Profile of comorbidity and multimorbidity among women attending antenatal clinics: An exploratory cross-sectional study from Odisha, India

Sanghamitra Pati[1], Parul Puri[2], Rajeshwari Sinha[3], Meely Panda[4], Sandipana Pati[5]

[1]Department of Health Research, ICMR-Regional Medical Research Centre, Bhubaneswar, Odisha, [2]International Institute for Population Sciences, Deonar, Mumbai, Maharashtra, [3]Independent Researcher, New Delhi, [4]Community Medicine and Family Medicine, AIIMS, Bibinagar, Hyderabad Metropolitan Region, Telangana, [5]Centre for Chronic Diseases and Injuries, Indian Institute of Public Health Bhubaneswar, Public Health Foundation of India, Bhubaneswar, Odisha, India

Abstract

Background: Multimorbidity is being recognized as a crucial maternal health challenge in India. However, pregnancy remains an exclusion criterion in most multimorbidity estimation studies resulting in a deficient understanding of the problem in this population. The present study aims to estimate the prevalence of multimorbidity, identify its correlates, and assess healthcare utilization and expenditure outcomes among women availing of antenatal care clinics. **Methods:** An exploratory cross-sectional study was conducted among 127 pregnant women attending three antenatal clinics of Bhubaneswar, Odisha, from February to July 2016. Data were collected using a "multimorbidity assessment questionnaire for primary care," contextualized for antenatal settings. The prevalence and correlates were determined using descriptive analysis, and the outcomes were measured by the number of healthcare visits, medications, and healthcare expenditure. About 15% of antenatal women were multimorbid. **Result:** Anemia (52.6%), hypertension (31.6%), acid-peptic diseases (26.3%), and thyroid (26.3%) were the leading chronic conditions. Statistically, significant association was found between multimorbidity and medical consultation, the medicines consumed, and functional limitation. The healthcare expenditure was significantly higher among the multimorbidity groups. **Conclusion:** Our findings suggest the inclusion of comprehensive multimorbidity assessment in routine antenatal screening. Preconception care should establish linkages between maternal and reproductive health with chronic disease prevention, and identify ways to reduce healthcare utilization and expenditure. Longitudinal studies to assess the trajectory and impact of multimorbidity on maternal and infant health are warranted.

Keywords: Comorbidities, gestational morbidity, healthcare expenditure, healthcare utilization, India, MAQ-PC, maternal health, multimorbidity, pregnancy, prevalence

Introduction

The hierarchical role of chronic and non-communicable diseases (NCD) replacing acute infectious diseases is becoming a major healthcare burden in low- and middle-income countries (LMICs).[1] Concomitantly, the number of individuals and populations with two or more chronic conditions, that is, multimorbidity, are being observed increasingly in these settings.[2] Multimorbidity is a novel concept that encompasses all long-term conditions (LTC) present in an individual. Contrary to comorbidity, it does not attribute centrality to any index condition; rather it views the patient as a whole and

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provides insights for patient-centered care.[3] Owing to its strong association with increased hospitalization, healthcare expenditure and mortality rates as well as inferior physical and mental health and impaired quality of life, multimorbidity has been the recent focus of clinicians and public health researchers globally.[4-6]

Within LMICs, India, the largest demography, is no exception, with studies documenting a steadily growing burden of multiple chronic conditions pervading all socioeconomic and geographic strata.[7,8] Our previous study, which was the first to assess multimorbidity in primary care, has estimated the prevalence to be one-third while two-thirds of these patients were below 50 years of age exhibiting worst quality of life and greater healthcare utilization.[9] Even though multimorbidity increases with age, the non-chance coexistence of multimorbidity is greater at younger ages with many being diagnosed during late adolescence and early adult life.[10]

While a majority of epidemiological studies have investigated the variation of multimorbidity across age and socioeconomic status, the role of gender has received comparatively lesser attention.[11] The burden and impact of multimorbidity particularly among women are not elucidated, since most studies have adjusted for the effects of gender on the association between multimorbidity and its outcomes.[12] A recent scoping review on multimorbidity in LMICs has highlighted the prevalence to be higher in females (25–52.2%) than males (13.4–38.6%), and more common in younger women.[13] A few recent studies in West Asia and India too have observed a higher prevalence in women.[14,15] According to a study based on the National Family Health Survey, India, nearly 17.5 per 100 women of reproductive age females have at least one morbidity.[16] This implies that many women of childbearing age would be entering into pregnancy with pre-existing multimorbidity.

The prenatal presence of chronic conditions is known to decline functional capacity and overall health. It further increases the risk of complications during pregnancy and childbirth with potential long-term outcomes for both mother and child.[17] The diverse physiological changes during pregnancy can even unveil certain latent chronic conditions with a significant impact on physical and mental wellbeing.[18] The propensity of adverse outcomes gets amplified when a pregnant woman has multiple long-term conditions—multimorbidity when the co-occurring diseases might exacerbate each other.[19] Pregnant women are, therefore, at greater risk due to multimorbidity, as it can impact both the intra-natal and perinatal outcomes (e.g., low birth weight, premature delivery, adverse birth outcomes, complicated delivery, neonatal complications). Overall, the continuation of NCDs in women post-delivery, and children may have the risk of having NCDs in early adult life.

