

Spring 2016

# Hypertensive Disorders of Pregnancy in Rural Maharashtra: a Preventative Approach to Risk Factor Reduction through Lifestyle Interventions

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## Recommended Citation

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# **Hypertensive Disorders of Pregnancy in Rural Maharashtra: a Preventative Approach to Risk Factor Reduction through Lifestyle Interventions**

Jess Wiken

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India: Public Health, Policy Advocacy, and Community  
Spring 2016

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## **Acknowledgments.**

In my studies in India I have had the privilege of working with and learning from multiple figures I have considered role models throughout this semester. To them I am incredibly grateful for their guidance and insight.

To the staff from SIT:

Azim Ji, thanks for your good sense of humor and guidance on the importance of personal and emotional connections and realizations made in field visits and studies in deepening the value and relevance of my work.

Abid Ji, thanks you for tolerating my endless questions and hypotheticals and incorporating humor and realism along the way.

Goutam Ji, thanks for being an incredible Hindi teacher, I have never had so much fun learning a language and so quickly. Also thanks for handling all my logistical affairs with such enthusiasm.

Bhavana Ji, thanks for your comfort and openness in all realms of life, I admire your utmost patience and kindness.

Archana Ji, thanks for your wit, humor, and although I never completely committed to the fashion, the fashion advice.

To the staff from CRHP:

Thank you for the food, accommodations, and Wi-Fi access. Also thank you for the fun and the wedding celebrations and immersing me in the culture of Jamkhed.

Ravi, thanks for your hospitality, humor, and influence of the value and impact the individual and collective drive to make a difference can have on a community.

Dr. Shobha, thanks for your incredible guidance on how to approach maternal studies and sharing your endless knowledge with me about maternal health and the lives of women and their greater communities in Jamkhed.

Jayesh, thanks for your amazing translation skills, enthusiasm, and commitment to the success of my study.

Surekha, thanks for offering me your translation skills and providing insight from your work with girls and women through social work.

## **Abstract.**

The primary purpose of this study is to assess the contribution and correlation between lifestyle behaviors and modifiable risk factors (MRF) established in adolescence and during pregnancy with development of hypertensive disorders of pregnancy (HDP) exclusive to preeclampsia (PE), eclampsia, and pregnancy induced hypertension (PIH). MRF include but are not exclusive to diet and nutrition, physical activity, and Mishri use. Associations of HDP with increased premature cardiovascular risk in the affected woman and child indicate the importance of healthy lifestyle modifications that promote cardiovascular health and longevity and reduction of risk factors through prevention. While cardiac conditions are primarily associated with patients over the age of 40, early prevention is key for establishing healthy behaviors. Subsequently, this study analyzed health behaviors and greater environmental factors in three stages of the woman's life: adolescence, pregnancy, and adulthood.

To follow, the secondary purpose seeks to analyze the impact and efficacy of lifestyle interventions and modifications made to prevent modifiable risk factors these three stages. Attention is focused on what factors influence or fail to influence women's decisions to modify their lifestyles following the complication. For women living in villages and slums in rural Maharashtra, greater cultural, religious, political, and socioeconomic factors shape the realities of their lifestyle decisions and education. Such factors include health education interventions and counseling, socioeconomic development, and the degree of relevant cultural application of these interventions. Primary actors facilitating these interventions include health and social workers and educators from various political and non-political sectors. Village health workers (VHWs) among other outreach agencies of the Comprehensive Rural Health Project (CRHP) in Jamkhed, Maharashtra have helped extend educational opportunities and health access for women seeking to understand health decisions and prevention throughout every stage of life. Interviews and

conversations with women with histories of complicated pregnancies, VHWs, social workers, and physicians helped contextualize prevalence and understanding of risk and prevention, prenatal and antenatal care, and the lifestyle behaviors of women with these histories. The interviews illustrated both the scientific and cultural complexity of risk factor assessment of HDP especially in the context of prevention through lifestyle MRF reduction but demonstrated numerous opportunities and platforms for building healthy lifestyle interventions in each of the three life stages included in this study.

## **Glossary.**

### *Program Terms*

CRHP - Comprehensive Rural Health Project  
AGP - Adolescent Girls Program  
ABP - Adolescent Boys Program  
VHW - Village Health Worker  
PV – Project Village

### *Colloquial terms*

Mishri – form of smokeless tobacco containing teeth cleaning powder commonly used in South India  
Shistari - Marathi term for nausea and vomiting

### *Maternal Complication Terms*

Mo - Mother  
ND - Not determined  
D - Deceased  
AB - Aborted  
MAC - Maternal age of complication  
TMP - Total maternal parity  
CP - complication parity  
M - Male  
F - Female  
T - Twins  
U - Unknown  
FE - Formal education  
HE - Health education  
V/M<2x Vegetarian or meat less than two times per week

### *Non-communicable Disease terms*

NCD - Non-communicable disease  
CVD - cardiovascular disease  
HTN - hypertension  
DM – diabetes  
MRF – modifiable risk factors, usually pertinent to lifestyle habits and behaviors

### *Clinical terminology*

HHDP - History of Hypertensive Disorder of Pregnancy  
HDP - Hypertensive Disorder of Pregnancy  
PE - Preeclampsia  
PIH - Pregnancy induced hypertension  
GH - Gestational Hypertension

HELLP syndrome - hemolysis, elevated liver enzymes, and low platelet count  
Hgb - Hemoglobin in mm Hg < 11 considered Anemia

Placental abruption - complication in pregnancy in which the placental lining separates from the uterus prior to delivery

Immunosuppression - compromise or reduction of the efficacy of the immune system

Uterine damage - damage to the uterus

Maternal cardiovascular risk - development of risk factors for cardiovascular disease in pregnancy including hypertensive disorders of pregnancy

Oliguria – Infrequent urination

Primigravida - a woman pregnant for the first time

Nulliparity - no history of parity

Multiparity - multiple histories of parity

Anemia - insufficient amount of red blood cells due to iron deficiency or other condition. Per Indian government standards a woman with a hemoglobin < 11 g/L is anemic. Symptoms include: fatigue, shortness of breath, tachycardia, dizziness, lightheadedness, or pallor

B12 deficiency - nutrient deficiency in B12, often secondary to anemia and vice versa

Protein deficiency - dietary protein deficit

Malnutrition - nutrient deficiency

PEM – Protein energy malnutrition, deficiency in protein and caloric intake

Infant mortality rate - compares the number of deaths of infants under one year old in a given year per 1,000 births in the same year. This rate is often used as an indicator of health in a country.

Framingham Risk Score – gender-specific algorithm used to estimate the 10-year cardiovascular risk of an individual generated from information on sex, age, total cholesterol, high-density lipoprotein cholesterol, SBP, DM, treatment for HTN, and smoking status completed 3 – 8 years after pregnancy

## **Introduction.**

### *Overview*

The field of Maternal Health has dominated global ‘Women’s Health’ campaigns and initiatives in an effort to improve health indicators including the infant mortality rate (IMR), maternal mortality rate (MMR), and the lives of women everywhere. The global ubiquity of these maternal-specific efforts have improved health indicators for women across the globe through the agencies of both international organizations such as the UN and UNICEF in addition to nation-specific efforts including the National Rural Health Mission (NRHM) and Reproductive and Child Health (RCH) programmes in India. With the upside of overall global improvement in maternal and child health and communicable diseases, in recent years greater attention has been called to the surge of non-communicable diseases (NCDs). In India, NCD prevalence has hugely increased due to various factors of globalization and urbanization including changes in diet and activity, increased stress, and tobacco use. As the leading cause of NCD mortality in India, CVD is of particular concern. Additionally, Indians specifically have demonstrated a predisposition to an increased cardiac risk factor of 3 to 5 fold compared to other ethnic groups (Gupta et al. 2006). While the debate remains whether the true magnitude of NCD prevalence was long underrepresented due to the popularity of other campaigns, regardless, with the gains in maternal and child outcomes through ‘Women’s Health’ campaigns including the UN’s MDG 5 to improve maternal and child health and India’s RCH Programme, women are generally living longer with improved quality and diversity of life and with better access health. As India continues to develop economically, politically, and socially, women will indubitably live longer with more autonomy over their health decisions and choices. The improvements in longevity, quality and diversity, and accessibility in the face of social and economic development

will expectedly alter women's lifestyle decisions and tend to the advent of NCDs, especially in the absence of preventative health outside of the maternal context. However, this development is disproportionate and benefits mostly female populations in high-caste, wealthy, urban populations and disadvantages women in poor rural populations. Marginalized women will disproportionately experience the consequences of social and economic development with little benefit. Their lifestyle choices are especially complicated by poor socioeconomic development and cultural barriers, making attention to NCDs in the female populations in lower middle income or less developed countries especially problematic and difficult to implement. However, because of the ubiquitous focus on maternal health in India in both urban and rural populations, as advanced through services like the ASHA and ANM, intersecting the two could call attention to the importance and uniqueness of NCDs in women and make NCDs more ubiquitous in women's health campaigns. Consequently, a reconfiguration of the relationship between maternal health and NCDs is required for improved delivery of preventative medicine. This transition should integrate the culmination of previous efforts and advances in women's health and NCDs.

This study hopes to draw associations between early youth interventions and empowerment and long-term behavioral and social change and habits focusing on cardiovascular health longevity in female populations. Cardiovascular health promotion and cardiac risk factor counseling, prevention, and treatment is often delayed into middle and old age and biased toward male populations in research and healthcare administration (Agency for Healthcare Research and Quality 2003; Herrick 2012). This demographic bias problematizes cardiovascular health for women in three ways: 1) limiting appropriate interventions for diagnosis and treatment of cardiovascular complications unique to female populations, 2) ignoring greater societal factors limiting her healthy lifestyle decisions and heart health promotion, and 3) compromising

opportunity for preventive early lifestyle interventions. This study seeks to reinforce the benefits of gender-specific cardiovascular health promotion by first calling attention to the gender discrepancies in cardiac health and subsequently emphasizing the importance of early preventative lifestyle interventions in adolescence and pregnancy. Maternal cardiovascular complications' association with the affected woman and her fetus's increased risk of early development of cardiac-related conditions illustrates one of numerous gender-specific discrepancies in CVD. As explored in this study, hypertensive disorders of pregnancy increase the risk for development of CVD later in life for the woman and the child (Ray et al. 2005; Herrick 2012; Palinski 2014). Consequently, framing CVD and CVD factors in this context partially bridges the gaps in women's health and contributes gender-specificity to CVD by interlinking maternal and child health and cardiovascular health. Preventive lifestyle habits including adequate nutrition, healthy eating, stress-management, and exercise established early in life are expected to build longer-lasting behavioral, social, and cultural change. Early-establishment of healthy lifestyle habits can act as a catalyst for a continuation of these habits later in life and ultimately, decreased cardiac risk generationally. By assessing lifestyles of women from adolescence, through pregnancy, and into the present, this study hopes to reinforce that cardiovascular risk factors begin early in life and are especially important in maternal health. As a result, greater emphasis needs to be placed on healthy lifestyle education and interventions starting in adolescence rather than in middle to late age, especially in reducing MRFs. HDP, as in the case of PE, PIH, and eclampsia in this study, increase the risk of early development of cardiovascular disease later in life. Consequently, early interventions act as a promising preventative mechanism against cardiac risk factors in women. This study approaches cardiovascular health in a female-specific setting through the case study of HDP in hopes to

augment three ideas: 1) reinforcing the importance of maternal cardiovascular risk reduction, 2) emphasizing longevity in women's health and 3) augmenting the importance of gender-specific approaches in assessing cardiovascular risk factors and prevention and treatment of these risks.

