS

2.1 Research Design

The design of this study was cross section descriptive design with quantitative approach. The data was collected once to measure the knowledge, attitudes and practices concerning iron and calcium supplementation among pregnant women.

2.2 Clinical Settings

The study was done in selected rural and urban union councils of Layyah district, in Punjab, Pakistan. Information was gathered from public sector health facilities such as Basic Health Units (BHUs), Rural Health Centers (RHCs) and tertiary care hospitals. The study population consisted of pregnant women, who attended the antenatal care services at these facilities, during the data collection period. These settings were able to give a workable picture of the access to service and the way iron and calcium was addressed in antenatal counseling throughout the district.

2.3 Sample Size

About 300 pregnant women were enrolled in the study, independently using standard prevalence-based formulas to ensure the representativeness of the sample. The sample size calculated as per the standard procedure of statistics.

$$n = \frac{z^2 \times p \times (1-p)}{d^2}$$

2.4 Sampling Technique

Multistage sampling:

- Selection of health facilities
- Participation in the survey by systematic random sampling of eligible pregnant women.

2.5 Duration of Study

The project actually required six months of work including proposal approval, development of a tool, data collection, data analysis and report writing.

2.6 Selection Criteria

2.6.1 Inclusion Criteria

- Pregnant women at any stage of pregnancy.
- Antenatal services were provided at selected BHUs, RHCs or DHQ Hospital and women attending it.
- Ruralites of Layyah district Females consent to sampling without misinformation.
- Informed consent of women who have consented to share.

2.6.2 Exclusion Criteria

- Pregnant women who may need emergency care because of serious medical problems.
- Pregnant women who have serious medical conditions that need urgent attention.
- Women who refuse or fail to give informed consent.
- The rights of tourists or people not residing in the area of Layyah

2.7 Ethical Consideration

The Ethics Committee of the institution, where the study is performed, approved the study. Informed written consent was obtained from all respondents after their need and the purpose of the study was explained. Participant confidentiality and anonymity were always observed and no identifying information was introduced during the analysis of data or in the report. There was no compulsory participation and it was entirely voluntary but the participants were able to withdraw at any time without any consequences.

2.8 Data Collection Procedure

Questionnaire was structured and pretested, and used face-to-face interviews to collect data. The selection of the questionnaire was based on literature and included sections on:

- Socio-demographic characteristics
- Knowledge of iron and calcium supplements
- Attitudes towards supplementation & perceptions
- The use of supplements and compliance to supplementation programs
- Counselling / Reflection during antenatal care

A pretest of the questionnaire was conducted on a small scale outside the study area to check the clarity and reliability. Modifications were made prior to final data collection as needed.

2.9 Data Analysis

The collected data were inputted and analyzed on the Statistical Package for the Social Sciences (SPSS) computer program. Socio-demographic variables and KAP responses were summarized using descriptive statistics which were frequencies and percentages. In order to investigate the association between the knowledge, attitudes, practices and selected socio-demographic variables, inferential statistical tests were used for the analysis with significance level of $p < 0.05$.

3. RESULTS

As could be seen in Table 3.1, 47.3% of the respondents were aged 21-30 years, 64.7% earned PKR less than 30,000 per month and 61.7% lived in the rural areas. The results suggested that the sample area of Layyah is highly vulnerable economically and had a mostly rural population. Moreover, the high percentage of housewives (82.7%) coupled with low literacy rate (27.3%) showed significant structural and socioeconomic dependency in making maternal health care decision.