Interestingly, studies entailing multimorbidity in either community or healthcare-based settings usually have "pregnancy" as one of the exclusion criteria in participant recruitment.[9,10,12] Moreover, since women during pregnancy visit designated

antenatal care (ANC) clinics, they naturally get excluded from any routine health facility-based survey. Such cumulative inadvertent exclusion has resulted in an underrepresentation of this vulnerable population in any multimorbidity research.[20] Our systematic review that profiled multimorbidity across South Asia had noted the paucity of studies focusing on the reproductive age of women.[21] Another recent systematic review of maternal morbidities in LMICs has highlighted conspicuous research gaps. Despite some progress, the majority has investigated specific NCDs like gestational diabetes, pregnancy-induced hypertension, or other hormonal disorders. Some have dwelled either on mental health, particularly depression, or chronic infectious diseases (e.g., Human immunodeficiency virus infection (HIV)), or nutritional deficiencies, having implications on maternal health. However, none of these studies specifically aimed to study multimorbidity nor had used a comprehensive panel of chronic conditions to estimate the same.[22] For maternal health service providers, an understanding of the complex role of multimorbidity is indispensable to provide safe, efficient, and optimal care for both mother and child.[23] Thus, any epidemiological estimation of multimorbidity among pregnant women should ideally be carried out across antenatal clinics. This knowledge is of considerable significance for a country like India, wherein both NCDs and maternal health indicators are being accelerated to achieve universal health coverage (UHC) as articulated by the Sustainable Development Goals (SDGs).[24,25] Moreover, antenatal care forms an important component of UHC. As per the World Health Organization (WHO), it is one of the 16 essential health services which are indicators of the level and equity of health services coverage in countries.

With an aim to address the current research gap, we undertook the present study to describe the epidemiology of multimorbidity among women attending antenatal care clinics in Odisha, an eastern state of India. Our objectives were three-fold: (1) to develop a comprehensive, contextualized tool for the assessment of multimorbidity for antenatal care; (2) to estimate the prevalence and distribution of multimorbidity using this tool in ANC settings; (3) to explore the outcomes of multimorbidity in terms of healthcare use and expenditure among these women.

Methods

Design and setting of the study

This observational study was conducted among adult females (≥18 years) attending antenatal clinics in Khurda district (Odisha), from February to July 2016. Three antenatal clinics, one each from the North, South, and Central zone, were randomly selected. Since we did not have any data on the prevalence of multimorbidity in pregnancy per se, we opted for an exploratory cross-sectional design spanning 6 months, and decided to include all adult females presenting for the first time to the selected antenatal clinics.

Each woman was briefed regarding the study objective, information to be assessed, and written informed consent was

obtained before data collection. To avoid any disruption or delay in the clinic's patient management system, we approached each participant when they were over with the physician consultation, and did the interviews at a quiet and comfortable place. The exit interviews also helped us to record the diagnosis in detail by going through the prescriptions. To prevent data duplication, each participant was given a unique identification number and those who have already been interviewed under the present study were excluded during the follow-up visits.

Study tool and data collection

Our study spanned 24 weeks which comprised 3 weeks for tool development and testing while the subsequent 21 weeks encompassed data collection. We used our previously developed and validated tool, Multimorbidity Assessment Questionnaire for Primary Care (MAQ-PC), for collecting data. The MAQ-PC (Supplementary File I) followed an iterative process; translated into the vernacular language (Odia) and demonstrated a good concordance with clinical records and physician prescriptions.[26] This structured tool was contextualized to include additional variables related to antenatal care and women, and cognitively interviewed to assess comprehensibility with eight women of diverse social, economic, and educational backgrounds. We then pre-tested it in a sample of non-study participants (volunteers) for clarity and ease of completion and finalized the instrument.

The MAQ- PC for antenatal women comprised segments namely sociodemographic data, maternal health covariates, multimorbidity assessment, and health outcomes—healthcare utilization, healthcare expenditure, self-rated health (SRH), and functional limitation. The sociodemographic section included information on the participant's age, ethnicity, place of residence (rural/urban), the level of education (including not educated, primary, high school/ secondary and above), employment (yes/no), and having any social security scheme (whether issued with below-poverty-line card).[27] The maternal health covariates consisted of past pregnancies, mode of deliveries, and birth outcomes.[28]

We approached 142 women, out of which 127 agreed to take part in the interview with a response rate of 90%. The most common reason cited for non-response was lack of time. The multimorbidity assessment collected information on whether the woman had been informed by a physician or a healthcare provider that she had any of the enlisted 18 chronic conditions. An additional option—diagnosed with other diseases was also included in the questionnaire. These conditions were self-reported doctor-diagnosed and cross-validated from the patient prescriptions. Healthcare utilization was measured in terms of physician/healthcare facility consultation (yes/no), prescription of medication (yes/no), and the current use of medication (yes/ no). Healthcare cost—out-of-pocket expenditure (OOPE)— was calculated by using money spent on medications, physician consultation, and laboratory investigations per month.[29] Self-rated physical and mental health were elicited using a Likert scale (e.g., excellent, very good, good, fair, and poor).[30]

Two trained public health nurses with prior experience in multimorbidity as well as maternal health did all the interviews. They were well versed with the local language and patient history taking. Each interview spanned from 20 to 25 min.

Ethical consideration

The ethical approval for the study was obtained from the Institutional Ethics Committee of the Indian Institute of Public Health, Bhubaneswar, Odisha (Vide no: IIPHB-IEC-2015/018). Written informed consent was obtained from all participants, and necessary steps were taken to ensure the confidentiality and anonymity of the patients. The approval of the medical officer in charge of the clinic was solicited before the data collection.

Data analysis

For analysis, we defined multimorbidity as the presence of two or more LTCs from which one is either: (1) A physical non-communicable disease of long duration, like hypertension, (2) a mental health condition of long duration, such as a mood disorder, or (3) an infectious disease of long duration, such as HIV.[31] Two variables—the total count of chronic conditions for each participant and the number of those who had two or more chronic conditions—were computed. We summarized the study enrolment characteristics as frequency and percentages. Further, the Chi-square (for variables with individual cell frequency ≥5) and Fisher's exact tests (for variables with individual cell frequency <5) P values were employed to identify the predictors of multimorbidity. Similar tests were performed to identify the association of multimorbidity with selected healthcare outcomes. The median OOPE along with the interquartile range (IQR) were reported to explore the variation in the healthcare expenditure by different LTC groups. These reported median values were substituted with the Mann–Whitney U test's P value to test the significant differences between the median OOPE between two disease groups (no/single morbidity and multimorbidity). The P value was two-sided and < 0.05 was considered significant. All data analyses were carried out using STATA version 15.0 (STATA Corp, Texas). A complete list of abbreviation used in the text can be seen in Supplementary file 2.