*Background.*

### *Maternal Cardiovascular Risk and Hypertensive Disorders of Pregnancy*

Hypertensive disorders of pregnancy (HDP) including preeclampsia (PE), eclampsia, and pregnancy-induced-hypertension (PIH) or gestational hypertension (GH) act as abnormal responses to cardiovascular and metabolic stressors in pregnancy and indicate cardiovascular risk later in life for the mother and her offspring (Ray et al. 2005; Herrick 2012; Palinski 2014). Consequently, some professionals have deemed pregnancy as a “vascular stress test”, highlighting pregnancy's ability to predict a woman's early development of cardiovascular disease (CVD) and related conditions contributing to her morbidity and mortality. According to a study assessing the impact of complications in pregnancy on women's cardiovascular risk later in life... “...adverse pregnancy outcomes are seen to increase odds of women falling in categories  $\geq 10\%$  higher risk for future CVD event (through Framingham score) by nearly three times” (Bhasin and Kapoor 2014). Women hold the potential to transmit an increased non-genetic risk of cardiovascular disease to their fetus in utero, known as the fetal origins hypothesis (Drake and Walker 2004). Adverse environments in utero, as exemplified by manifestations of HDP, are indicated to pose risks to the infant later in life, including increased susceptibility to cardiovascular disease (Fraser et al. 2012). The pathogenic impact of HDP on reduced and excessive growth in infants and subsequent increased premature cardiac risk varies by complication and severity but indicates a multiparty impact of maternal cardiovascular complications on both the mother and infant (Smith et al. 2013; Palinski 2014). Considering maternal cardiac complications endanger a healthy in-utero environment, continuation of this

trend poses a significant potential threat to future generational cardiac health. The Indian genetic predisposition to CVD further increases generational risk (Gupta 2006). Further, poor adolescent girls' predispositions to anemia, preterm delivery, and malnutrition in pregnancy subsequently predisposes her to increased risk of preeclampsia and a secondary risk of cardiovascular disease in her and her offspring (Phuphong et al. 2007; Palinski 2014). Framing CVD and CVD factors in this context partially bridges the gap in women's cardiovascular health by interlinking maternal and child health and cardiovascular health.

Additionally, the discovered correlation between urbanization lifestyle changes and increased cardiovascular risk increases this already demonstrated risk (Cruikshank et al. 2001). As India continues to develop economically, politically, and socially, transitioning to a westernized model of a high--fat high--sugar diet, high levels of stress, and low levels of exercise poses exponentially elevated cardiovascular risk (Yusuf et al. 2001). Further research is needed to assess lifestyle choices and behaviors in rural communities and whether the impact of urbanization affects the Indian rural Geographic.

Studying the efficacy of cardiac health promotion programs for the purpose of improving female health, promoting healthy habits and longevity, and preventing transmission of higher cardiac risk factors in utero in the case of pregnancy necessitates adolescent women as the applicatory subjects for this study. Cardiac health in middle--aged women is also critical, but given that the median age of first birth in India is 19.8, most women who will bear children in India are suspected to have already born children at this age, indicating this stage's incompatibility with one of the preventative focuses of this study: targeting prevention of her cardiac risk during pregnancy and transmission of cardiac risk factors in utero (NFHS-3 2005). Prevention and management of women's cardiac risk factors in pregnancy requires educational

empowerment and interventions through adequate prenatal care. Prenatal care should promote healthy diet and activity, micronutrient counseling and supplementation, regular monitoring of signs and symptoms, and reinforcement of the continuation of these habits and ensured access to quality prenatal care and obstetric interventions optimized for prevention and management of HDP.

### *Hypertensive Disorders of Pregnancy Diagnosis and Management*

Hypertensive Disorders of Pregnancy (HDP) affect approximately 10% of pregnancies globally. HDP are subcategorized into four conditions: 1) preeclampsia, 2) eclampsia, 3) pregnancy-induced-hypertension (PIH) or gestational hypertension (GH), and 4) chronic hypertension (National High Blood Pressure Education Program Working Group 2010). Preeclampsia is one of the leading global causes maternal and perinatal morbidity and mortality and correlates to increased risk of early development of CVD later in life for both the woman and the child, leading to its original selection as the singular interest of this study. However, the only partially known etiological nature and the complexity, causal relationship, and overlap of diagnosis and differentiation in severity among the hypertensive disorders of pregnancy, modified the study interest to include PE, eclampsia, and PIH (WHO 2011). Chronic hypertension in pregnancy was not included in this study's analysis due to a lack of cases.

The significant impact of HDP on maternal mortality has necessitated their inclusion in the aforementioned Government of India's Guidelines for Pregnancy Care. The Government of India Ministry of Health and Welfare in conjunction with the Armed Forces Medical College and the World Health Organization (WHO) developed standard treatment guidelines (STGs) for management and costing for medical conditions including pregnancy care. STGs

contextualization must be included for relevancy and analysis of the contents of this study.

According to Madhya Pradesh's Ministry of Public Health and Welfare STG guidelines for 2014,

“...Standard Treatment Guidelines ensure consistency, treatment efficacy for patients The Guidelines provide an expert consensus, quality of care standard, basis for monitoring for service providers and makes demand more predictable, allows pre-packs for supply managers...The guidelines enable consistent and predictable treatment from all level of service providers and at all locations within the healthcare system” (Madhya Pradesh Ministry of Public Health and Welfare 2014).

A similar approach to STGs can be predicted in the context of the Maharashtra state setting given STGs were designed in a national and not a state context. While degree of implementation likely varies with dissimilarities in healthcare policies and affairs from state to state, the STGs were developed by the Indian government and not by a specific state for a specific state. Subsequently, this national design expectedly ensures STGs' compatibility with implementation in any of the Indian states' healthcare systems.

The Government of India initiated implementation of STGs of pregnancy care (STGPC) as part of an effort to reduce its maternal mortality to 100 per 100,000 births among the progress of other lower middle-income nations such as Sri Lanka and Thailand (Government of India Ministry of Health Division 2005). Interventions for reduction of maternal mortality have been integrated into India's Reproductive and Child Health (RCH) Programme through strategies and interventions. Interventions will continue accelerate in implementation in an aim to reduce maternal mortality and improve India's health indicators. The STGPC serve as methodological guidelines for these strategies and interventions through extensive delineation of standards of prenatal and antenatal care, common signs and symptoms of complications in pregnancy, and appropriate diagnosis, treatment, and care corresponding to these conditions encountered in pregnancy (Government of India Ministry of Health Division 2005).

The Government of India's *Guidelines for Pregnancy Care and Management of Common Obstetric Complications* has well established protocol for detection, diagnosis, and management of HDP and related conditions and risk factors (Table 1, 2).

**Table 1.** Differential diagnoses of hypertensive disorders of pregnancy (STGPC 2005).

Diagnosis	Blood Pressure	Edema	Proteinuria	Seizures and/or Convulsions	Gestational age
Preeclampsia (mild)	- >140/90 mmHg - systolic increase by 30 mmHg from baseline -diastolic increase by 15 mmHg from baseline x2 6 hours apart	Not always Present	PC $\geq$ 0.3 g/L x2 6 hours apart  $\leq$ 2+	Absent	>20 weeks
Preeclampsia (severe)	- >160/110 mmHg -diastolic increase by 20 mmHg from baseline x2 6 hours apart	Present	PC $\geq$ 0.3 g/L x2 6 hours apart  $\geq$ 3+	Not present	>20 weeks
Eclampsia	Acute >140/90 mm Hg	Present	$\geq$ 2+	Present	>20 weeks
Eclampsia (Imminent)	Acute >160/110 mmHg + 2 manifestations - headache - visual disturbance -UAP - oliguria - hyperreflexia OR - edema	Present	$\geq$ 3+	Present	>20 weeks
PIH or GH	>140/90 mm Hg x2 4 hours apart	Not always present	Absent	Absent	>20 weeks

Further, the STGs for HDP identify high-risk groups and factors characteristic of increased risk of development and exacerbated severity or mortality by HDP. Prenatal care guidelines are well established for management of each of the three HDP diagnoses included in this study in addition to appropriate labor and delivery guidelines (Table 1, 2). Prenatal guidelines rely primarily on regular monitoring for signs and symptoms of HDP manifestations with subsequent

detailed protocol on interventions required for management and prevention of the escalation or continuation of the condition (Government of India Ministry of Health Division 2005). In case of unmanaged HDP, the STGPC outlines action required for the lowest-risk delivery and subsequent immediate postpartum care for the health of the woman and child. Additionally, acute ill effects of improperly managed HDP on the mother and fetus in the perinatal period are outlined. Standards for appropriate clinical interventions for management of HDP have been outlined in meticulous detail (Government of India Ministry of Health Division 2005).

**Table 2.** Characteristics and treatment for hypertensive disorders of pregnancy (STGPC 2005)

Diagnosis	Other Manifestations (depending on severity)	Cause	Risk factors	Treatment
Preeclampsia	headache, shistari, upper abdominal pain, changes in vision, sudden weight gain, oliguria, diminished fetal movement  Complications: eclampsia, HELLP syndrome, placental abruption, CVD, lack of blood flow to placenta, HTN, liver damage, poor fetal growth	Unknown  Theories: blood vessel damage, immunosuppression, certain genes, utero damage	primigravida (age >35, age <20), pregnancy intervals <2 years or >10 years apart, personal or family history of DM, kidney disease, HTN, PE, eclampsia	Bed rest, monitor BP, visit doctor, anti-HTN if SBP>110 mmHg  Delivery (early induction 32 - 36 weeks)  Referral to PHC or FRU
Eclampsia	Severe headache, shistari, upper abdominal pain, changes in vision, sudden weight gain, oliguria  Complications: HELLP syndrome, placental abruption, CVD, lack of blood flow to placenta, HTN, liver damage, poor fetal growth	Unknown  Theories: blood vessel damage, immunosuppression, certain genes, utero damage	Chronic HTN, headaches, obesity, Twins, primigravida (age >35, age <20), multiparity, personal or family history of DM, kidney disease, HTN, PE, eclampsia  +PE risk factors	Rest, anti-Convulsants, fluid management  Delivery (early induction 32 - 36 weeks)  Referral to PHC or FRU
PIH or GH	Complications: Post-partum HTN, PE, eclampsia, HTN	Unknown  Theories: blood vessel	History of HTN, DM, Twins, Primigravida,	Rest, monitor BP Early induction if necessary

		damage, immunosuppression, certain genes, utero damage	Multiparity	
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The STGPC has well-established protocol for detection of risk factors, signs and symptoms, diagnosis, and clinical management of HDP but requires expansion of its preventative approach. The STGPC identify appropriate risk factors contributing to HDP risk but fail to include specific methods and counseling agencies that reduce severity and incidence of risk factors, coexisting conditions, and unhealthy behaviors in pregnancy.

*Micronutrient deficiencies and caloric deficits in Rural Maharashtra, correlation to HDP*

The STGPC stress the importance of a energy and nutrition-sufficient diet rich in protein, calcium, and iron in pregnancy and list protocol and standards for physicians and health-workers on how to achieve adequate nutrition through counseling and supplementation (Government of India Ministry of Health Division 2005). However, risk factor counseling and prevention through reinforcement of healthy lifestyle habits has a minimal presence in the context of HDP management within the STGs of pregnancy compared to diagnosis treatment of these conditions (STGs 2012). Energy and nutrition deficiencies in pregnancy have been correlated to an increased risk of complications in pregnancy linked to development of HDP, however, malnutrition and anemia were not listed in the STGPC HDP section, indicating gaps in information and linkages among coexisting conditions (Government of India Ministry of Health Division 2005). Conditions of anemia, protein and B12 deficiency, and calcium deficiency contribute to this increased risk (Agrawal et al. 2015; Phuphong et al. 2007; Palinski 2014; WHO 2012). This is of particular concern given the significant prevalence of each of the three nutrient deficiency conditions in Rural Maharashtrian women throughout adolescence, pregnancy, and adulthood. Additionally, dietary deficits and micronutrient deficiencies are of acute interest

because they represent modifiable risk factors for HDP. The modification allows ample opportunity for preventative intervention (Table 3, Table 4; NNMB 2012).