3.1. Socio-Demographic Summary (N = 300)

Determinant	Socio-Demographic Categories	Frequency (n)	Percentage (%)
Age Profile	Under 20 Years	36	12.0%
	21–30 Years	194	64.7%
	Above 30 Years	70	23.3%
Residency	Rural Union Councils	185	61.7%
	Urban Areas	115	38.3%
Education	Illiterate / No Formal Schooling	82	27.3%

Determinant	Socio-Demographic Categories	Frequency (n)	Percentage (%)
	Primary / Middle (1–8 Years)	98	32.7%
	Matric / Intermediate (10–12 Years)	85	28.3%
	Graduation & Above	35	11.7%
Monthly Income	Low Income (< 30,000 PKR)	142	47.3%
	Middle Income (30,000 – 60,000 PKR)	118	39.3%
	High Income (> 60,000 PKR)	40	13.3%
Employment	Housewife	248	82.7%
	Employed	52	17.3%

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Table 3.2 showed that the majority of women in the sample were multigravida (54.7%) and only 30.0% had the recommended number of ANC visits (4 or more). Logistical and systemic barriers were very strong, with 62.7% of the pregnant women living more than 5 km from health facilities and 65.0% having irregular or rare availability of the supplements at public-sector health facilities. This demonstrated that the utilization of antenatal care in the district was sub-optimal, with physical distance and supply chain issues being significant influential factors.

3.2. Obstetric History and Healthcare Access Profile

Clinical Matrix	Response Modalities	Frequency (n)	Percentage (%)
Gravidity	Primigravida (1)	92	30.7%
	Multigravida (2–4)	164	54.7%
	Grand Multigravida (≥5)	44	14.6%
Current Trimester	First Trimester	58	19.3%
	Second Trimester	124	41.3%
	Third Trimester	118	39.4%
ANC Visits	0–1 Visit (Inadequate)	74	24.7%

Clinical Matrix	Response Modalities	Frequency (n)	Percentage (%)
	2–3 Visits (Sub-optimal)	136	45.3%
	≥ 4 Visits (Optimal Protocol)	90	30.0%
Logistics/Distance	Proximal (< 5 km)	112	37.3%
	Intermediate (5–10 km)	126	42.0%
	Distant (> 10 km)	62	20.7%
Supply Stock	Always Available	105	35.0%
	Intermittent / Sometimes Stocked	138	46.0%
	Rarely / Never Available	57	19.0%

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As could be seen in figure 3.1, only 31.3% of the sample had optimum high compliance, whilst the remainder, 68.7%, had either erratic or total non-adherence to the compliance. This low adherence was a major challenge to the effectiveness of the preventive maternal health interventions in the district.

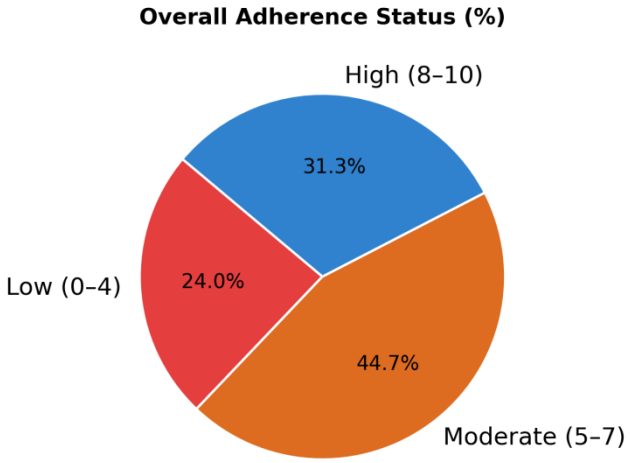


Figure 3.1: Composite Self-Rated Adherence Status (%)

As indicated in Figure 3.2, gastrointestinal side effects (38.7%) and behavioral forgetfulness (28.0%) were reported as the main factors limiting frequent use of supplements. This showed that physiological stress, like nausea and constipation, not managed, is the most frequent cause for active treatment discontinuation when it occurred together with the absence of routine reminder systems.