Results

Participant characteristics

Tables 1 and 2 describe the sociodemographic characteristics and past obstetric history of the study participants, respectively. Additionally, these findings were supplemented with the Chi-square and Fisher's exact tests P values to simultaneously study the association between the selected variables and multimorbidity.

The mean age of the participants was 25.9 (standard deviation [SD] 4.04) years ranging from 18 to 36 years [Table 1]. As presented, 35.4, 44.8, and 19.6% of the respondents belonged to the age group 18–24, 25–29, and 30–36 years, respectively. About 87% of the participants belonged to the non-scheduled castes/tribes.

Table 1: Sociodemographic characteristics of the study participants				
Predictors	Total (*n*=127)	Single Morbidity (*n*=99)	Multimorbidity (*n*=19)	*P*
Age group (in years)				
18-24	45 (35.43%)	34 (75.56%)	7 (15.56%)	
25-29	57 (44.88%)	45 (78.95%)	9 (15.79%)	
30-36	25 (19.69%)	20 (80.00%)	3 (12.00%)	0.952
Ethnicity				
Scheduled Castes/Tribes	16 (12.60%)	15 (93.75%)	1 (6.25%)	
Non-Scheduled Castes/Tribes	111 (87.40%)	84 (75.68%)	18 (16.22%)	0.323
Education				
Till high school	92 (72.44%)	71 (77.17%)	13 (14.13%)	
Secondary and above	35 (27.56%)	28 (80.00%)	6 (17.14%)	0.587
Employed				
Yes	18 (14.17%)	15 (83.33%)	2 (11.11%)	
No	109 (85.83%)	84 (77.06%)	17 (15.60%)	1.000
Socioeconomic Status				
Below Poverty Line	56 (55.91)	37 (66.07%)	13 (23.21%)	
Above Poverty Line	71 (44.09)	62 (87.32%)	6 (8.45%)	0.018
Type of House				
Kutcha	36 (28.35%)	27 (75.00%)	5 (13.89%)	
Pucca	91 (71.65%)	72 (79.12%)	14 (15.38%)	0.521
Place of Residence				
Urban	41 (32.28%)	35 (85.37%)	3 (7.32%)	
Rural	86 (67.72%)	64 (74.42%)	16 (18.60%)	0.240

Table 2: Pregnancy-related outcomes of the study participants				
Past-obstetric Characteristics	Total	Single Morbidity	Multimorbidity	*P*
Parity				
Primigravida	56 (44.09%)	47 (83.93%)	7 (12.50%)	
Multigravida	71 (55.91%)	52 (73.24%)	12 (16.90%)	0.284
Type of delivery				
Not applicable	65 (51.18%)	52 (80.00%)	10 (15.38%)	
Vaginal	48 (37.80%)	36 (75.00%)	7 (14.58%)	
Cesarean	14 (11.02%)	11 (78.57%)	2 (14.29%)	0.822
Outcome of last pregnancy				
Not applicable	54 (42.52%)	45 (83.33%)	7 (12.96%)	
Full-term	55 (43.31%)	43 (78.18%)	6 (10.91%)	
Preterm	6 (4.72%)	3 (50.00%)	3 (50.00%)	
Abortion	12 (9.45%)	8 (66.67%)	3 (25.00%)	0.132
History of preeclampsia				
Yes	6 (4.72)	5 (83.33%)	1 (16.67%)	
No	121 (95.28%)	94 (77.69%)	18 (14.88%)	1.000
Total	127 (100.00%)	99 (77.95%)	19 (14.96%)	

A majority (72.4%) of the women had education up to high school level while 85.8% of the participants were not engaged in any employment. More than half of the interviewed women belonged to the below-poverty-line (BPL) group while 67.7% were residing in rural areas.

The findings from Table 2 illustrate that more than half (55.9%) of the participants were multigravida (more than one pregnancy). Nearly 38% had a history of normal vaginal delivery in their last childbirth. The participants who had a full-term baby were 43.3% while the rest had unfavorable pregnancy outcomes, namely preterm deliveries, abortions, and stillbirths.

Almost all (95.2%) did not have any previous history of pre-eclampsia [Table 2].

Morbidity profile

Out of the 127 study participants, around 78% had a single long-standing condition while 15% were having multimorbidity, and the rest did not report any morbidity [Table 1].

Figure 1 depicts the individual prevalence of chronic conditions along with their prevalence within multimorbidity. Anemia, thyroid diseases, and HIV/ Acquired Immune Deficiency Syndrome (AIDS) were found to be the most prevalent LTCs with a reported
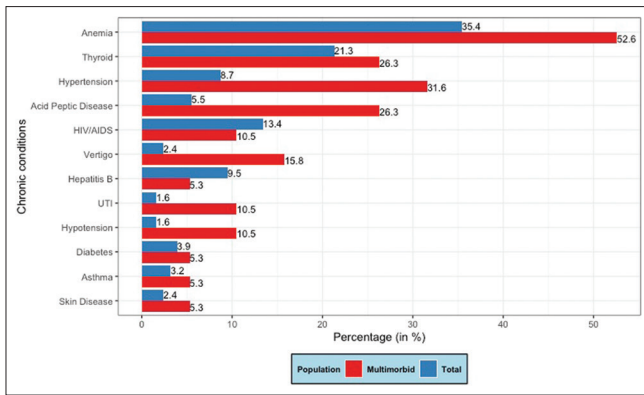
Figure 1: Prevalence of leading chronic conditions overall and within a multimorbid population. (Note: UTI-Urinary tract infection)

frequency of 35.4, 21.2, and 13.4%, respectively. Among those who had multimorbidity, anemia was the most common condition (52.6%) followed by hypertension (31.6%), acid-peptic disease (26.3%), and thyroid diseases (26.3%). It is worth mentioning that, out of all the LTCs included in the questionnaire, only those highlighted in Figure 1 were reported at least once. Owing to the small sample size, we could not identify any patterns emerging as dyads and triads or a combination of two and three LTCs, respectively.