**Table 3.** Daily nutrition requirements and recommended daily dietary requirements for Indian women in adolescence, pregnancy and adulthood.<sup>1</sup>

Development Stage	Total protein (g/dl)	Total Energy Requirements (kcal)	Iron (mg) and Folic Acid ( $\mu$ g) requirements	B12 requirements ( $\mu$ g)	Calcium requirements (mg)
Adolescence	~ 1.15 g per body weight kg	~2300 Ranging from 1900 - 2900 depending on activity level	~1.30 mg S 26 - 27 mg DI 150 - 200 $\mu$ g	0.2 - 1.0	800 - 1000
Pregnancy	1 g per body weight kg + 0.3 g per body weight kg	Adult + 300	2.80 mg S 35 mg DI 500 $\mu$ g	1.2	1200
Adult	1 g per body weight kg	1900 - 2900 depending on activity	1.65 mg S 21 mg DI 200 $\mu$ g	1.0	600 - 800

<sup>1</sup>All calculations for daily dietary requirements for moderately sedentary Indian woman with low protein intake in lower-middle-income regions (National Institute of Nutrition 2009).

**Table 4.** Average daily nutrient and dietary intakes among select groups of women in Maharashtra and proportion of group meeting >70% threshold of RDA (NNMB 2012).

Development Stage	Total protein intake (g/dl)	Total Energy intake (kcal)	Iron (mg) and Folic Acid ( $\mu$ g) intake	B12 intake ( $\mu$ g)	Calcium intake (mg)
Adolescence I. 13 - 15 n = 148 II. 16 - 17	I. 32.9 + 16.4 35.8% II. 35.9 + 18.2 40.9%	I. 1274 + 551 22.3% II. 1301 + 575 28.7%	I. 8.8 + 7.6 mg DI 89.2 + 56.4 $\mu$ g 10.8%;17.6% II. 10.5 + 8.4 18.3%;23.5%	NA	I. 170 + 131 6.8% II. 180 + 177 11.3%
I. Pregnant Sedentary	I. 36.2+11.0 2.9%	I. 1267+335 14.7%	I. 10.2+4.3 81.7+44.5 $\mu$ g 0.0% (both)	NA	I. 116+165 0.0%
I. Adult Sedentary II. Adult Moderate	I. 38.4 + 16.9 49.8% II. 41.8 +17.1 26.3%	I. 1390 + 540 53.9% II. 1537 + 524 48.4%	I. 11.5+75 g 101.6+54.9 $\mu$ g 12.6%; 26.6% II. 13.3+9.0 117.1+67.4 $\mu$ g	NA	I. 227 + 203 21% II. 223 + 213 18.9%

			20.4%; 36.2%		
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All calculations for average dietary intake for Indian woman in Maharashtra with low protein intake in rural populations. Listed values mean + SD. %RDA >70 listed as % value.

Broken down, the majority of women in all of the groups did not meet the RDA for daily micronutrient and energy requirements. The associations between micronutrient deficiencies and caloric and protein deficits and poor maternal and fetal development necessitate study of these dietary deficiencies in the context of the woman’s behavior and choices during pregnancy, her complications and conditions of pregnancy, and greater socioeconomic and cultural environmental influences (Agrawal et al. 2015). While dietary diversity and nutritional deficiencies are modifiable risk factors, as indicated by rural Maharashtrian women’s inability to meet the RDA, health risk behavior, access to resources, and access to preventative care is largely predicated on the women’s greater socioeconomic and cultural environment. Consequently, this study emphasizes assessment of health risk reduction through lifestyle interventions in rural marginalized women in Maharashtra with limited socioeconomic resources.

*Adolescence, a critical development stage for prevention of HDP and cardiovascular risk*

Adolescence is a critical development window for biological and social development. Health education programs and interventions targeting adolescent girls hold potential to promote social development in girls and their greater community through behavior change and long-term healthy lifestyle habits (Ballard and Syme 2016). Programs oriented at reducing this cardiovascular risk indirectly and directly through chronic disease education, healthy eating promotion, anemia prevention, high-risk pregnancy education, and physical activity promotion have the potential to positively impact long-term cardiovascular health. Concurrently, socioeconomic development and opportunity must be promoted and established for ample health risk reduction from an early age. As aforementioned, developmentally, adolescents carry a

remarkable potential for evoking long-term social and behavioral change making this age-group key for interventions in lifestyle education and socioeconomic empowerment. The adolescent period has more promise in evoking long-term behavioral and social change geared at reduction of HDP and subsequent generational cardiac risk through early promotion of healthy living and cultural and socioeconomic development.

*CRHP VHW Model, opportunities for lifestyle and socioeconomic interventions*

CRHP has been training VHWs, women designated by their communities as “...key agents for a comprehensive approach to health improvement...”, in women and child’s health and nutrition and maternal health since the 1970s in its project villages in the greater Jamkhed area. VHWs are actively involved in their community’s AGP, Women’s Group, and Women’s Self-Group in conjunction with the CRHP Mobile Health Team. VHWs help catalyze change in the project villages by helping identify and combat socioeconomic and cultural barriers for in their communities (CRHP 2012). A more exhaustive description of the roles of the VHW and her training in prenatal care related to HDP is further delineated in the methods section of this study.

*CRHP AGP, Women’s Group, and Women’s Self-Help Group*

This study is interested in the role of education and empowerment groups in catalyzing socioeconomic and cultural development in addition to healthy lifestyle behaviors in women from an early age. CRHP’s AGP, Women’s Group, and Women’s Self-Help Group help facilitate interventions and promotion of this change.

The AGP curriculum was shaped both by issues in the girls’ home communities and the issues and interests articulated by the girls during sessions. Girls are selected from project villages and attend the AGP in weekly sessions over a 6-month period. Curriculum includes education and empowerment agencies pertinent to this study including education high-risk

pregnancies, diet and nutrition, maternal and child health, exercise, and NCDs. The AGP promotes female youth empowerment through martial arts and self-defense modules in addition to lessons about gender equity and economic empowerment. Additionally, the social health worker of CRHP's mobile health team educates the girl's family members about the importance of these interventions and her development (Interview 16 2016). The women's and women's self help group operate under a similar premise of women's empowerment, health, and socioeconomic development. Because of the nature of this study's focus on prevention in adolescence, logistics of the latter two programs were not surveyed to the degree of the AGP in this study.

#### *Other Risk Factors*

Additional modifiable risk factors evaluated in this study include use of the smokeless tobacco product Mishri and the impact on activity and exercise on HDP risk reduction. Some evidence has suggested a beneficial impact of physical activity in the form of mild exercise during pregnancy (Sattar and Greer 2002; Jeyabalan 2013) Studies indicate a mechanistic link between the angiogenic factors of preeclampsia and obesity, suggesting that physical activity benefits fetal development by preventing reduced fetal growth associated with obesity in pregnancy (Smith et al. 2013; Palinski 2014). However, this finding's applicability to this study is limited, given its target demographic is obese sedentary populations and the demographic of this study is both largely micronutrient and calorically deficient and very physically active due to the demands of labor.

However, the concept of negative impact of reduced fetal growth on increasing cardiovascular risk in pregnancy carries some weight with Mishri use. Given low-birth weight's pathogenic associations with increased cardiovascular risk later in life, conditions or lifestyle

habits which contribute to low birth weight children pose a threat to increasing this risk (Bhasin and Kapoor 2014). A study conducted in rural Maharashtra indicated a significantly lower birth weight in users of Mishri and worse perinatal outcomes than non-users (Pratinidhi et al. 2016). The study showed a reduction or reversal of this risk in women who were formerly users who stopped prior to or in pregnancy. The earlier women stopped using Mishri, the higher the birth weight of the child (Pratinidhi et al. 2016). Mishri use represents a modifiable risk factor that can be prevented through appropriate health education interventions.

### **Study Setting.**

This study was conducted in 6 rural villages and 1 slum in the greater Jamkhed region of the Ahmednagar district in Maharashtra, India. Jamkhed, a town of approximately 35,000, is located approximately 3300 km east of Mumbai and is drought-prone and poverty-stricken. Surrounding villages are divided by caste lines and politics and women are marginalized by poor socioeconomic and cultural status, contributing to their poor literacy rate and inadequate access to resources and healthcare conducive to healthy development (The Jamkhed Model 2015). In order to combat these issues, CRHP has established healthcare and social outreach in this region since the 1970's for promotion of healthy development and human rights. The principles of the Jamkhed Model include equity, integration, and empowerment under the primary goal to,

“...build the capacity of village people to enable them to participate actively and responsibly in primary health care (PHC) activities to improve the health (physical, mental, emotional, psychological, social, spiritual, economic) of the whole community” (The Jamkhed Model 2015).

CRHP's several health interventions mobilized through VHWs, the Mobile Health Team, and others provided the platform and connections necessary to conduct this study. CRHP provided transportation and translation necessary to access project villages with established CRHP

interventions and the nearby Indira Nagar slum with and without interventions. CRHP interventions include the adolescent girl's program (AGP), adolescent boy's problem (ABP), the women's self help group, the women's group, and the farmers club. This study emphasized analysis regarding efficacy and outreach of the AGP, women's group, and women's self help group in promoting and fostering an environment conducive to healthy lifestyle decision making and behaviors in village women.

### **Purpose.**

This study seeks to study women with histories of HDP through assessment of the development of their condition and the degree of its predication on presence or absence of education and empowerment educations in adolescence, prevention and management of HDP in pregnancy, and continued counseling, education, and support systems promoting healthy living in adulthood. Healthy living is interplay between the woman's ability to make decisions and access resources fundamental for her development and the greater environment that either restricts or promotes her choice. The study hopes to expose gaps and identify shortcomings of interventions in each of the three development stages and the consequence on the health of the woman. Consequently, this study hopes to reinforce propositions for: 1) better early detection of high-risk groups and management and understanding of their risk early on in life, 2) ensured speedy access to interventions and treatment in high-risk scenarios, and 3) stronger follow-up, prevention, and management through risk factor reduction of complications secondary to HDP post-pregnancy and through adulthood.

### **Methodology.**

*Interview style and construction*

This study used a semi-structured style when conducting interviews. Interviews were conducted with the help of local translators familiar with the villages and the language, Marathi, in three components over a 2-week period. Interviews were conducted in 6 CRHP project villages and 1 slum nearby to the CRHP campus. The first component of this study consisted of 12 interviews with women with histories of complicated pregnancies and classic signs and symptoms of PE, eclampsia, and PIH including edema, headache, Shistari, and fatigue. Elevated blood pressure was implied in all complications. Additionally, one interview was conducted with a woman currently experiencing symptoms in pregnancy and one recent member of CRHP's adolescent girl's program (AGP). Special attention was designated to conducting interviews with women who were formerly students of the AGP for analysis of CRHP's health and lifestyle education efforts in adolescence. The second component included one interview with a VHW, and the third included an interview with an OB GYN practicing in villages and in the CRHP hospital. Interviewees gave full consent prior to being interviewed. All subjects of the study will remain anonymous.

### *Subject selection*

The women were selected based on the advice of CRHP coordinators and the VHWs knowledge women with select hypertensive disorders of pregnancy. The interviews required travel with a CRHP designated translator and VHW to conduct interviews with preselected women, most commonly at their residence or mother's home residence. Women were interviewed using a semi-structured style regarding their complications and lifestyle in pregnancy, current lifestyle, and lifestyle in adolescence. Women were also interviewed about their perceptions of health, environment, and accessibility to health in each of the three selected life stages. While not all of the subjects were educated about the specific medical classifications

of their complication, for relevancy and aided contextualization, questions were directed to assess both their open description of any complication in pregnancy and guided questions about incidence of indicators specific to PE, eclampsia, and PIH during their pregnancies. The VHW provided further clarification in the advent of any miscommunication regarding the complication or condition between the interviewee and interviewer. Analysis of the women's lifestyles included descriptive questions about nutrition and diet, activity and exercise, labor and work habits, home environment and duties, and family medical history. Additionally, data collection was conducted in which the women were asked a series of more direct quantitative questions about signs, symptoms, indicators, and metabolic values in pregnancy (Appendix I). Women with histories of complications and manifestations of PE, PIH, or eclampsia in pregnancy within the last 10 years were selected for interviews. All women interviewed in this study were of the age of 18 and older. Interviews were most commonly conducted in their homes or mother's home with multiple family members and friends present. The presence of mothers, mothers-in-laws, father-in-laws, and husbands expectedly introduced some bias into the interviewees' answers and ability to speak freely on certain topics.