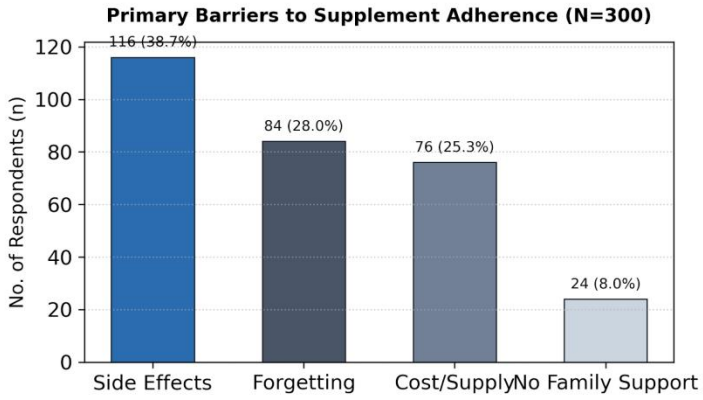


Figure 3.2: Breakdown of Primary Stated Barriers (n)

Table 3.3 indicated that supplement adherence status was significantly associated with Area of Residence (p=0.009), Maternal Education (p=0.001), ANC Visits (p<0.001) and Side Effects (p=0.005). These findings were consistent with other reported data indicating that socially and environmentally, low maternal literacy and rural living were significant risk factors for poor compliance. The highest statistical correlation with therapeutic drop-out rates among participants is inadequate clinical contact (ANC visit).

3.3. Finding Patterns Between Variables: The Pearson Chi-Square Approach

Risk Factors Evaluated	Low Adherence (n=72)	Med/High Adherence (n=228)	Pearson χ^2	p-value	Statistical Inference
Residence: Rural / Urban	56 / 16	129 / 99	6.841	0.009	Significant ($p < 0.05$)
Education: Illiterate-Primary / Matric+	52 / 20	128 / 100	11.423	0.001	Significant ($p < 0.01$)
ANC Engagement: ≤1 Visit / ≥2 Visits	38 / 34	36 / 192	24.154	< 0.001	Highly Significant ($p < 0.001$)
Side Effects: Experienced / Absent	48 / 24	102 / 126	7.912	0.005	Significant ($p < 0.01$)

Table 3.4 displayed the multivariate logistic regression model, which validated that having received ≥4 ANC visits was the strongest independent positive predictor with odds of adherence 3.15 times (p<0.001). Comprehension was significantly scaled by higher maternal

literacy, with odds of 2.31 times (p=0.004) being more likely for higher maternal literacy. Further, using digital media was an important independent facilitator (R^2=0.284), and urban residency (AOR=1.99) doubled the likelihood of adherence, bypassing the effects of physiological side effects.

3.4. Assessing Multiple Predictors Through Binary Logistic Regression

Independent Predictors	Coeff. (β)	S.E.	Wald	df	p-value	Adjusted Odds Ratio (AOR)	95% C.I. for AOR
Urban Residence (Ref: Rural)	0.577	0.241	5.731	1	0.016	1.78	[1.11, 2.85]
Higher Education (Ref: Illiterate)	0.837	0.292	8.216	1	0.004	2.31	[1.31, 4.09]
Optimal ANC visits (≥4) (Ref: < 4)	1.147	0.311	13.601	1	< 0.001	3.15	[1.72, 5.79]
No Side Effects (Ref: Experienced)	0.688	0.222	9.605	1	0.002	1.99	[1.29, 3.07]
Digital Media Exposure (Ref: No)	0.445	0.210	4.491	1	0.034	1.56	[1.03, 2.38]
Constant	-2.114	0.455	21.587	1	< 0.001	0.12	—

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4. DISCUSSION

This research explores the actual reasons for supplement taking amongst 300 pregnant women of the District Layyah, contrasting the realities in the locality with those at national and international level.

The results show a wide gap in the field of public health: merely 31.3% of the women in Layyah have the capacity for high compliance with both the iron and calcium protocols. This equates to a whopping 68.7% in "irregular/absolute non-compliance zones." This is in line with Pakistan's national trends, which have consistently demonstrated such rural and urban disparities over the years, as illustrated in the PDHS analyses. Multi-year country coverage assessments, which integrate data from the period from 2006 to 2019 [21] indicate that although this has increased over time, there are significant differences between countries that mean they still have deep coverage gaps. Although national policies are in place, they can be seen as ineffective in making behavioral changes at the grassroots level, that is, at key time points in the fetal development, with motherless vulnerable.