In terms of the sociodemographic characteristics, no definite association could be found between these variables with the morbidity profile except the socioeconomic status, which exhibited association with the number of chronic conditions in these women participants [Table 1]. Out of all the respondents below the poverty line, 66% reported a single chronic condition while 23% had multimorbidity. When compared to BPL counterparts, 87% of the women above the poverty line were having one chronic condition (single morbidity) while that being 8.5% for multimorbidity. In other sociodemographic characteristics, namely age group, ethnicity, education levels, type of housing, and place of residence, a greater percentage of the study participants reported having single morbidity compared to multimorbidity.

Table 2 also indicates that for the study participants with different past obstetric characteristics, single morbidity was seen in a higher percentage but multimorbidity was also quite evident. Multimorbidity is seen in more cases with more than one pregnancy (16.9%) as compared to those with single pregnancy (12.5%). Study participants with vaginal delivery and cesarean delivery who were multimorbid were 14.5 and 14.2%, respectively. About 50% (half) of the study participants who had preterm pregnancies were also multimorbid whereas 25% (one-quarter) who had an abortion and 10.9% who carried till full-term were having multimorbidity.

Healthcare utilization, expenditure, and SRH

Table 3 depicts the summary statistics for different parameters of healthcare utilization in terms of the number of medical consultations made, medications being prescribed, and continuing medicines. Additionally, it describes the self-perceived severity

Table 3: Healthcare utilization and outcome across morbidity groups

Characteristic	Morbidity		P
	Single morbidity (*n*=99)	Multimorbidity (*n*=19)	
Medical Consultation	98 (78.40%)	19 (15.20%)	0.159
Medicines Taken	95 (79.17%)	19 (15.83%)	0.010
Continuing Medicine	88 (80.00%)	19 (17.27%)	0.000
Functional Limitation			
Not at all	27 (90.00%)	1 (3.33%)	
A little	33 (75.00%)	5 (11.36%)	
Somewhat	19 (95.00%)	1 (5.00%)	
Quite a bit - a lot	20 (60.61%)	12 (36.96%)	0.001
Self-rated Health			
Excellent/very good	18 (78.26%)	3 (13.04%)	
Good	51 (85.00%)	6 (10.00%)	
Fair/poor	30 (68.18%)	10 (22.73%)	0.315
Total	99 (77.95%)	19 (14.96%)	

of the condition (functional limitation owing to morbidity), and SRH. Table 4 provides the summary statistics on healthcare expenditure.

A statistically significant association was found (*P*-value < 0.05, Fisher's exact test) between multimorbidity and the medicines consumed and continuing medicine. Further, there was a significant difference in the functional limitation between multimorbidity and single morbidity groups. No significant association was observed between multimorbidity and SRH.

The median expenditure was found to be higher (statistically significant difference) for the multimorbidity group than their peers without multimorbidity. The OOPE on both the medicines and laboratory investigations was found to be significantly higher, at 5 and 10% levels of significance, respectively, for the multimorbidity group. Furthermore, the median OOPE was higher for multimorbid women (INR 2,975), with the percentage share of healthcare expenditure being 39.6, 10.2, and 31.7%, for medicine, medical consultation, and laboratory investigations, respectively [Table 4].

Discussion

During the past few decades, many LMICs are experiencing colliding epidemics of chronic infectious, tropical, and NCD leading to a growing number of populations with multimorbidity.[32] Alongside, an increasing prevalence of multiple chronic conditions in young females particularly maternal morbidities is a key health challenge in these settings.[15,16,33] Within LMICs, India contributes to a major share of chronic conditions at the same time accounting for one-quarter of maternal deaths globally.[6,34] However, the exact burden of maternal multimorbidity is not yet well elucidated in India. Our study, exploratory in nature, intended to estimate the prevalence of multimorbidity among antenatal women in India using a specifically developed and validated tool (MAQ-PC). A total of

Comparison Group	Median OOPE (IQR)	Median OOPE (IQR) (Percent share of total expenditure)		
		Medicine	Consultation	Laboratory
No or single morbidity	1880 (2160)	500 (700) (28.33)	200 (300) (12.12)	1000 (1500) (31.19)
Multimorbidity	2975 (2270)	1000 (1600) (39.59)	1000 (400) (10.22)	1500 (1750) (31.68)
Mann-Whitney U test, *P*	0.0057	0.0243	0.4316	0.0722

Table 4: Median OOPE and share of expenditure (%) of the total expenditure (in INR)

127 pregnant women attending three antenatal clinics (under the public health care system) were interviewed. It may be noted that with most of the available literature on multimorbidity confined to older adults, it is challenging to compare our findings with similar studies.