The second aspect of this study included interviews with VHWs, a focus group was conducted prior to formal introduction of the study and one interview was conducted with a selected VHW. The VHWs have undergone extensive training in prenatal, antenatal, and maternal care, and other health conditions and an general understanding the signs and symptoms of preeclampsia, eclampsia, and pregnancy induced hypertension as facilitated by CRHP's VHW training program. The VHWs communicated understanding of the triad of preeclampsia: edema, hypertension, and proteinuria among other indications and the subsequent need for immediate referral. VHWs are equipped with blood pressure cuffs necessary to conduct regular BP checks

with women in the village. After the 4th month of a woman's gestation, the VHW registers her in her prenatal care log and begins documenting the woman's health and indicators during pregnancy including the BP. VHWs primarily rely on physical signs and any records the woman obtains from a physician during her pregnancy as they are not fully equipped with the capacity to perform laboratory testing. The primary role of the VHW is counseling the woman through promotion of a healthy pregnancy in addition to basic tests and checks including BP and presence of edema.

### *Consultation of Medical Professionals and Literature for Study Design*

Medical professionals trained in maternal health and other related health conditions were consulted regarding accuracy of this study's analysis and portrayal of the aforementioned hypertensive complications of pregnancy. Additionally, a semi-structured conversational interview with CRHP's social worker helped to contextualize greater social, economic, and political environmental factors influencing women's past and current lifestyle habits and choices in addition to preexisting and existing barriers to lifestyle interventions or modifications. Formal definitions of PIH, PE, and eclampsia were obtained from clinical standards (Government of India Ministry of Health Division, Table 2). Diagnoses and management protocol were obtained from the Government of India Maternal Health Division's *Guidelines for Pregnancy Care and Management of Common Obstetric Complications* (Government of India Ministry of Health Division 2005). Dietary and nutrition assessment and recommendations were contextualized to the demographic of this study using data from the Indian National Institute of Nutrition (National Institute of Nutrition 2009; NNMB 2012). For contextual relevancy and accuracy of this study, standards used in the content of this study were predominately from Indian sources and Indian

studies. Chronic hypertension was not included in this study's analysis because no cases presented in which the hypertension predated the women's pregnancies.

### *Colloquial Adjustment of Study and Interview Constructions*

Interview questions (Appendix I, II) were designed to ask about indicators specific to PIH, PE, and eclampsia and lifestyle behaviors related to cardiovascular health promotion including nutrition, exercise, tobacco use, and stress. Questions were oriented to assess the subject's understanding of the complication and understanding of their lifestyle choices and restrictions in the context of greater environmental factors and influences. While the foundation of this study is maternal cardiovascular health, the term 'cardiovascular' was rarely used for medical relevancy in the context of this study setting. Heart health was substituted for greater understanding and terminological context. The term 'BP' was often substituted for hypertension and 'swelling' with a gesture to the lower extremities was substituted for edema, 'high sugar' was substituted for edema. The study did not specifically ask about 'maternal cardiovascular health' and 'maternal and fetal cardiovascular risk' but conducted through the study of maternal cardiovascular manifestations of PIH, PE, eclampsia and known cardiovascular risk factors such as HTN, DM, high sodium and fat intake, sedentary lifestyles, tobacco use, and a lack of diet diversity.

Various clinical terms were simplified for colloquial relevancy in the context of this study's setting. The premise of this study, maternal cardiovascular health, was studied through analysis of the hypertensive disorders of pregnancy PIH, PE, and eclampsia. The medical signs, symptoms, and manifestations of these conditions were appropriately discussed and conditioned to the respective jargon used among the VHWs, the CRHP mobile health team, and the women in the village related to these complications. 'Heart health' was the predominant substituted term

for ‘cardiovascular health’ accompanied with descriptions of cardiac symptoms including chest pain or heaviness, difficulty breathing, and sweating for further context. ‘BP’ was often substituted for hypertension, ‘swelling’ with a gesture to the lower extremities was substituted for edema, ‘high sugar’ was substituted for diabetes, ‘hemoglobin’ was used to describe anemia, and ‘Shistari’, a Marathi term, was used for nausea and vomiting. Consequently, the study did not explicitly include the terms ‘maternal cardiovascular health’ and ‘maternal and fetal cardiovascular risk’ in order to improve contextual relevancy and aid in the subjects’ comprehension of questions asked related to the study. The study of the maternal cardiovascular manifestations of PIH, PE, eclampsia and known cardiovascular risk factors such as HTN, high sodium and fat intake, sedentary lifestyles, tobacco use, and a lack of diet diversity were all topics explored in their respective colloquial terminologies throughout the study.

## **Results & Analysis**

### *Trend Overview – Factors in HDP*

#### Gestation

- I. Multiparity
- II. Primigravida
- III. Maternal history of complications including:
  - A. HDP
  - B. Spontaneous abortions
  - C. Stillbirths
- IV. Multifetal gestation

#### Coexisting conditions

- I. Demonstrated: Anemia
- II. Hypothesized: Protein-Energy Malnutrition (PEM), Calcium Deficiency

#### Signs, Symptoms, and other Manifestations

- I. Shistari
- II. Edema
- III. Headache

#### Quality of Life Indicators

- I. Education promotes health-seeking behavior

- A. Private care first choice
- II. Autonomy over food choice and healthcare choice
- III. Physical activity inconclusive
- IV. Mishri use

#### Limitations, Risks, Complications

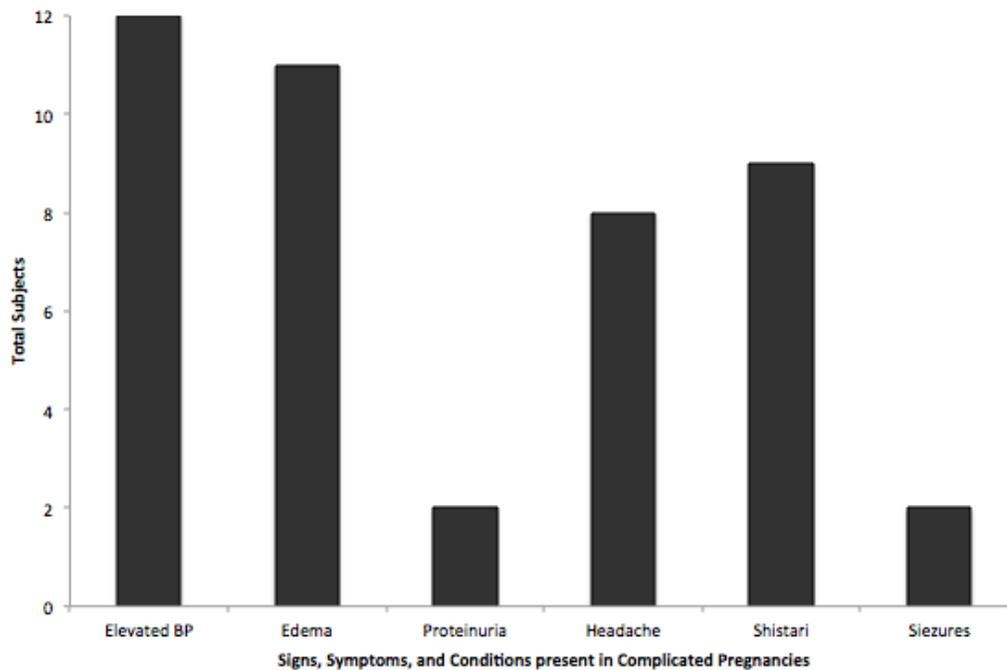
- I. Access to records and health information
- II. Referrals during delivery
- III. Lack of consolidation of prenatal care
- IV. Symptoms or conditions experienced post-pregnancy, cardiovascular manifestations

#### *Presentation of Hypertensive Disorders of Pregnancy*

The hypertensive disorders of pregnancy indicated in the findings of this study include PIH or GH, PE, and eclampsia. An OB-GYN of CRHP noted the resurgence of HDP in more recent years because,

“...over the last four years have had difficulty keeping nutrition up because people don’t have enough money and hemoglobin has been trending down, so if occurring in younger population, one of the reasons we hypothesize is preeclampsia becomes less with good nutrition, but progressively over the last four years we have had problems with nutrition and there has been an increase in hypertension, this has been an issue in the risks run. So this has been a newer problem as compared to the older time. For many years (pre)eclampsia stopped in all women we realized because of good nutrition and good prenatal care...” (Interview 15 2016).

In the interviews conducted, subjects offered descriptive narratives of their complications of pregnancy through recall and in select cases, the aid of hospital records and the knowledge of the VHW if she was involved in the woman’s pregnancy. Among the 12 interviews conducted, several conditions, signs, and symptoms periodically presented in each woman’s description of her complications during pregnancy. Elevated blood pressure and edema were among the most common conditions women experienced in their complicated pregnancies. Henceforth, headaches and Shistari appeared the most frequent symptoms and signs related to the underlying conditions secondary to the hypertensive disorders (Figure 1).



**Figure 1.** Prevalence of signs, symptoms, and conditions among 12 subjects of study with a history of a select HDP.

Guidelines delineating definitions, symptoms, causes, complications, prevention, and treatment of HDP guided the construction and facilitation of interview questions. The signs, symptoms, and conditions delineated by the women’s descriptive narratives of their complicated pregnancies in addition to the VHW’s knowledge of the women’s pregnancy were consistent with the criteria for PIH, PE, and eclampsia (Table 5, Government of India Ministry of Health Division 2005). Certain cases were complicated by the women’s lack of records or lack of knowledge of specific values related to her complication, such as exact systolic and diastolic blood pressure readings and the presence of absence of proteinuria. The women’s knowledge of exact values was contingent on the degree of communication from the doctor or provider of prenatal and antenatal care in addition to her access and procurement of maternal records (Jamkhed Field Notes 2016). Consequently, certain variables were either unknown or implied depending on her narrative of the complication and the involvement of the VHW present during

the interview. Elevated blood pressure was formally present in most studies and circuitously implied in the remaining cases based on signs, symptoms, and the memory of the VHW and woman. In most cases, exact readings of multiple BP values and the degree of elevation from the woman's baseline were lacking as previously attributed to the lack of hospital records. Much of knowledge regarding BP was gathered from the memory of the VHWs as most women were unsure whether their BP was elevated or not because it was not communicated to them. However, in the women with hospital records available, they did exhibit elevated BP from what is considered a normal baseline. Additionally, VHWs referenced elevated blood pressure in a majority of the women interviewed. The two women interviewed in the Indiranagar slum did not have a village present but presented ASHA records of elevated blood pressure in pregnancy, neither had proteinuria (Interview 11, 12 2016).

Similarly, while proteinuria was infrequently mentioned in women's descriptions of their complications, this was largely because the presence or absence of the condition was unknown. Due to the lack of consistent hospital records and values required for definitive breakdown of diagnoses of HDP consistent with medical guidelines, the women's complications were conglomerated into the former. In certain subjects, the generalized HDP diagnosis was further specified through clinical confirmation of eclampsia or preeclampsia based on hospital and ANM records and the VHWs knowledge (Jamkhed Field Notes 2016). The two subjects with known cases of eclampsia manifested and had specific knowledge and confirmation of the complications of edema, seizures, and elevated blood pressure consistent with WHO criteria and India's STGPC for eclampsia but were unable to verify proteinuria (Interview 2, 3; WHO 2016). Several subjects specifically alluded to having preeclampsia as per their recall of the doctor's diagnosis that completed the delivery at the time. Again, these PE cases did not have records to

conclusively verify the triad of proteinuria, elevated blood pressure, and edema but depended on memory and knowledge of the woman and her respective VHW, if involved in the pregnancy. Regardless, the subjects' descriptions of their symptoms and conditions in pregnancy were generally consistent with criteria for the HDP PIH, PE, and eclampsia. The degree of severity of signs, symptoms, and complications varied from a subject-to-subject basis.

