Understanding the Burden of Hypertension and Diabetes in Rural Uttar Pradesh: Findings from a Comprehensive Survey of NCD Prevalence and Risk Factors in Risia and Huzoorpur blocks

Background

India's healthcare system is grappling with multifaceted obstacles in tackling non-communicable diseases (NCDs) among vulnerable rural communities. These hurdles include geographical isolation, inadequate healthcare infrastructure, and insufficient human resources, resulting in the unavailability of timely and comprehensive healthcare services for individuals. Furthermore, socio-economic, cultural, and systemic imbalances deepen the health disparities that disadvantaged populations face, exacerbating cycles of ill-health and perpetuating intergenerational poverty.

NCDs, especially diabetes and hypertension, were once thought of as illnesses that only affected developed nations. However, they have now spread to developing nations like India. Historically, communicable diseases were the major contributors to disease burden in these regions until the 1990s. Today, NCDs are responsible for 60% of all deaths in India, with diabetes and hypertension-related heart conditions and strokes accounting for roughly 3% and 45% of these deaths respectively. As a result of rapid development, acculturation, migration, and increased access to processed and packaged foods that are high in unhealthy fats and sugar content, NCDs are no longer limited to the urban elite, but are now affecting rural populations as well. Unfortunately, these communities often lack knowledge about healthy lifestyles and NCD risk factors, as well as sufficient income to access nutritious foods such as fresh fruits, vegetables, and whole grains. This makes it difficult for them to take preventive healthcare measures and receive proper treatment for existing conditions, thereby making NCDs a silent epidemic among rural areas.

Rural areas are facing an alarming rise in NCDs like diabetes and hypertension, which adds to the already existing burden of undernourishment and infectious diseases. Unfortunately, the current public health infrastructure is not equipped to handle this situation appropriately. The COVID-19 pandemic and its subsequent lockdowns, travel restrictions, and overwhelmed healthcare facilities have exposed the healthcare access barriers experienced by marginalized communities. This has highlighted the fragility of the existing healthcare system, emphasizing the need for resilient models and transformative approaches to healthcare delivery. Leveraging technology, community engagement, and innovation, along with informed policies that actively reform social determinants of health, can help address these healthcare challenges effectively. Such a comprehensive approach can make a significant difference in the lives of those in need.

Objective

The main focus of this initiative was to perform active door-to-door screening for NCDs, in collaboration with telemedicine centers. The screening aimed to pinpoint those who were vulnerable to NCDs, detect NCDs in their early stages, and offer preventative measures for managing diabetes and hypertension to avoid complications.
It was expected that the successful execution of the project would act as a deterrent to the burden of complicated NCD cases, improve overall community health and reduce the economic burden posed by NCDs and their treatments in impoverished rural communities.

Project Design and Strategy

The project was implemented in two blocks - Risia and Huzoorpur of Bahraich district, Uttar Pradesh, India, covering a total of 77 villages across the target geography. The three month long project focused on screening every person over the age of 30 and pregnant women of any age within the 10km distance of the telemedicine centres in Bahraich district. The aim was to reach 67,500 people and refer them through the initiative.

The Design:

The project constituted a dedicated team comprising a Pilot-cum-helper / Social Worker and Nurse Team / Lab technician. The Pilot-cum-Helper/ Social Workers were responsible for raising awareness, scheduling screenings, and engaging with residents, while the Nurse / Lab Technician undertook the actual medical assessments of the gathered health data.