Adherence is strongly linked to socioeconomic status, as indicated by statistical models. The influence of residence was significant (p = 0.009) and it was harder for women who reside in rural areas. Worse, almost half of this group (47.3%)

earns PKR less than 30,000 per month in a family. The financial constraints are similar to what Nisar et al. [19] found in their analysis of poverty and lack of rural health outreach which are major constraints on continuing consumption. Given the reality of family survival on a day to day basis, attending to pick up the supplements is low priority.

Maternal education emerged as a powerful positive predictor (x^2 = 11.423, p = 0.001, AOR = 2.31). There was a positive association with women who are well educated using supplements whenever compared with those who are not well educated, which is similar to the results found by Mughal et al., in Rawalpindi [22]. Literacy enables mothers to understand, appreciate health messaging and appreciate the dosages, and understand the risks of poor nutrition. Unfortunately, structural autonomy in Layyah is low 82.7% of them are full time house wife and 27.3% has no formal education. The lack of any other means of transport and medical costs isolation arises in women's case, because they had to depend on their husbands or extended family for these costs, therefore it is important that the household decision makers must be engaged in health counselling.

Moreover, the number of the ANC visits, four or more was determined as the only significantly associated factor with high adherence (x^2 = 24.154, p<0.001, AOR = 3.15). The women who had routine checkups were three times more adherent. Only 30.0% of the participants achieved this milestones for ANC; and 62.7% lived more than 5km distance from the health center. The disconnect in care due to the distance causes reduction of counselling and replenishment of stocks. This is compounded by the slow and fragile flow of the public sector supply chain with 65.0% of respondents reporting chronic stockouts, which meant that they had to either purchase expensive commercial alternate supplies or do without treatment entirely, in keeping with the alert raised by Nisar et al. [19].

Physical side effects also are very detrimental to adherence (x^2 = 7.912 and p = 0.005). Nausea, constipation or a metallic taste was cited by 38.7% of women as the leading barrier which was supported fully by Mughal et al. [22] and Nisar et al. [19] from their studies, and a clinical fact linked with these side effects being mentioned. Mothers are inclined to perceive them as evidence of physical harm and discontinue use of the medication without clinical guidance and counseling. In addition to the physical complaints were behavioural forgetfulness complaints – cited by 28.0% of women. However, there was a more contemporary and inexpensive answer: women who received health remindaries via cell phone/mobile devices had much more likelihood of compliance (AOR = 1.56, p = 0.034), reflecting the issues of forgetfulness mentioned by Nisar et al. [19]. This principle can be easily implemented through automated SMSes or Voice messages.

Such suboptimal adherence has significant public health implications. Poor nutrition status, infection with diseases and low literacy directly impact high anemia rates, increasing the likelihood of POH, LBW and maternal mortality, as highlighted in Milman et al. [25] and Lover et al. [24]. Furthermore, Hambide et al. [23] highlight the "Women First" randomized controlled trial, which shows that supplemental nutrition just before and in early pregnancy has a significant impact on stunting and infant growth. In Layyah, however, there are many women who postpone care until the second (41.3%) or third (39.4%) trimester.

Finally, a paradigm shift is needed within public health interventions from mere pill distribution. In areas such as Layyah, enhancing local health knowledge and literacy, challenging cultural beliefs, creating financial and geographic accessibility, and involving families in integrated, community-based health solutions are essential to tackle the issues of maternal anemia and neonatal stunting.

5. CONCLUSION

The study highlights a significant public health problem in District Layyah as optimal adherence

to iron and calcium pills is observed in only 31.3% of pregnant women, thus compromising public health gains in the region for maternal anemia treatment. Books, education, regular attendance to antenatal care (ANC) are extremely important to improve adherence, but chronic public facility stockout and gastrointestinal side effects are significant limitation. Ultimately results show that the passive distribution approaches are ineffective and a proactive supply chain management, family-based counselling, automated communication reminders and grass roots community outreach is essential for sustainable maternal-fetal health and timely antenatal supporting services.

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