The prevalence of single morbidity was around 78%, whereas 15% of the interviewed women reported multimorbidity. This is lower than our previous primary care-based multimorbidity estimate with a prevalence of 28.3%.[35] One of the reasons could be the slim and younger age range (18–36 years) of our study participants; as early childbearing is commonly seen in India.[36] However, our observed multimorbidity prevalence in antenatal women is higher than a recent report based on National Family Health Survey (NFHS) 4, India, where the prevalence of multimorbidity was 3.5% in the reproductive age group.[16] There could be a few explanations for our higher estimates. First, the physiologic changes of pregnancy can unmask some underlying chronic conditions.[18] Second, previous ANC encounters of pregnant women might have detected these conditions resulting in higher prevalence.[37] Third, NFHS had included a smaller number of chronic conditions, thus, leading to a possible underestimation.[38]

Like other studies, we observed multimorbidity increasing with age demonstrating a positive association.[39] Though most pregnant women were in the younger age bracket, nonetheless, the subgroup with higher age and multimorbidity possess a much greater risk of pregnancy-related complications, and hence, need special attention from the maternal healthcare providers.[40,41] No other variables except for socioeconomic status (SES) emerged as a correlate for multimorbidity. This could primarily be attributed to the small size of 127 and narrow age range (18–36 years) of our study sample. Another reason could be the homogeneity in the characteristics of the respondents since most of the women were coming from the vicinity of the respective antenatal clinics.

The association between multimorbidity and SES revealed interesting observations. Though the prevalence of single LTC was more in women of higher SES, the prevalence of multimorbidity was found to be greater in the lower SES group (below poverty line) or deprived women. Traditionally, maternal health indicators have remained inextricably linked to social disparity and gender inequity.[42] Similarly, social deprivation and multimorbidity are interwoven, as evident from the accumulating literature.[11] These women constitute the

most vulnerable group with the triple burden of deprivation, multimorbidity, and a compromised physiological state of pregnancy. The health systems must ensure care equity for this fragile population through ample financial as well as health protection measures.

In parallel with the increasing number of chronic conditions, healthcare utilization is seen to increase.[5,29] We too observed all three indicators of healthcare utilization (medical consultation, consumption of medicines, and continuation of medicines) to be significantly higher in women with multimorbidity. The added number of healthcare consultations for chronic conditions along with their scheduled ANC visits could be challenging.[23] Entwined screening and management for these LTCs with routine ANC could help reduce the frequency of healthcare visits. Among those with multimorbidity, tribal females and homemakers had significantly lower healthcare utilization vis-à-vis their non-tribal and employed counterparts. Healthcare utilization is influenced by care-seeking behaviors and access to care, which in turn, are modulated by a woman's health literacy and socioeconomic status.[42,43] Accordingly, gender inequity and social disparity through women empowerment and health literacy appear to be a sustainable strategy.

Overall, healthcare expenditure was significantly higher in women of the multimorbidity group when compared to none or single morbidity. This is in congruence with reports of a positive association between OOPE and multimorbidity in LMIC settings.[5,29] Further, the multimorbid women incurred higher OOPE on medicines and laboratory tests as compared to their non-multimorbidity counterparts. Interestingly, the physician consultation costs did not reveal any significant difference between the two groups. While the consultation visits are similar for women in both the groups, due to the coexistent multiple conditions, additional costs for medicines and laboratory investigations are incurred, thus, tilting the OOPE. In other words, it is the 'multimorbidity' per se which increases the healthcare resource use.[29] Moreover, the percent share of OOPE incurred on medicine, consultation, and laboratory was greater than 10%, and therefore, can be treated as catastrophic.[44] Various studies have demonstrated the catastrophic impacts of high OOPE among individuals with NCDs where nearly half of the OOPE was related to the purchase of medicines, diagnostics, and medical appliances.[5,45] The high financial burden associated with multimorbidity might push these pregnant women's households into impoverishment. Despite various public-funded

maternal welfare schemes, such high OOPE by pregnant women is a matter of policy concern and warrants adequate financial protection measures incorporated into the current Maternal and Child Health (MCH) program.[37]

We could not find any emerging patterns within multimorbidity. This may be attributed to the exploratory nature of the study comprising a small sample size. Anemia, hypertension, acid-peptic diseases, and thyroid were the leading chronic conditions. Due to the frequency of health encounters, they might have been diagnosed during pregnancy. and since we did not elicit the chronology of LTCs. it is difficult to ascertain whether they were recently diagnosed or had been in the past. In our study, self-reported anemia was not graded according to its severity, and hence, could result in a higher prevalence.[46] Similarly, our prevalence estimates of hypertension (16.4%) were higher than reported in the other studies (10%).[47] The routine screening for hypertension and hyperglycemia in antenatal care under the National MCH program could have led to increased detection.[23]

We found a significant difference in the functional limitation between multimorbidity and non-multimorbid groups. A functional limitation is an acknowledged indicator of the severity of a chronic condition which cumulatively leads to an inferior quality of life and self-perceived health.[19] While designing a chronic care model for antenatal women, conditions that have a greater impact on the functional limitation need to be prioritized for intervention.[3] SRH is considered as a proxy estimate of health-related quality of life.[30] Though we did not find any statistically significant difference in SRH, the overall health was rated low by all women either having single LTC or multimorbidity which is concerning. Pregnancy should be a psychologically sound state for better fetal and maternal outcomes and the low perception of one's health is a matter of concern. A woman during pregnancy experiences certain psychological changes as well, thus, requiring mental healthcare.[48] One option could be the incorporation of emotional and mental wellbeing into ANC by the health workers or nurses in community-based settings or through group sessions.[49]

The prevalence of multimorbidity during pregnancy is a reliable marker for future multimorbidity in both mother and child. Offspring born to mothers with multimorbidity have substantially increased the odds of developing chronic diseases in later life. Considering its effect on the pregnancy outcomes and post-pregnancy period, maternal multimorbidity should be recognized as an issue of significant public health concern. Both NCD prevention and MCH programs need to harmonize their service delivery toward a collaborative woman-centric care model by integrating chronic disease management with antenatal care. Pregnancy may be viewed as a window of opportunity for screening multimorbidity and its risk factors, by harnessing on the existing community-level platforms like Village Health and Nutrition Days (VHND).[50] Lastly, the emerging burden of chronic diseases entwined with the prevailing compromised maternal health situation defines the need for the current maternal, child, and adolescent health program in India to renew its focus and infuse stronger financial protection measures.[51]