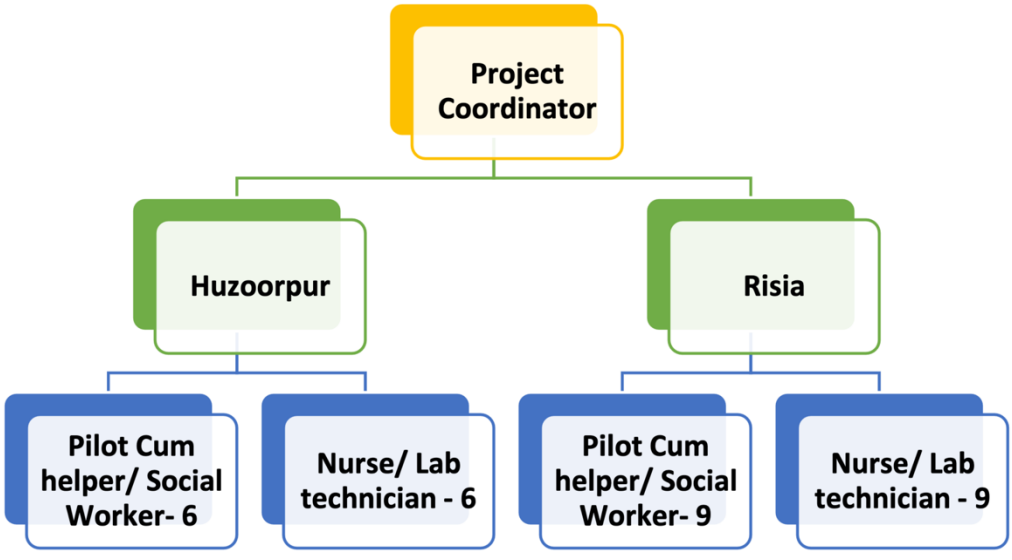


Fig 1: Organogram of implementation staff

Risk Assessment and Screening: The team carefully undertook risk assessments and screenings for hypertension and diabetes through door-to-door outreach and was involved in taking measures of blood pressure (BP) and blood glucose levels of every member above 30 years in each household visited.

Awareness and Education: The Pilot Cum Helper/Social Worker engaged actively with the communities in disseminating critical information and distributing IEC resources on various NCDs, their risk factors, the preventive actions and the importance of early detection and management.
Referral and Follow-Up: If any resident of the visited households displayed explicit risk factors such as obesity or elevated blood pressure/blood glucose levels during the screenings, they were promptly referred to healthcare facilities – PHCs and the telemedicine centre for further evaluation and treatment.

Data Collection and Reporting: A systematic collection and recording of data on screening results, referrals, and patient follow-ups were undertaken using the robust data collection platform - **AMRIT** (Accessible Medical Record through Integrated Technology) platform. The process ensured timely, regular and rigorous analysis of data for program evaluation and subsequent evolution.

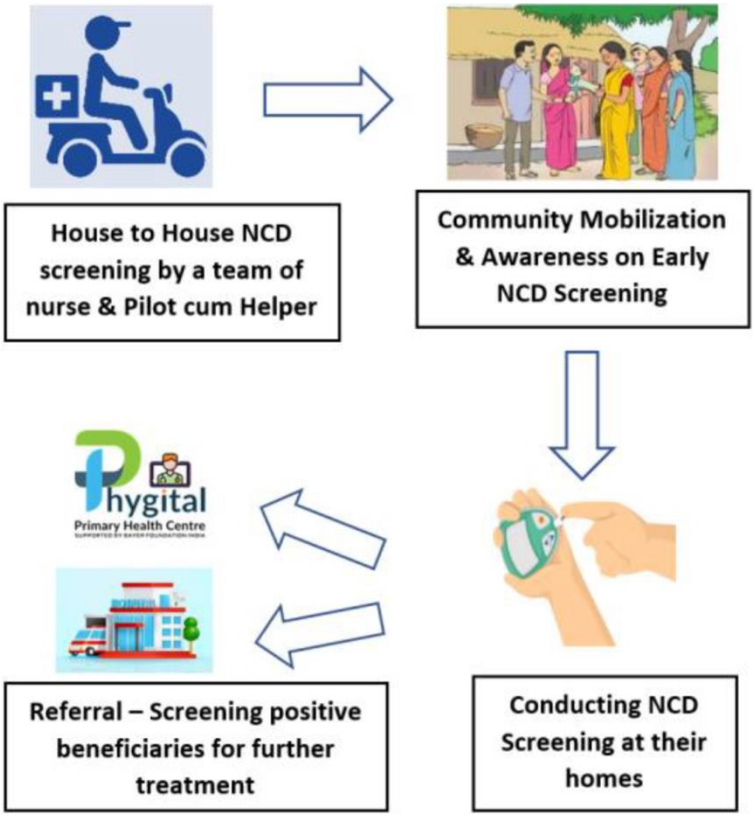


Fig 2: Implementation of the project strategy

Findings from Evaluation of data following Project Conclusion

The door-to-door NCD screening conducted in the rural blocks of Huzoorpur and Risia in Uttar Pradesh elucidated the demographic and clinical landscape of NCDs among 66,553 unique participants against the target population of 67,500 demonstrating a highly successful execution of the project. The demographic, behavioural and clinical characteristics of the participants captured from the data collected during the screenings are described in **Table 1**.