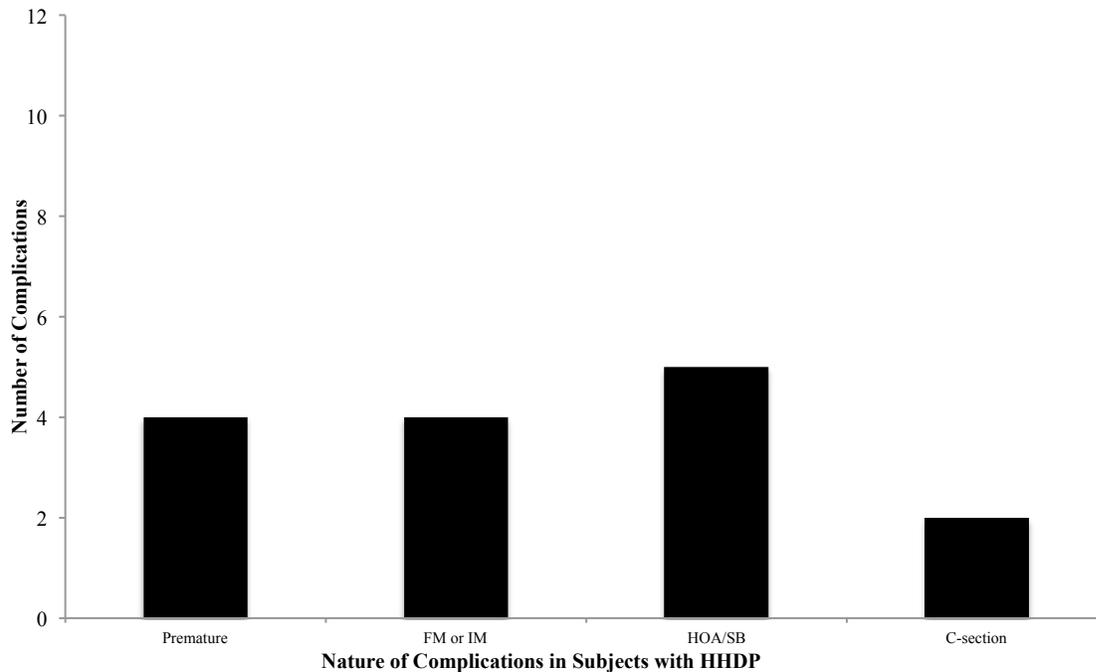
Additional symptoms present the cases including Shistari and 'deep' headache are common to HDP per the STGPC. No abnormal or unexpected symptoms were exhibited. (Table 1, 2). Case by case presence of subjects' signs, symptoms, and conditions in pregnancies are delineated in further detail below (Table 5).

#### *Gestational complications predating and secondary to Hypertensive Disorders of Pregnancy*

The average total parity (TP) of the women studied was 2.83 and the average parity of complication was 2.45. The women's ages during their complicated pregnancies ranged from 17 - 28 with a median and modal age of 24 and an average of 23.3. Several women had complications predating pregnancy: 2 women had a history of a spontaneous abortion or stillbirth in pregnancy and 1 woman had a history of 2 spontaneous abortions. The exact etiological natures of the complications were unknown but generally attributed to excessive exertion during manual labor and other environmental factors. One woman recalls "...having a miscarriage in my 3rd month because I had a long journey to take by bus on a bad road to reach my mother's house 3 hours away..." (Interview 12 2016). Contrastingly, several women developed complications secondary to their respective hypertensive disorders of pregnancy with no history of gestational complications. One woman with definitive PIH underwent a spontaneous abortion at 27 weeks in her 3rd parity as a result of maltreated and untreated symptoms, risks, and conditions of her HDP including edema, anemia, and suspected PEM. She retold her complication as

“...in 6 month I had bad swelling (edema) in my hands and went to a private clinic doctor who said it was anemia (Hgb 9.8) and gave me a 15 day prescription costing me 3500 Rs. At 7th month my (systolic) blood pressure went up to 270 even with taking the medication. I went back to doctor but (the doctor) would not agree to a cesarean section until 8.5 months because of the complication. My baby aborted in this house at about 8 months because of my high blood pressure. I just stayed at home after that and did not go back to doctor or for help elsewhere because I didn't have money or interest for help after spending so much (~55000 Rs total) without much help...” (Interview 4 2016).

This particular woman's private doctor lived 13 km away in Jamkhed, requiring her to travel during a complicated high-risk pregnancy. The two women with HDP carrying twins were prematurely induced and either lost one or both of the twins (Interview 5, 8). Complications were present in children of several women with HDP including neonatal death and disabilities. Of the 12 women with histories of hypertensive disorders of pregnancy (HHDP), 4 deliveries were premature, 4 pregnancies resulted in fetal mortality (FM) or infant mortality (IM), 5 abortions or stillbirths were detected in previous pregnancies, and 2 cesarean sections were required. Some women had multiple complicated HDP pregnancies and histories of multiple abortions or stillbirths (Figure 2, Table 5).



**Figure 2.** Complications of pregnancy and delivery in women with HHDP.

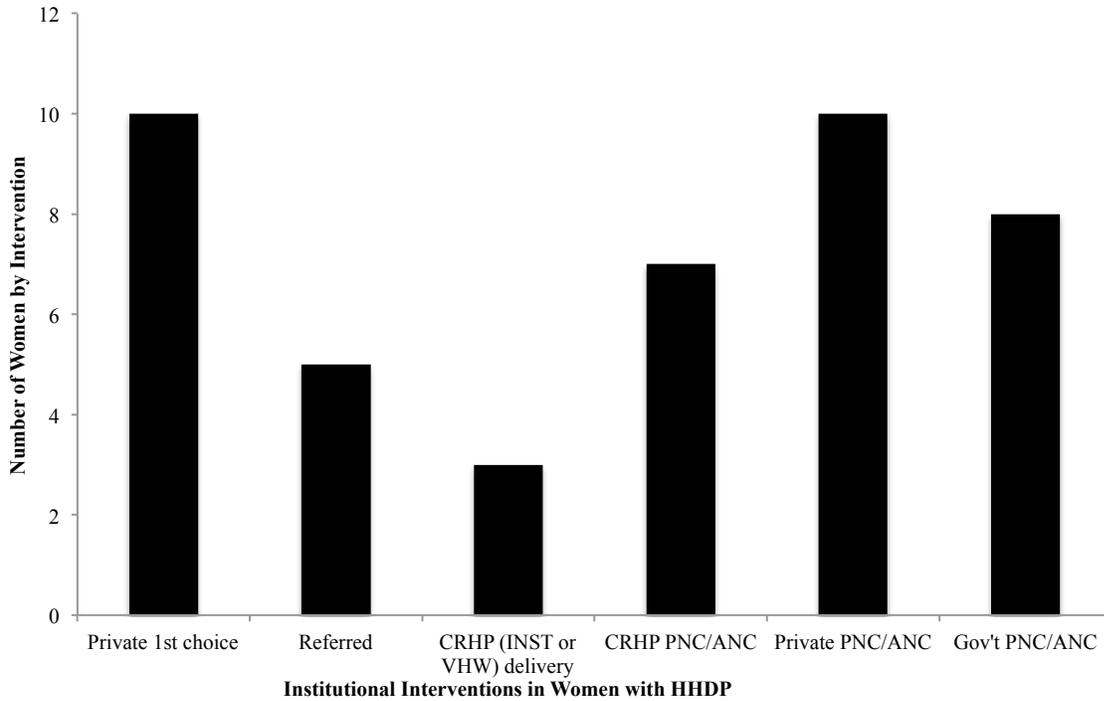
*Complications exacerbated by long-commutes, referrals, and lack of healthcare guarantees*

As evidenced in the case of the woman with the elevated BP of 270, shortcomings and failures of care in management and understanding of hypertensive disorders of pregnancy contributed to if not compromised a safe and healthy pregnancy. Several women required referral in labor to a location at least approximately 10 km away because of the complicated nature of their pregnancies, one of which

“... came to know of having complications last minute from government doctor in Jamkhed, I was referred to Ahmednagar (76 km away) because pregnancy was too complicated. My mother, father, and husband took me based on doctor’s decision because I was unconscious” (Interview 3 2016).

Of the 12 women interviewed, 5 were referred to another hospital or clinic after first attempting to deliver at their first choice of delivery location. All women with the exception of one had institutional deliveries. Referrals required transportation ranging from 10 to 80 km in distance. Shortcomings in knowledge, equipment, and facilities required to adequately manage severe HDP cases of preeclampsia and eclampsia were largely responsible for affected women's

referrals. According to the insight of one of CRHP's physicians, the Indian government is becoming stricter about who can manage and how to manage these conditions through laws and policies, leading to women's referrals to larger primary institutions. Most deliveries were conducted at private institutions with a private physician per the woman and her family's preference. Most women interviewed had long-established relationships with their private doctors and delivered in previous pregnancies with this doctor. Most commonly, their choice of physician was based on consistency, history, and trust. Their respective private doctors administered prenatal care services including folic acid, iron, tetanus toxoid injections, and maternal and fetal heartbeats. The women went for prenatal care with their private physician ranging from 2 times during the gestational period to monthly depending on the woman (Multiple Interviews 2016). Despite having a primary relationship with a private doctor and receiving the bulk of their prenatal services from this doctor, 75 percent had some sort of prenatal and/or antenatal care from government services including but not exclusive to ASHAs, Anganwadi workers, and ANM. Additionally, because all interviews, with the exception of the two women in the Indiranagar slum, were conducted with women in CRHP project villages, 58.3 percent had established a relationship and received some prenatal or antenatal care and counseling through a VHW (Figure 3).



**Figure 3.** Prenatal care and Institutional Delivery choices of 12 subjects with HHDP.

Multiple issues related to compliance and confusion in services was observed throughout the interviews. The nature of the issues was primarily related to gaps in consistent services and lack of education in prenatal counseling. One repeated issue was compliance with folic acid and iron supplementation. Nausea and vomiting is a common side effect of taking these supplements in pregnancy. Consequently, women who experienced worsened Shistari when taking the supplements would infrequently take or stop taking them due to the side effects (Multiple Interviews 2016). When women were asked about the benefits of taking these supplements in pregnancy, many knew they were related to hemoglobin levels and anemia but were not exactly sure why this was beneficial for their pregnancy. This non-compliance demonstrates a lack of education and lack of counseling in prenatal services available to these women.

*Impact and Limitations of Village Health Worker on education of high-risk pregnancies*

VHWs and the CRHP mobile health team social worker voiced the importance of educating adolescent girls and women about high-risk pregnancies and contributing factors to these high-risk pregnancies, including those specific to HDP. Girls in the AGP and girls visited by VHWs are educated about risks and consequences associated with primigravida, closely spaced and multiparous pregnancies, excess exertion in labor, and micronutrient deficiencies among multiple other high risk factors. Additionally, the AGP and VHWs incorporate education about NCDs including HTN and DM, self-empowerment, and socioeconomic development (Interview 14, 17 2016). However, the degree of education the girl receives by the VHW or AGP in her community was predicated on her age of marriage, compliance of her family, and her pursuit of the AGP or VHW in these topics. Women from poor low-caste marginalized backgrounds and those married at an earlier age had fewer opportunities for education on these subjects.