Although limited to a particular geographic region, our study provides the first of its kind epidemiological insights into the hitherto unexplored dimension of gestational multimorbidity. Since the data presented were 5 years old, the current magnitude may be higher than our estimated prevalence. Further research, preferably longitudinal, should, therefore, assess the magnitude of multimorbidity and investigate its short, intermediate, and long-term health outcomes in this particular population group. Toward this, setting up electronic antenatal health records is a critical step forward as the current medical data keeping is fragmented as revealed in our previous chart review of primary care outpatients' clinics.[52] Establishing community-based young women cohorts would enable a better understanding of directionality and strength of associations between the different types of chronic conditions and the clustering effect within maternal multimorbidity. Moreover, with the emergence of the COVID-19 pandemic, its linkages with multimorbidity have also received attention. Patients with multimorbidity have been reported to be at a greater risk of the COVID-19 infection. Studies have demonstrated the deleterious effect of multiple chronic diseases on the COVID-19 risk and outcome.[53] Exploring the linkages between multimorbidity in pregnant women with COVID-19 could be another important dimension to investigate further.

Strengths and limitations

The key strength of our study is being the first to report the prevalence and correlates of multimorbidity among pregnant women in India. Using a specifically developed and validated questionnaire to assess multimorbidity (MAQ-PC) is another strong point. One limitation is that the precision of the study was compromised due to its small sample size, and hence, strong associations could not be elucidated. However, the random inclusion of antenatal clinics could be considered as a representative indicator. Further, those who did not avail of public ANC services, could not be included in our study.

Conclusions

Our study reports multimorbidity to be quite prevalent in pregnant women attending routine antenatal care, associated with increased healthcare utilization and expenditure. The observed burden combined with greater healthcare resource use offers a compelling case for recognizing gestational multimorbidity as an issue of concern and calls for catalyzing horizontal amalgamation between NCD prevention and reproductive health promotion programs. Our study findings are expected to influence policy implications such as integration of antenatal (Reproductive, Maternal, Newborn, Child and Adolescent Health (RMNCHA)+ programs) with NCD control program, promotion of preconception health, improvement of adolescent health, a greater focus on the management of NCDs in women's health, and development of clinical care protocols to address the dual

challenge of multimorbidity while keeping the mother and child safe. We also suggest investing in innovative strategies and dedicated financing mechanisms for sustainable improvements in women's, children's, and adolescent's health. Future research, in the form of community-based adolescent girl cohorts, is merited to better understand the epidemiology, trajectory, and impact of multimorbidity among reproductive age women across varied regions and contexts.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflicts of interest

There are no conflicts of interest.

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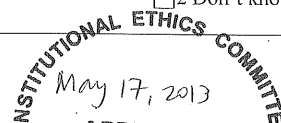
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Supplementary Files

Supplementary File 1: Multimorbidity Assessment Questionnaire (MAQ-PC) tool

PATIENT CODE:			]

Part-1 (Background Information)