The mean age of participants was 43.8 years, with a substantial proportion (30.9%) being 50 years or older, indicating an ageing demographic susceptible to NCDs. Female participants (53.8%) outweighed the males, possibly owing to the absence of working males from the household at the time of the screening visit by the team. A majority of the participants led a sedentary lifestyle, as 52.8% of the participants reported not partaking in any physical activities on a regular basis.

In terms of NCD prevalence, hypertension was detected in 14.1% of the participants when based solely on measured BP (Fig 3), while this prevalence escalated to 19.5% when considering both measured BP and pre-existing hypertension (i.e., both newly detected and old cases) as illustrated in Fig 4. This suggests that a substantial proportion of the existing hypertensive cases may have attained normotensive/ pre-hypertensive states with medication or lifestyle modification, or both.

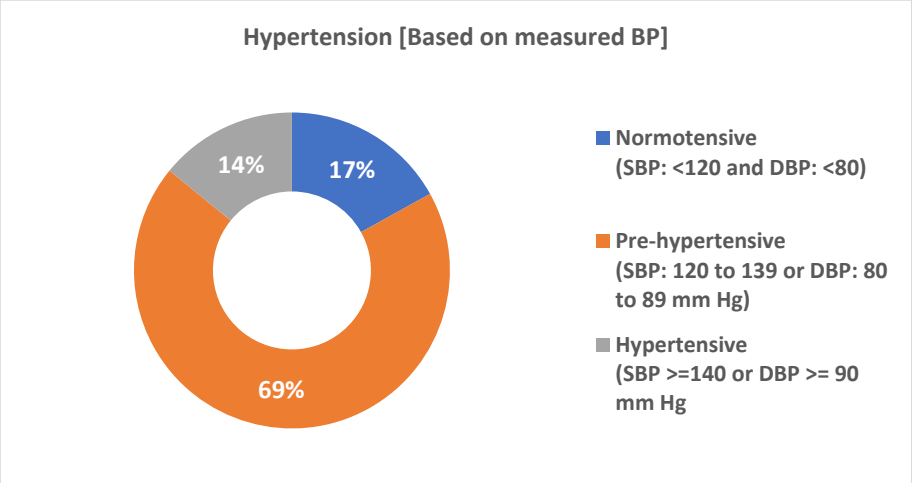


Fig 3: Hypertension based on solely measured BP

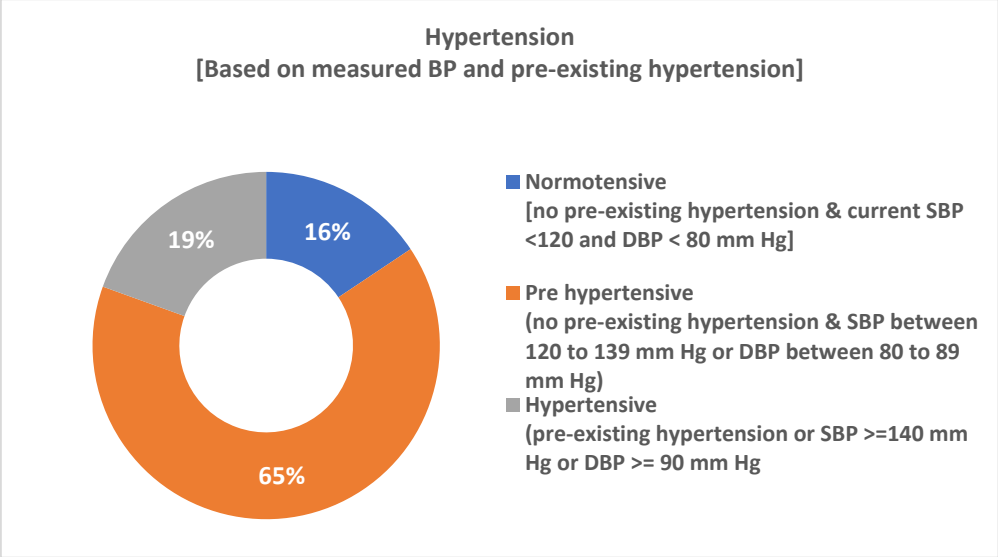


Fig 4: Hypertension based on measured BP and pre-existing hypertension

Regarding diabetes mellitus (DM), about two percent of the participants, respectively, were identified as having DM based on their random blood glucose level (>=200 mg/dL) (Fig 5). The prevalence of diabetes went up to about eight percent when considering both random blood glucose levels and/or a pre-existing DM, as illustrated in Fig 6.