#### *CRHP VHW Prenatal and Antenatal Care Model*

The CRHP VHW prenatal and antenatal care model was assessed through a focus group with 6 VHWs and a one-on-one interview with a VHW. VHWs trained by CRHP in prenatal and antenatal care listed technical characteristics of a healthy pregnancy as: 1) growth of 11 kg over pregnancy, 2) 3 kg birth weight full-term delivery, 3) normal blood pressure 4) hemoglobin over 11, 5) No RH factor, 6) immunizations, and 7) no HIV. The VHWs also listed several factors of a healthy environment and healthy behaviors for a healthy pregnancy including regularly eating, light activity, attention to mental health and well being, taking regular rest and a phrase that was strongly reinforced, “Healthy woman gives birth to health child” for the purpose of prevention of complications of pregnancy (Interview 9, 10, 17 2016). According to several VHWs, adequate assessment and guarantee of characteristics of a healthy pregnancy requires monthly checkups

and counseling the pregnant woman in addition to the members of her home including her mother-in-law, father-in-law, and husband. Counseling should include the importance of a healthy and sufficient diet, rest, importance, misconceptions, and side-effects of supplements, medications, and vaccinations, characteristics of a high-risk pregnancy, and physical and mental development. One VHW asked about high-risk HDP risk factors and characteristics listed weakness, edema, anemia - which she visually demonstrated by acting out looking at a woman's tongue, eyes, and nails, - fatigue, pallor, deep headaches, dizziness, loss of appetite and lack of maternal weight gain, convulsions, high blood pressure, and protein in the urine. According to her, appropriate interventions for HDP manifestations range from rest and a decrease in sodium intake for mild cases to immediate referral to a hospital in severe cases. Mild cases include moderate edema with a slight rise in blood pressure and severe cases include elevated blood pressure and convulsions. Regardless, she iterated that women should see a doctor for any complication(s) experienced in pregnancy and use her recommendations for advise as a way to immediately manage conditions until she sees the doctor.

The VHW has some training to prevent, monitor, and manage HDP. The VHW has some limits to conducting tests based off portability and expense of equipment and accessibility to respective resources. This restricts her capacity to conduct more resource exhaustive tests such as a hemoglobin test. However, she can take a BP reading using a manual blood pressure cuff and can also check for edema and anemia through physical visualization and palpation exams. Additionally, older VHWs are trained to conduct an albumin urine test to assess proteinuria. However, due to the change in the healthcare system, most women undergo testing with their physician or ANM. While VHWs are aware and educated about HDP,

“...the ASHA has taken over the delivery system, so the ASHA and ANM work more on incentives and VHW had to take a step back because the system has changed. But VHW

still an encourager to go around and encourage villagers to check blood pressure and such, but the ANM visits every week. By nature, we are supposed to be ahead of the government and lead the way so they can see what things work and what doesn't work, but our role is not to replace the government" (Interview 15).

Consequently, more recent VHW trainings have adapted to this system and stopped training VHWs to conduct an albumin urine test because the women will be referred to their physician for completion of the test and instead reinforced her role as an encourager to make use of incentives are services available to her by the government ASHAs, ANMs, etc. Regardless an informational and consistency gap exists in the prenatal care system given 67% of women interviewed with unknown microalbumin levels, generally inconsistent records of BP readings, and sparse or nonexistent records on maternal weight and gestational weight gain. It can be hypothesized that while woman may have these services available through the government, there is a lack adherence and utilization of these service. The VHWs resources that she does have can be utilized where gaps exist and her education of maternal and child health should serve to educate women about risks and the need for good prenatal care.

However, as aforementioned, while most women had some sort of relationship with a VHW, most women only sought out her services 1 - 2 times during her pregnancy, mostly at the initiation of the VHW. Underutilization of the VHW may be a result of the women's choice to also seek prenatal care through the private sector and government. As a result, she may only seek help from the VHW if she feels an inadequacy of care in the former two service agencies. Additionally, consistent accessibility to a VHW is compromised by the tradition in which women travel to their mother's home for rest in the 8th month of pregnancy until her delivery. With the exception of two women, all women were interviewed in their husband's village with a VHW of that village present. Consequently, a VHW or a VHW with which a woman has an established relationship earlier on in her gestation may not necessarily be present in her mother's village.

This is equally problematic if a woman relies on services of an ASHA or ANM in her home and not also in her mother's village. Inconsistency of access and underutilization of counseling and education in these ways can compromise counseling and education for healthy pregnancy, varying by woman and her health-seeking behavior. To further reiterate the consequences of unconsolidated care, given most women interviewed received services in pregnancy from the private sector, government, and CRHP, a lack of consolidation of information among the three has demonstratively contributed to gaps in her care and compromises her good prenatal care.

Many VHWs also have knowledge on conducting deliveries, one VHW described a time when she had to perform an immediate delivery on the side of the road and trying to maintain privacy by covering the woman with a Sari while waiting for the ambulance (Interview 17 2016). Increasing government restrictions and regulations of qualifications required to give certain prenatal services, such as iron and folic acid supplements and tetanus toxoid injections, and the increasing push for institutional deliveries have redirected the VHWs role to counseling and basic management of women's health in pregnancy. She bases her counseling off her knowledge and VHW training in addition to any information and doctor recommendations gathered from the women's hospital records.

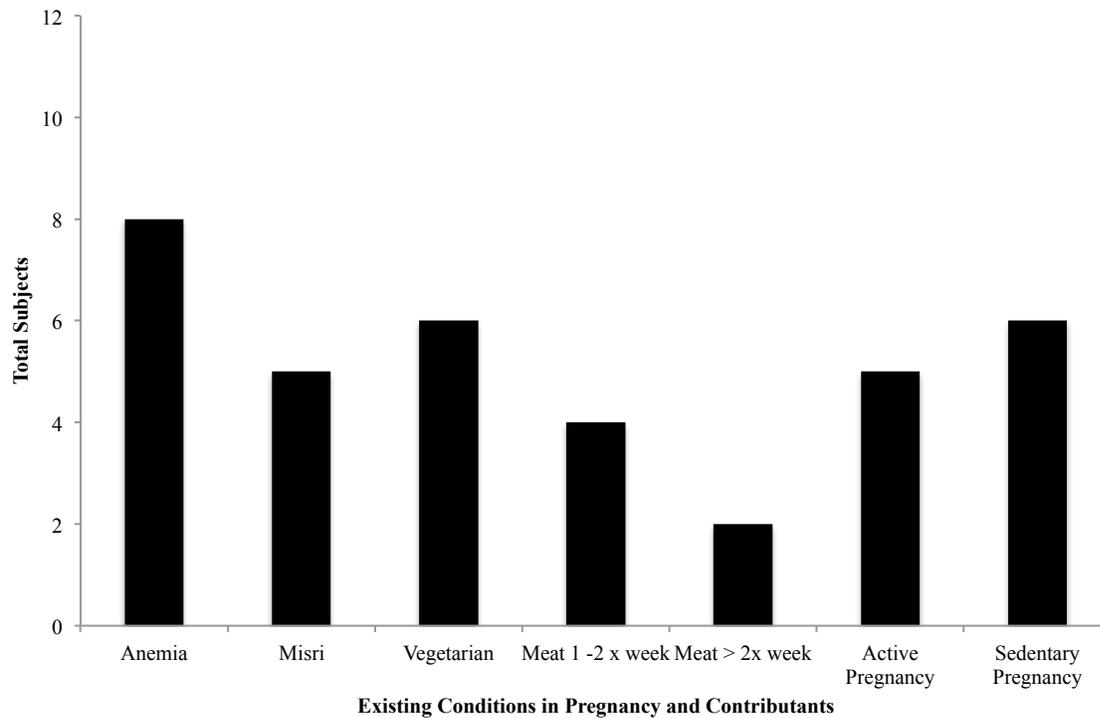
#### *Perceptions of a healthy pregnancy*

When women were asked to describe their perception of a healthy pregnancy the most common answers were: no problems as in no Shistari, headache, or edema, normal (non-cesarean) delivery, eating good food, enjoying life and no stress, and working less. Their perceptions of healthy pregnancies were largely contingent on physical happiness and physical symptoms. Comparatively, VHWs and physicians answered more technically by incorporating characteristics of good prenatal care in addition to listing physical signs and symptoms of unhealthy or healthy pregnancies (Jamkhed Field Notes 2016, Interview 17 2016). Considering

most of the women interviewed received services from three different sectors, one of CRHP's physicians pointed out the inherent difficulty in ensuring consistency in delivery of prenatal services, counseling, and education month by month when care is being distributed among three different agencies. Given the complexities of management of HDP, inconsistencies in prenatal services introduced by too many choices without shared documentation and regulation among the agencies can lead to service, education, and counseling gaps and later consequences for the woman and child. While the prenatal services provided and promoted by CRHP VHWs well thoroughly assessed, this study did permit time for assessment of services, education, and counseling provided by private doctors and government workers, consequently an accurate representation of their services is limited to the descriptions included in the women's narratives.

*Complications exacerbated by risk factors and lifestyle behaviors, impact of interventions*

Prenatal services and monitoring of the woman and child's health during pregnancy served to assess and reduce the risk of high-risk pregnancies. As aforementioned, several conditions have been linked to increasing risk for HDP in women including anemia and malnutrition and appeared as coexisting conditions in women with HDP. 83.3 percent of women were vegetarian or consumed meat or protein in the form of mutton, chicken, dried fish, or eggs less than 2 times per week. Protein intake may have been further restricted given a majority of the women consuming protein in the form of meat, dairy, fish, or eggs during their pregnancy experienced Shistari with consumption of these foods. Consequently, women frequently experienced a loss of appetite and decreased their intake of these protein sources in an attempt to manage their Shistari. The majority of the women's diets during pregnancy consisted of vegetables, pulses, and different grains (Figure 4, Table 6, 7).



**Figure 4.** Coexisting conditions and lifestyle behaviors in pregnancy of 12 women with HHDP.

While specific quantifications of daily intake of grams in protein was not calculated, based off the women’s descriptions of their diets during their pregnancy and statistics of the average intake of protein in rural Maharashtrian women in 2012, some degree of protein deficiency likely in the form of PEM is indicated in the majority of women interviewed during their maternal period (Table 4, 6, 7; Figure 4; NNMB 2012).

*Perceptions of a healthy lifestyle, adolescence, pregnancy, and adulthood*

All women were asked to describe their perception of a healthy lifestyle. Their descriptions of physical activity, diet, and Mishri use helped contextualize practice of modifiable risk factors and opportunities for interventions. The most frequent responses included eating good food, having good mental health, good physique, no disease, having happiness in the home, and being able to work and do daily chores (Multiple Interviews 2016). The women’s responses were remarkably well rounded to include physical, social, and mental health and well-being.

While the responses generated are holistic in nature, local cultural context based off beliefs and long-established practices needs to be taken in to consideration. Women interviewed practice components of a healthy lifestyle but their broken-down interpretations of certain components such as what is good food and what is good physique indicates room for lifestyle educational interventions to improve their health outcomes. A similar trend holds that women's perception of health is largely contingent on physical manifestations, demonstrating a gap in a preventative mentality and opportunity for intervention. In one case, when one interviewee was asked about exercise she responded, "why would I walk or exercise when I am thin" (Interview 9 2016). This demonstrates a lack of a preventative mentality regarding physical activity for healthy lifestyle promotion. Only 1 – 2 respondents exercised deliberately, mostly in the form of walking. These two respondents had established educational interventions leading to their decision to take up exercise in adulthood. One of the respondents described her investment in making lifestyle modifications to improve her health outcomes per the recommendation of her private doctor following her complicated pregnancy and development of hypertension post-pregnancy. She walked some and added healthy foods such as nuts and fruit into her regular diet (Interview 4 2016). However, a majority of the women did not see a reason to exercise unless they were overweight or had a specific intervention from a health care provider. The amount of physical labor performed by women must be incorporated into analysis. 50% of women described a sedentary lifestyle in pregnancy and denied physical labor, ~43% are laborers in adulthood with no external physical activity habits, and the remaining 57% worked in the home with about half carrying out some mild exercise through walking or yoga.