1	Block Code	2	Village	3	Type of Facility: [_]0 Public [_]1 Private	4	Serial Number

5	Age in Years	
6	Sex	[_]0 Female [_]1 Male
7	Religion	[_]0 Hindu [_]1 Islam [_]2 Christian [_]3 Others
8	Marital Status	[_]0 Never Married [_]1 Currently Married [_]2 Separated/Divorcee [_]3 Widow/Widower
9	Date of Birth (If available)	
11	Ethnicity	[_]0 Schedule cast [_]1 Schedule Tribe [_]2 General
12	Present place of living	[_]0 Urban [_]1 Semi urban [_]2 Rural
13	Highest Education	[ ]0 Illiterate [ ]1 Primary [ ]2 High school or Secondary [ ]3 Graduation and above
14	Housing type:	[_]0 Kutcha [_]1 Pucca [_]2 Semi Pucca
15	Gross family income per month(INR):	
16	APL/BPL (as per ration card):	[_]0 APL [_]1 BPL
17	In the **past 12 months** have you been **admitted** to hospital for any diseases (Excluding trauma/accident)?	[_]0 No [_]1 Yes [_]2 Don't Remember
18	If *Yes*, how many nights altogether have you stayed in hospital as a patient in the past 12 months	.... (Nights)
19	*Besides the hospitalization*, in past 12 months how many times you have visited a **Public Hospital** for consultation?	.... times
20	*Besides the hospitalization*, in past 12 months how many times you have visited a **Private Hospital** for consultation?	.... times
21	How many *different types* of medicines/drugs are you taking at present?	.... (count)
22	Are you covered under any health insurance? Like Rastriya Swasthya Bima Yojana/Employee State Insurance Scheme	[_]0 No [_]1Yes [_]2 Don't know
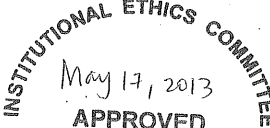
Instruction: *Please ask both 'A' & 'B' sections for each disease (Where ever applicable),*
if the **answer for either 'A' or 'B' is 'Yes'** *then* **pick the sheets** *asking generic questions about the same* **disease.**
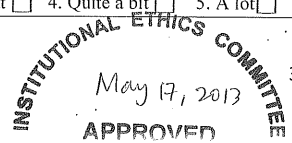
23. Conditions			Yes/ No
Arthritis	A.	Have you ever been **diagnosed** by a doctor with *Arthritis?*	Yes[_] No[_]
	B.	In the **last 12 months** have you experienced *pain, aching, stiffness or swelling in or around the joints (like arms, hands, legs or feet)* which were not related to an injury and lasted for more than a month?	Yes[_] No[_]
Diabetes	A.	Have you ever been **diagnosed** with *Diabetes* (high blood sugar)? *(Not including diabetes associated with a pregnancy)*	Yes[_] No[_]
	B.	*Not applicable*	NA
Hypertension	A.	Have you ever been **diagnosed** with *high blood pressure* (Hypertension)?	Yes[_] No[_]
	B.	*Not applicable*	NA
Chronic Lung Diseases(Including Asthma)	A.	Have you ever been **diagnosed** with *Chronic Lung Disease (Emphysema, Bronchitis, Asthma, COPD)?*	Yes[_] No[_]
	B.	*Not applicable*	NA
Acid Peptic Disease	A.	Have you been **diagnosed** with *Acid-Peptic Ulcer Disease* (Gastritis) in last 12 months??	Yes[_] No[_]
	B.	*Not applicable*	NA
Chronic Back Ache	A.	In **last 12 months**, have you been diagnosed with *Chronic Back Pain*?	Yes[_] No[_]
	B.	In **last 12 months**, have you had continuous Back pain for more than 3 weeks?	Yes[_] No[_]
Heart disease	A.	Have you ever been **diagnosed** with *Angina/ heart attack/heart disease?*	Yes[_] No[_]
	B.	In the **last 12 months** have you experienced *any pain or discomfort* in your chest when you walk uphill or hurry or normal walking?	Yes[_] No[_]
Stroke	A.	Have you ever **been told** by a health professional that you have had a *Stroke*?	Yes[_] No[_]
	B.	In the **last 12 months** have you suffered from **sudden onset of paralysis or weakness** in your arms or legs on one side of your body for **more than 24 hours**?	Yes[_] No[_]
Blindness	A.	Have you been diagnosed with **blindness**?	Yes[_] No[_]
	B.	Do you have *difficulty with vision* (Answer No if you can see OK with glasses)?	Yes[_] No[_]
Deafness	A.	In the **last 12 months**, have you been diagnosed with **deafness**?	Yes[_] No[_]
	B.	In the **last 12 months** do you have *Deafness or difficulty in hearing* for more than 3 months?	Yes[_] No[_]
Dementia	A.	Have you ever been **diagnosed** with D*ementia*?	Yes[_] No[_]
	B.	Do you have *memory problem* which **hinders** your *Activities in Daily Life*?	Yes[_] No[_]
Alcohol disorder	A.	Have you **visited** any doctor because of *Alcohol Habit*?	Yes[_] No[_]
	B.	Are you *habituated to Alcohol*?	Yes[_] No[_]
Cancer	A.	Have you ever been **diagnosed** with any type of *Cancer*?	Yes[_] No[_]
	B.	*Not applicable*	NA
Chronic Kidney Diseases	A.	Have you ever been **diagnosed** with a *long term Kidney problem*?	Yes[_] No[_]
	B.	Have you ever been on *Dialysis*?	Yes[_] No[_]
Epilepsy	A.	Have you ever **been told** by a health professional that you have *Epilepsy*?	Yes[_] No[_]
	B.	Have you ever **suffered** from *sudden onset of seizure while at work or at rest*?	Yes[_] No[_]
Thyroid Disease	A.	Have you ever been **diagnosed** with *Thyroid diseases*?	Yes[_] No[_]
	B.	*Not applicable*	NA
Tuberculosis	A.	Do you suffer from *TB*?	Yes[_] No[_]
	B.	Are you **under** any **treatment for** *TB*?	Yes[_] No[_]
Filariasis	A.	Do you have *Filaria*?	Yes[_] No[_]
	B.	*Not applicable*	

2

24	**DEPRESSION**				
	Over the past 2 weeks, how often have you been bothered by any of the following problems:	Not at all	Several Days	More than half of the days	Nearly every Day
A	Little interest or pleasure in doing things	0	1	2	3
B	Feeling down, depressed, or hopeless.	0	1	2	3
If a + b = 2 or more, continue to c. If not, then move to next condition					
C	Trouble falling/staying asleep, sleeping too much.	0	1	2	3
D	Feeling tired or having little energy.	0	1	2	3
E	Poor appetite or overeating.	0	1	2	3
F	Feeling bad about yourself – or that you are a failure or have let yourself or your family down.	0	1	2	3
G	Trouble concentrating on things, such as reading the newspaper or watching television.	0	1	2	3
H	Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual.	0	1	2	3
I	Thoughts that you would be better off dead or of hurting yourself in some way.	0	1	2	3
C.	Have you ever been to **private health center** for feeling sad/ depressed? (e.g. Clinic, hospital)	[_] Yes [_] No			
D.	Have you ever been to **government hospital** for feeling sad/ depressed?	[_] Yes [_] No			
If Yes to C or D, then Ask E., If No, move to G					
E	When did you **last visit** a doctor about feeling sad/ depressed? *Enter number of months(M) or years (Y) or Today (T)*	.....M T .....Y			
F	Where did you **last visit** for this condition? 1. PHC[_] 2.CHC [_] 3.SDH [_] 4.DH [_] 5.MCH [_] 6. Private [_]				
G	Have you ever been prescribed any **medication** for feeling sad/ depressed?	[_] Yes [_] No [_]NA			
	If yes, continue to H. If no, go to J				
H	If **yes**, are you still **continuing** it?	[_] Yes [_] No [_] NA			
I	If **No**, what was the reason for **stopping** it?				
J	Are you taking any medication for sadness/depression that wasn't prescribed by a doctor or nurse (e.g. you bought it at a pharmacy or given to you by a relative)?	[_] Yes [_] No			
K	Have you ever consulted **any other treatment** such as Ayuraveda/ Traditional Healer/ Faith Healer etc for feeling sad/depressed ?				
L	How much is depression **limiting your activities**? 1. Not at all [_] 2.A little[_] 3.Somewhat [_] 4. Quite a bit [_] 5. A lot[_]				

3

25. Have you been diagnosed with depression by any physician?   [_] Yes   [_] No

26. Do you suffer from any other chronic health problems?   [_] Yes   [_] No

If yes, name them and indicate how much each problem is limiting you in your daily activities

1.................................. 1. Not at all [_]   2.A little[_]   3.Somewhat [_]   4. Quite a bit [_] 5. A lot[_]

2.................................. 1. Not at all [_]   2.A little[_]   3.Somewhat [_]   4. Quite a bit [_] 5. A lot[_]

3..................................1. Not at all [_]   2.A little[_]   3.Somewhat [_]   4. Quite a bit [_] 5. A lot[_]

4

SF-12v2™ Health Survey Scoring Demonstration

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities.