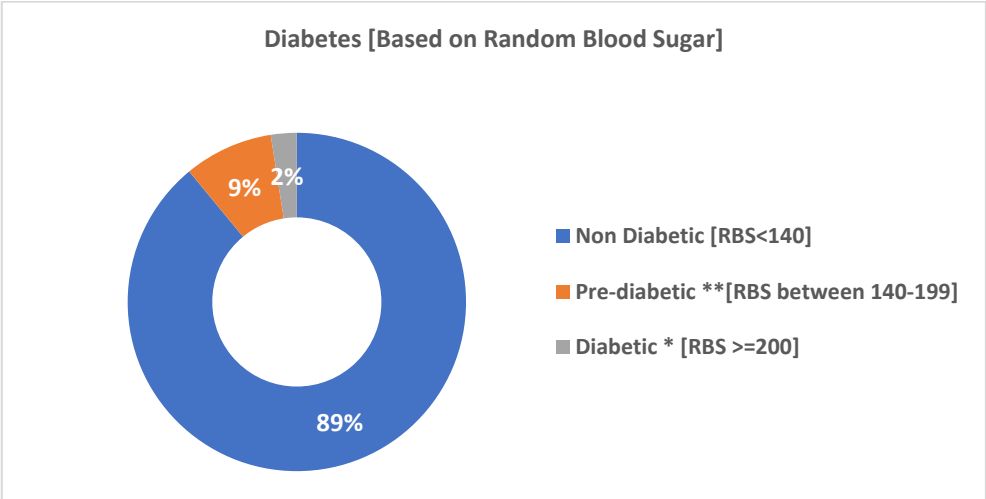


Fig 5: DM based on measured random blood glucose

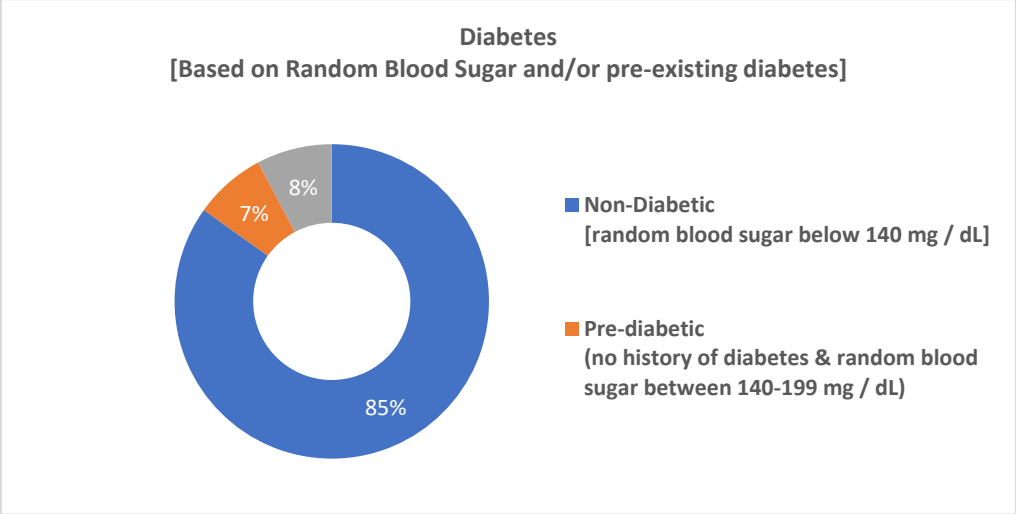


Fig 6: DM based on measured random blood glucose or pre-existing DM

About one-fifth (21.1%) of the participants were affected by either hypertension or DM. Co-morbidity of both conditions was observed in 6% of the individuals, as presented in Fig 7.