This activity pattern does not drastically differ from habits in adolescence given ~65% of women played games and exercised in adolescence and the remaining women primarily worked

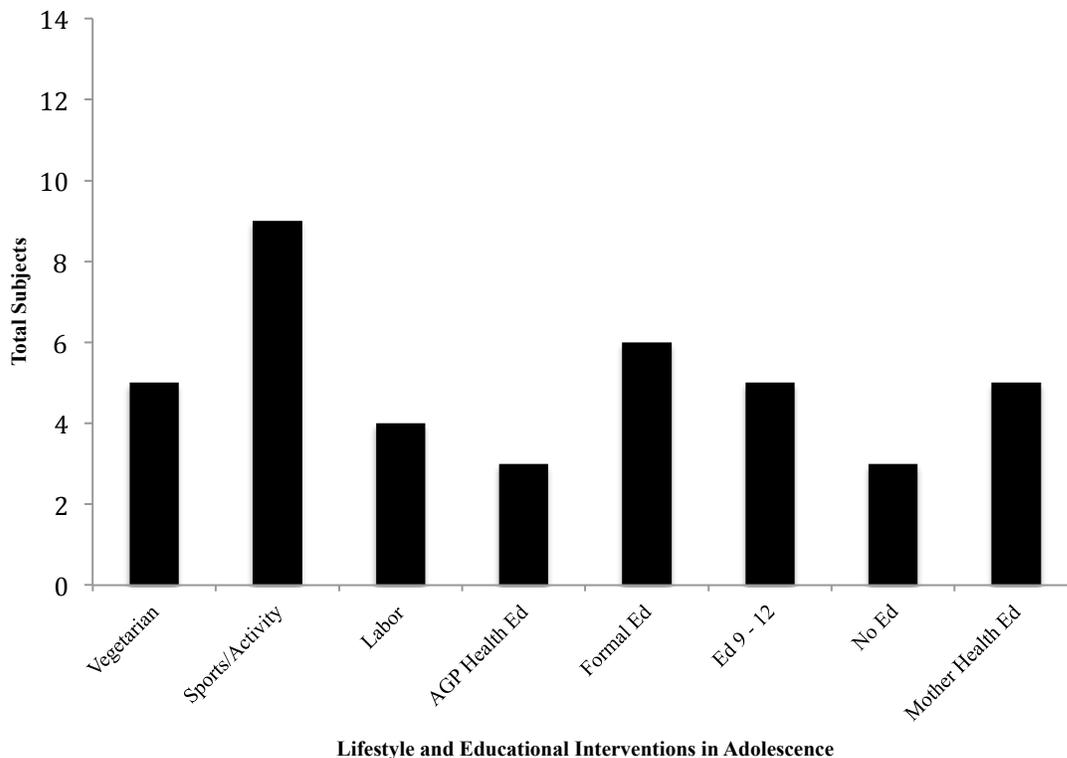
in the home and went to school (Jamkhed Field Notes 2016). The nature of women's physical activity habits must be analyzed through a cultural context for relevance. Per the CRHP social worker Surekha, women in Rural Maharashtra do not regularly practice exercise due to three factors: shyness, lack of time, and cultural incompatibility. However, she noted that

“...If a woman has diabetes or something and gets other women to exercise with her, more likely that women will exercise. Women will walk or exercise in a group but alone is unrealistic...” (Interview 16 2016).

This demonstrates that the establishment of regular physical activity for healthy living and CVD risk reduction requires cultural compatibility. More platforms for women to collectively exercise with other women are required for realistic incorporation of physical activity into their lifestyles. Given a the close ratio of women sedentary in pregnancy and active through labor and other physical activity, the impact of activity and labor on pregnancy outcomes related to prevention or exacerbation of conditions of or related to HDP was inconclusive. While the modifiable risk factor of sedentary behavior may not directly play a role in prevention of HDP, given that HDP increases CVD risk later in life and exercise's correlation to decreased obesity and CVD risk, building a lifestyle habit of exercise and activity and providing avenues for healthy living across her development stages is of great benefit post pregnancy for risk reduction of further development of CVD. Additionally, no correlation could be drawn between lifestyle habits of physical activity in adolescence and propensity to exercise in pregnancy and adulthood because of general cultural irrelevance and incompatibility with physical activity in adulthood.

All subjects interviewed were asked to describe their diet in adolescence and pregnancy, and their current diet. When asked about what foods they consider a part of a healthy diet the most frequent foods included were vegetables, pulses, grains. Economic realities and seasonal availability limited regular inclusion and consumption of certain foods women considered

‘healthy’ such as eggs, nuts, and fruit. Independent of the demonstrated reduction in consumption of select protein sources in pregnancy due to Shistari, in general, women maintained similar diets and eating habits across these three life stages consisting of vegetables, pulses, and grains (Figure 4, 5; Table 6, 7).



**Figure 5.** Lifestyle and Educational Interventions in Adolescence. Results from 12 women with histories of HDP, 1 woman symptomatic of a HDP, and 1 former attendee of the AGP with no maternal history.

All women interviewed had been given iron folic acid supplements in prenatal care in some capacity and appeared well familiar with dietary iron supplementation and counseling on anemia. However, their supplement adherence was contingent on the severity of side-effects and the degree of their education and beliefs about the benefits of taking iron and folic acid. The women interviewed had an average Hgb of 9.6 with only one woman exceeding the acceptable Hgb level of 11 mm Hg with a value of 12 mm Hg. These results indicate that on average, the

women interviewed were anemic or borderline anemic demonstrating disparity in administration and adherence to the iron supplements. As aforementioned, side-effects play a large role in the woman's compliance with periodic supplementation indicated a need for improved counseling related to side-effects and better prevention and management of these side-effects.

Women were less sure and less educated about the benefits of calcium and protein in the diet for healthy development. While results demonstrated a similar trend of dietary deficiency as in the case of anemia, women were not being educated about the importance of protein and calcium in the diet to the degree of iron.

Despite women's 'theoretical inclusion' of more protein rich foods such as milk, curd, eggs, and nuts or meat in non-vegetarian cases, protein deficiency was indicated across the board across the board per the woman's dietary habits. Calcium deficiency was not thoroughly assessed due to time limitations of this study, but data from the National Nutrition Institute of India indicates significant prevalence of calcium deficiency in rural Maharashtrian women, especially in pregnant populations. The WHO has reinforced the importance of sufficient intake of calcium for prevention of HDP in populations with low-calcium intake and high risk of development of HDP, indicating a more than halved risk for development of HDP specific to PE of this demographic (WHO 2011). More exhaustive studies on calcium intake interventions in rural Indian women with high-risk factors for HDP may be beneficial for the development of this finding in an India specific context.

All women interviewed claimed autonomy over their dietary decisions and denied alterations to their diets if given the chance in all three development stages (Jamkhed Field Notes 2016). Their claim of a 'controlled sufficient' diet reinforces the subjects' reservations to alter their diet behaviors because per their understanding they are consuming a sufficient amount of

calories and nutrients. Consequently, an obvious gap exists in reinforcing healthy diet behaviors between women and health workers in adolescence, pregnancy, and adulthood. The consistency of the women's dietary habits across adolescence, pregnancy, and adulthood, in addition to her decreased intake of certain foods in pregnancy, indicates a significant inadequacy in dietary counseling and reinforcement interventions in these populations. Caloric and nutrient requirements should *increase* in pregnancy for healthy development of the mother and child per RDA guidelines (Table 3). Consequently, consistent if not reduced intake of calories and certain nutrients during pregnancy has detrimental impacts on the health of the mother and child. As previously indicated, malnutrition and anemia increased risk for development and exacerbation of HDP demonstrating the necessity of better nutrition counseling programs in pregnancy for prevention of these conditions. Additionally, the consistencies of the subject's dietary habits reinforce the notion that habits and behaviors built in adolescence tend to continue without appropriate interventions and empowerment opportunities. Even in women who grew up very poverty-stricken but currently live with more fiscal capacity, diets were not indicated as drastically different in adulthood from adolescence. One subject who exemplified this transition from extreme poverty to relative poverty exercised similar dietary habits and behaviors in adolescence through pregnancy and per her description, did not make alterations to her diet until her third pregnancy in prenatal care when a physician counseled on the importance of the inclusion of certain foods including eggs, various nuts, and fruit. The woman made dietary changes based off the recommendation of her doctor and now continues to include these foods in her regular diet into present day. This woman's case indicates that counseling and education interventions played a more significant role in evoking dietary behavioral change than socioeconomic growth.

The final modifiable risk factor assessed in this study was use of Mishri. 42 percent of women used Mishri in some form during their pregnancies introducing risk for low birth weight and subsequent risk of complications in pregnancy and latter CVD risk. This finding demonstrates the need and opportunity for effective interventions counseling against Mishri use in this demographic for further risk reduction.

### *Trends in effective interventions and concluding remarks*

#### III. Consistent counseling and health education

Several trends indicated more success in certain intervention techniques. Interventions which included thorough and consistent education and counseling on the part of the health worker or social worker paired with a receptive mentality and commitment to these interventions had more success. Women counseled on the importance of exercise, such as the case of women with consistent involvement in the AGP and those regularly counseled by their physician made more impactful lifestyle changes promoting activity and healthy eating and reinforcing health-seeking behaviors in adolescence, pregnancy, and adulthood. However, consistency and commitment in addition to change in the woman's greater social and cultural environment was key to lasting change. This was indicated in interviews with former AGP members who knew and vocalized the value of exercise as a part of a healthy lifestyle but did not partake themselves due to a lack of compatibility with her greater environment whether it be due to her familial or work obligations or a lack of community or solidarity in physical activity. The trend of the success of consistent and committed education interventions versus other interventions was consistent in various other aspects of the study assessing modifiable lifestyle behaviors.

#### IV. Academic education

Academic education was not directly correlated to improved HDP outcomes but those with more education tended to be more likely to seek-help and regularly see a doctor. This trend may be biased by better economic standing meaning women with more primary education tended to be better off socioeconomically in adolescence and into adulthood making it more economically viable for them to see doctor regularly. However, all women interviewed denied fiscal or social barriers to seeing a doctor when needed and all except one woman considered their health equal in importance to their husbands. Ergo, more education in adolescence especially in women with supplementary health education in adolescence from their mothers, their school, or the AGP indicated more periodic health seeking behaviors and commitment to medication and lifestyle recommendations made by the physician or health worker in pregnancy, which may have prevented or lessened exacerbation of their HDP. Additionally, the habit of periodic visits to a doctor or at least commitment to seeing a doctor when symptomatic of disease provides more opportunity for early intervention and prevention of further exacerbation of disease risk, especially in the case of CVD.

This study indicated the importance of effective and consistent health education interventions on establishment of healthy living practices conducive to CVD and HDP risk reduction in adolescence, pregnancy, and adulthood. Additionally, the study indicated gaps in health education and counseling and reinforcement of this intervention. This was partially hypothesized to result from the complicated and unconsolidated network of prenatal health and health services women receive and can seek out from the private sector, government sector, and CRHP. Indication of PEM, anemia, and other preventable conditions despite multiple prenatal agencies indicates gaps in the system and a need for consolidation of care. In women with established networks and relationships with their provider or VHW, gains in healthy living

practices were more prominent. These findings were impacted by the women's greater socioeconomic and cultural environment and only relevant to the degree of their ability to be practiced in conditions of these environments. This further reinforces the need to reassess the efficacy of existing nutrition counseling and activity promotion programs and make appropriate alterations to improve these health indicators for better management of HDP and CVD risk.

### *Limitations*

The results of this study are limited and statistically inconclusive in the field of HDP research due to the small sample size and lack of comparative analysis between an experimental and control group. Additionally, conducting a non-retrospective study assessing the impact of lifestyle interventions on HDP outcomes and CVD risk would be of great benefit for this field of study.