Answer every question by selecting the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

1. In general, would you say your health is:
   [_]Excellent   [_] Very good   [_] Good   [_] Fair   [_] Poor

2. The following questions are about activities you might do during a typical day. Does <u>your health now limit you</u> in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all
A. <u>Moderate activities</u>, such as moving a table, pushing a vacuum cleaner, bowling	[_]	[_]	[_]
B. Climbing <u>several</u> flights of stairs	[_]	[_]	[_]
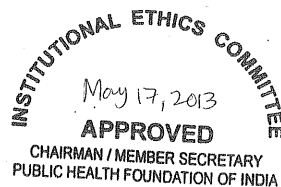
3. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u>?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
A. <u>Accomplished less</u> than you would like	[_]	[_]	[_]	[_]	[_]
B. Were limited in the <u>kind</u> of work or other activities	[_]	[_]	[_]	[_]	[_]

4. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of any emotional problems</u> (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
A. <u>Accomplished less</u> than you would like	[_]	[_]	[_]	[_]	[_]
B. Did work or activities <u>less carefully than usual</u>	[_]	[_]	[_]	[_]	[_]

5. During the <u>past 4 weeks</u>, how much did <u>pain</u> interfere with your normal work (including both work outside the home and housework)?

5

[_] Not at all   [_] A little bit   [_] Moderately   [_] Quite a bit   [_] Extremely

6. These questions are about how you feel and how things have been with you <u>during the past 4 weeks</u>. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the <u>past 4 weeks</u>...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
A. Have you felt calm and peaceful?	[_]	[_]	[_]	[_]	[_]
B. Did you have a lot of energy?	[_]	[_]	[_]	[_]	[_]
C. Have you felt downhearted and depressed? [_]	[_]	[_]	[_]	[_]

7. During the <u>past 4 weeks</u>, how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting friends, relatives, etc.)?

All of the time	Most of the time	Some of the time	A little of the time	None of the time
[_]	[_]	[_]	[_]	[_]

Thank you for completing these questions!

6

Disease name:

Arthritis	[ ]	Heart disease	[ ]	Cancer	[ ]
Diabetes	[ ]	Stroke	[ ]	Chronic kidney disease	[ ]
Hypertension	[ ]	Blindness	[ ]	Epilepsy	[ ]
Chronic lung disease	[ ]	Deafness	[ ]	Thyroid	[ ]
Acid Peptic disease	[ ]	Dementia	[ ]	Tuberculosis	[ ]
Chronic back ache	[ ]	Alcohol	[ ]	Filaria	[ ]

C.	Have you ever been to **private health center** for this condition? (e.g. Clinic, hospital)	[_] Yes [_] No
D.	Have you ever been to **government hospital** for this condition?	[_] Yes [_] No
*If **Yes** to C or D, then Ask E., If No, move to G*		
E	When did you **last visit** a physician about this disease? *Enter number of months(M) or years (Y) or Today (T)*	.....M T .....Y
F	Where did you **last visit** for this condition? [_] 1. PHC [_] 2.CHC [_] 3.SDH [_] 4.DH [_] 5.MCH [_] 6. Private	
G	Have you ever been prescribed any **medication/Inhaler/Hearing aid/** for this condition by a doctor?	[_] Yes [_] No [_] NA
*If yes, continue to **H**. If no, go to **J***		
H	If **yes,** are you still **continuing** it?	[_] Yes [_] No [_] NA
I	If **No,** what was the reason for **stopping** it?	
J	Are you taking any medication for this condition that wasn't prescribed by a doctor or nurse? (e.g. you bought it at a pharmacy or given to you by a relative)?	[_] Yes [_] No
K	Have you ever consulted **any other treatment** for this condition? [_]1. Ayurveda [_] 2. Traditional Healer [_] 3. Faith Healer [_] 4. Home Remedy [_] 5. Others Specify ( )	
L	How much is this condition **limiting your activities?** [_] 1. Not at all [_] 2. A little [_] 3.Somewhat [_] 4. Quite a bit [_] 5. A lot	

7

Supplementary File 2: List of abbreviations used

List of Abbreviations	
ANC	Antenatal Care
BPL	Below Poverty Line
LMIC	Low- and Middle-Income Countries
MAQ-PC	Multimorbidity assessment questionnaire for primary care
NCDs	Non-communicable diseases
OOPE	Out of Pocket Expenditure
UHC	Universal Health Coverage
USD	United States Dollar
OOPE	Out of Pocket Expenditure
LTCs	Long Term Conditions
VHND	Village Health and Nutrition Day
NFHS	National Family Health Survey
HRQoL	Health Related Quality of Life
MCH	Maternal and Child Health
SRH	Self-Rated Health
INR	Indian Rupees
SDG	Sustainable Development Goals
WHO	World Health Organization
ST	Scheduled Tribe
SC	Scheduled Caste
OBC	Other Backward Class
APL	Above Poverty Line
JSY	Janani Suraksha Yojna
RSBY	Rastriya Swasthya Bima Yojna
APD	Acid Peptic Disease
ANM	Auxiliary Nursing Midwife
RMNCHA+	Reproductive Maternal Neonatal Child and Adolescent Health