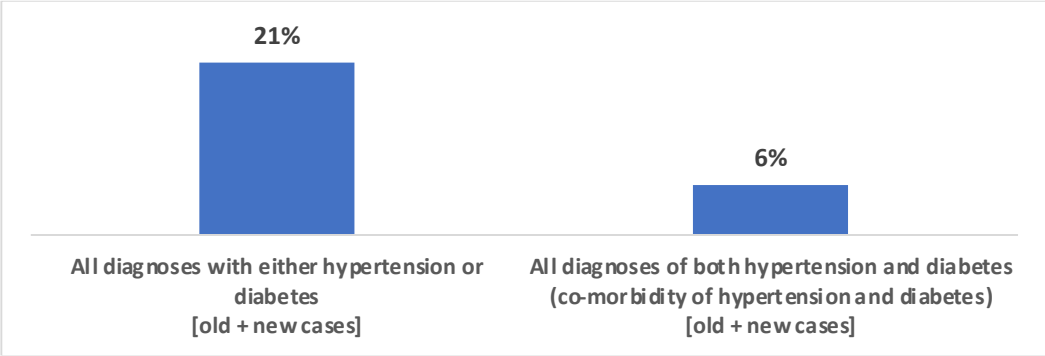
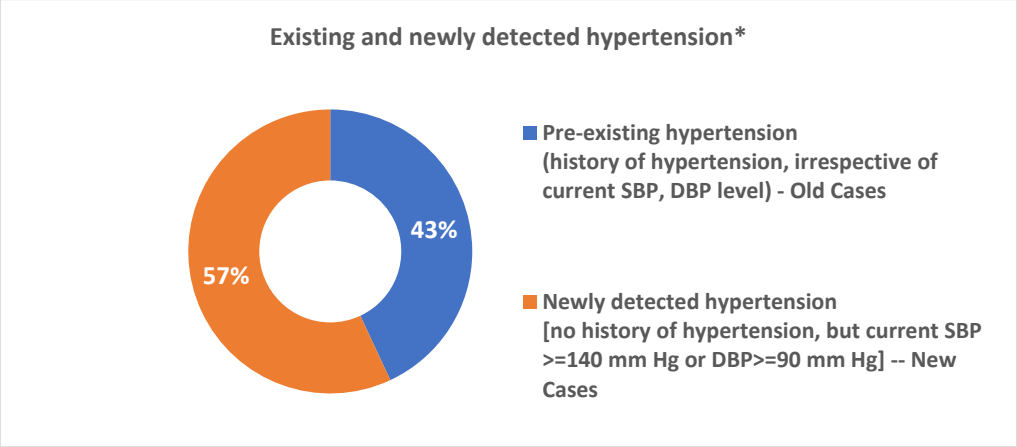


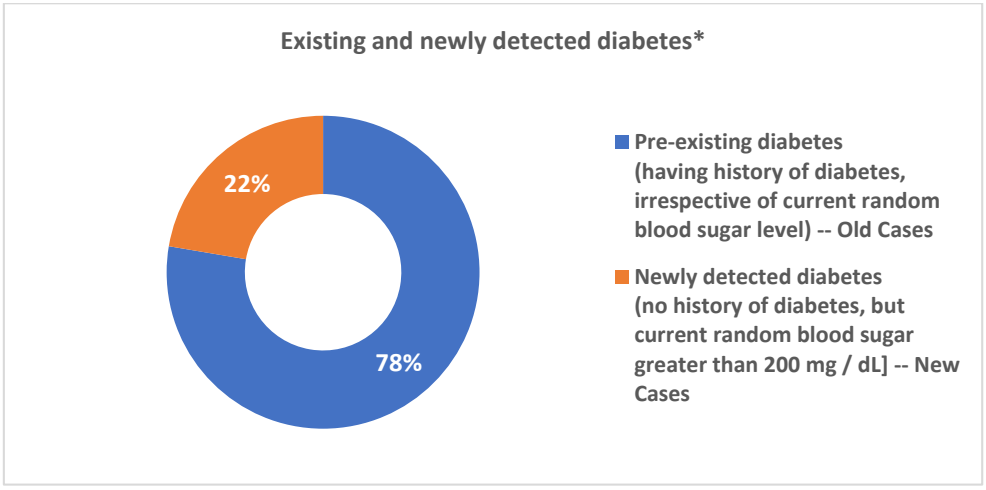
Fig 7: Prevalence of any morbidity (either hypertension or DM) and co-morbidity (both hypertension and DM)

Of the prevalent burden of the detected hypertension, a majority were identified during the survey (termed as 'new cases'), and can be assumed to be hitherto undiagnosed (depicted in Fig 8). However, for DM, more than three-fourth of the cases were pre-existing (Fig 9).