### *Need for Future Research*

Further research is needed on the impact referrals and inconsistent monitoring of BP, microalbumin, etc. on timely deliveries and outcomes of complication pregnancy in women with HDP. Additionally, given the correlation between calcium deficiency and HDP risk, further studies are needed to assess the impact of calcium supplementation on reduced HDP risk in rural Maharashtra and other Indian demographics. Given the complex and partially unknown etiological nature of HDP, more studies identifying high-risk populations for HDP and assessing their lifestyle habits' contribution to increased or decreased HDP risk poses great potential and benefit for future studies.

In general, more research is needed to assess the efficacy and failures of lifestyle interventions in rural women at multiple life stages and the larger impact on CVD risk reduction. Appropriate interventions require relevant social and cultural facilitation for development.

Assessments should include promotion of the concept of healthy living and the opportunity for women to practice healthy lifestyle practices of healthy diet, caloric sufficiency, physical activity for preventative health and promotion of mental well-being, and discouragement of packaged foods and Mishri use. Concurrently, consistent counseling and access to resources for women are required for the mobilization and longevity of healthy living practices in the rural female demographic. For successful interventions, cultural relevance in caste, religious, and gender terms need to first be taken into consideration for initial establishment of interventions and latter breakdown of greater cultural and socioeconomic factors restrictive to women's healthy living and potential for maximum development.

## Data Collection.

- I. Name
- II. Age
- III. Occupation
- IV. Education Level
  
- I. Maternal age(s)
- II. Maternal parity
- III. Premature or full--term birth(s)
- IV. Malnutrition -(Y/N)
- V. Anemia (Y/N)
  - A. Hemoglobin level (if available)
- VI. Birth weight of each child
- VII. Activity during pregnancy (home/labor amount high/low/nil)
- VIII. Exposure to
  - A. Chewing tobacco
  - B. Brushing with Misri
- IX. Delivery location, why did you choose this location?
  - A. Home
  - B. Institutional
    1. Who conducted delivery?

## Interview Questions for Women with History of Complicated Pregnancy.

### Part A. Pregnancy

- 1) Did you get prenatal care, if so, what kind?
- 2) Describe any complications you experienced during pregnancy, were these different from other pregnancies?
  - a) If not mentioned ask...
    - i) Edema (Y/N)
    - ii) Headache (Y/N)
    - iii) Abdominal Pain (Y/N)
    - iv) Shistari (Nausea and Vomiting) (Y/N)
    - v) Proteinuria (Y/N)
    - vi) Fatigue (Y/N)
- 3) When you experienced these complications or uncertainties during your pregnancy(s) did you seek help? From whom did you seek help?
- 4) Describe your lifestyle during pregnancy, did you make any changes in diet, activity level, or labor/work habits? What or who influenced these changes?
- 5) What does a healthy pregnancy mean to you?
- 6) Did you have the ability to seek help for you complications when you needed? Were there any limitations?

### Part B. Lifestyle

- 1) Describe your typical day...including meals, housework, labor, transportation, and activity.
- 2) What does your diet currently consist of on a weekly basis?
- 3) On a weekly basis, what should a healthy diet consist of?
- 4) Do you exercise, if so, how do you exercise?
- 5) How much control do you have over your health, do you have the ability to see a doctor when needed?
- 6) To you, what does it mean to be healthy? Does health vary by gender?
- 7) Describe your perception of a healthy lifestyle.
- 8) Are you experiencing any symptoms or health complication following your pregnancy(s)? (Guide to hypertensive or cardiac symptoms)
- 9) Do you have any family history of hypertension or heart disease? Other disease(s)?

#### Part C. Adolescence

- 1) What do you remember about your adolescence?
  - a) Siblings
  - b) Parent's work
  - c) Marriage age
- 2) What was your role in the home during adolescence, was it different from your brother's or other family members?
- 3) What type of work did you do during adolescence?
- 4) What did you eat during adolescence? Who did you eat with and when?
- 5) Were you educated to a certain standard? Did you want to be educated?
- 6) How often did you play with your friends and exercise during your adolescence?
- 7) Did you have any health education in adolescence? If so, what aspects of health were you educated about?

#### **Appendix II.**

##### Interview questions for Village Health Workers and Physicians

- 1) What does a healthy diet mean to you?
- 2) Do you counsel about diet and nutrition and exercise differently in adolescent girls and pregnant women?
- 3) What does a healthy mean, how do you determine whether the pregnancy is healthy or not?
- 4) What prenatal care and antenatal care do you provide?
- 5) What are the signs and symptoms of preeclampsia and how do you manage the condition?
- 6) Describe the role of prevention in health outcomes.
- 7) What were you trained on about heart health risks and prevention?
- 8) When should non-communicable disease education and prevention start?

#### **Appendix III.**

**Table 5.** Pregnancy Indicators of 12 subjects with HHDP

Interview	Age	MAC	TMP	CP	Conditions, Signs, & Symptoms (High BP implied)  Risk factors	Marriage age	Village
Interview 1	28	19	2	1 UD	PE, edema, shistari, proteinuria  Hgb 9 (A) V/M<2x	18	Padali
Interview 2	35	29	4	4 M	Eclampsia, edema, headache, seizures, proteinuria  Hgb UNK V/M<2x	13	Saradvadi
Interview 3	20	17	3	2 M	Edema, Shistari, proteinuria unknown, convulsions  Hgb 8 (A) V/M<2x	14	Sakat
Interview 4	28	24	3	3 D	Edema  Hgb 10 (A) V/M<2x	9	Sakat
Interview 5	27	23	4	3 FT D	Edema, shistari, headache  Hgb 9 (A)	17	Patoda
Interview 6	23	22	3	3 F	Edema, shistari  Hgb UNK	17	Patoda
Interview 7	25	22	2	2 U	Edema, headache,  Hgb 10 (A)	18	Ghodegaon
Interview 8	28	24	3	1 MTD	Headache, shistari  Hgb 11 (BA) V/M<2x	22	Ghodegaon
Interview 9	29	26	2	1, 2 M	PE, edema, headache, anemia, C- section required  Hgb 8 (A)	13	Nimbodi
Interview 10	22	20	3	3 U	Headache, abdominal pain, weakness, Shistari	17	Nimbodi

					Hgb 12 V/M<2x		
Interview 11	30	28	2	2 M	Headache, edema  Hgb 9 (A) V/M<2x	11	Indira Nagar
Interview 12	25	24	3	1 M	Headache, edema, shistari  Hgb 10 (A) V/M<2x	14	Indira Nagar
Interview 14 (36 weeks gestation)	20	20	1	U	Shistari, edema, skin infection of unknown origin  Hgb V/M<2x	19	Patoda

**Table 6.** Adolescence indicators and lifestyle of 14 subjects, 12 with HHDP

Interview	Diet	Activity	Siblings	Parent's Occupation	F Ed.	H Ed.
Interview 1	Meat 1-2x week Vegetables, grains	Sport games (both sexes), walking, no labor	2 B 2 S	Farmers	10	0
Interview 2	Vegetarian, occasional fruits, occasional milk and curd, grains	Swimming, Farm labor, domestic work	2 B 4 S	Farmers	0	0
Interview 3	Vegetarian, pulses, grains, sweets, milk and curd	Sugarcane cutting/labor, sport games	1 B 1 S	Laborers	7	0
Interview 4	Vegetarian, grains	Labor	1 B 4 S	Laborers	0	0
Interview 5	Meat, fruit, grains, vegetables	Farm labor	1 B 3 S	Farmers	12 (religious)	0
Interview 6	Grains, vegetables, meat, sweets and salty snacks	Some domestic work	1 B 5 S	Father woodcutter	4	0
Interview 7	Meat or egg 2x week, vegetables, pulses, fruit	Sport games	4 B 2 S	Farther barber	7	Mo
Interview 8	Vegetarian, pulses, milk and curd, grains	Sport games, domestic work	2 B 1 S	Farmers, floor-making (high-caste)	12	Mo

Interview 9	Meat or seafood 1x week, grains, pulses, vegetables, fruit	Sport games	2 B	Laborers	7	0
Interview 10	Meat 2x week, pulses, vegetables, starches, grains	Sport games, Karate	1 B 4 S	Farmers and Laborers	4	AGP
Interview 11	Meat 1-2x week, milk and curd, pulses, vegetables	Sport games	2 B 3 S	Farmers	0	Mo
Interview 12	Vegetarian, pulses, grains	Some domestic work, uninterested in games	1 B	Father conductor Mother farmer	8	Mo
Interview 13 (Age 18, nulliparous)	Vegetarian, pulses, sprouted beans, occasional fruit, occasional eggs	Running, Asana yoga 4x week, Sport games (both sexes)	2 S 1 B 1 TS	Farmers	12	AGP, Mo
Interview 14 (Age 20, 36 weeks pregnant)	Meat, vegetables, sprouted beans, grains	Sport games, self-defense, karate	4 S 1 B	Farmers, VHW in family	12	AGP

**Table 7.** Current lifestyle and health indicators of 14 subjects, 12 with HHDP

Interview	Diet	Activity/Daily Routine	Occupation	Existing complications, condition or family history
Interview 1	Vegetarian, occasional fruits, grains, rice, meat 1-2x per week, occasional sweets  Would include: eggs, milk, fruit, vegetables, meat	Daily chores, labor on farm ~6 hours daily	Farmer	N/A
Interview 2	Vegetarian, occasional fruits, occasional milk and curd, grains, pulses	Labor on farm, stopped working in sugarcane factory due to child with special abilities from HDP, daily chores	Farmer	N/A
Interview 3	Vegetarian, pulses, grains, sweets, milk and curd, salty snacks	Daily chores, fetching water, no work on farm due to drought, some walking	Domestic	N/A
Interview 4	Vegetarian, grains, pulses, jaggery, nuts (doctor's recommendation), fast-rice, purchases bottled water, no milk or curd	Daily chores, some walking	Domestic	Anemia, HTN (sustained at SBP 120)  taking ecosprin 75 mg QD for HTN, also

				taking supplements Calcium/D3, folic acid, and ferrous sulfate
Interview 5	Meat (includes in healthy diet), fruit, grains, vegetables	Labor on farm, walking, daily chores	Farmer	N/A
Interview 6	Grains, vegetables, daily meat, sweets and salty snacks	Daily chores, farm labor, no walking or exercise	Farmer	N/A  Maternal history of HTN, potentially rheumatoid arthritis
Interview 7	Meat or egg 3x week, peanuts, vegetables, pulses, fruit, sweets	Domestic work, daily chores, little walking	Domestic	N/A
Interview 8	Vegetarian, pulses, milk and curd, grains, salty snacks daily	Daily chores, floor making ~ 4 hours daily	Floor-making	N/A  Paternal history of DM
Interview 9	Meat or seafood 1x week, grains, pulses, vegetables, fruit	Daily chores, no exercise	Domestic	Intermittent chest pain and palpitations, no HTN
Interview 10	Meat 2x week, pulses, vegetables, starches, grains  (in pregnancy only ate vegetables and grains)	Daily chores, recently worked in brick-making, no exercise	Farmer and Labor	N/A
Interview 11	Meat 1-2x week, milk and curd, pulses, vegetables	Daily chores, walking (deliberate exercise to lose weight)	Domestic	N/A  Paternal history of obesity and DM
Interview 12	Vegetarian, pulses, grains	Daily chores, caring for infant	Domestic	Intermittent chest pain and heaviness, difficulty breathing and fatigue with activity
Interview 13 (Age 18, nulliparous)	Vegetarian, pulses, sprouted beans, occasional fruit, occasional eggs	Daily chores, applied to police academy  Exercise: running and asana yoga 4x week	Domestic	N/A
Interview 14 (Age 20, 36 weeks pregnant)	Meat, vegetables, sprouted beans, grains	Daily chores, no exercise	Domestic	Shistari, edema, skin infection during entire pregnancy, anemia  Mother has rheumatoid arthritis

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