* Out of all diagnosed hypertension cases

Fig 8. Distribution of diagnosed hypertension cases that were detected during the project and that were pre-existing



* Out of all diagnosed DM cases

Fig 9. Distribution of diagnosed DM cases that were detected during the project and that were pre-existing

This suggests a considerable burden of undetected chronic ailments like hypertension and DM in the targeted rural settings, underscoring the need for rigorous public health strategies to mitigate the impact of these conditions. The following **Table 1** presents the detailed findings from the data.

Table 1: Distribution of demographic, behavioral and clinical parameters of the participants (N = 66553)#

Total No. of participants	**66553**		
	Mean	**Std. Dev**	
Age	43.8	13.4	
Height (In cms)	156.3	8.0	
Weight (In kg)	54.1	11.7	

Total No. of participants	**66553**		
Blood Pressure (SBP)	127.5	17.9	
Blood Pressure (DBP)	84.0	10.5	
Random Blood Sugar	111.8	42.0	
	No. of individuals	**Total Screened**	**%**
Age Category			
below 20 years	52	66496	0.1%
20 to 29 Years	1663	66496	2.5%
30 to 39 years	29296	66496	44.1%
40 to 49 Years	14910	66496	22.4%
50 to 59 Years	9437	66496	14.2%
60 and above	11138	66496	16.7%
Gender			
Female	35822	66553	53.8%
Male	30548	66553	45.9%
Caste			
Scheduled Tribes	3711	66553	5.6%
Scheduled Castes	6991	66553	10.5%
Other Backward Castes	25524	66553	38.4%
Other Castes / General Castes	30327	66553	45.6%
Pregnancy Status (among women)			
Non-Pregnant	28602	29548	96.8%
Pregnant	946	29548	3.2%
Alcohol Consumption Status			
Currently consuming	1151	43664	2.6%
Not currently consuming but used to consume in the past	628	43664	1.4%
Never consumed	41885	43664	95.9%
Smoking			
Currently smoking	8126	45419	17.9%
Not currently smoking but used to consume in the past	1743	45419	3.8%
Never smoked	35550	45419	78.3%

Total No. of participants	**66553**		
Physical activity			
No Exercise routine reported	20727	39534	52.4%
Some Exercise routine reported	18807	39534	47.6%
Normal BMI (18.5 to <25)			
Overall	38470	65445	58.8%
Female	20573	35104	58.6%
Male	17799	30160	59.0%

Values and percentages may not sum to total or 100% due to missing and rounded numbers

^ Based on measured BP (SBP≥140 mm Hg or DBP>90 mm Hg)

^^ Based on measured BP (120 mm Hg≤SBP<140 mm Hg or 80 mm Hg≤DBP<90 mm Hg)

* Based on measured random blood sugar (RBS≥200 mg/dL)

** Based on measured random blood sugar (140 mg/dL ≤RBS<200 mg/dL)

Table 2A delineates the characteristics of participants across their hypertension status. On a closer look, several epidemiologically pertinent trends seem to emerge. The age distribution reveals a proportional relationship between the prevalence of hypertension and advancing age cohorts, with the overall prevalence of hypertension (including pre-existing and newly detected cases) increasing from less than eight percent in individuals between 20-29 years to about 32.8% in those aged 60 years and above. This suggests a heightened susceptibility to hypertensive states with increasing age—a finding consistent with established cardiovascular risk profiles. Gender-specific data indicate a higher prevalence of normotension in females (18.8%) versus males (11.8%), concomitant with an elevated prevalence of pre-hypertension in males (68.2%). The higher incidence of normotension in females warrants further investigation into potential protective factors or reporting biases in this demographic. Among caste categories, 'Other Castes/General Castes' exhibited the lowest prevalence of normotension and the highest prevalence of hypertension (pre-existing + newly detected), suggesting potential variances in genetic predisposition or lifestyle factors conducive to higher blood pressure levels within this group. Pertaining to lifestyle determinants, the prevalence of normotension is inversely related to smoking and alcohol consumption behaviors, with past smokers and individuals with a history of alcohol consumption showing a higher prevalence of hypertension, especially pre-existing hypertension. Notably, the subset who are current smokers and current consumers of alcohol demonstrated the highest rates of newly detected hypertension, signifying a probable causal link warranting further exploration into these modifiable risk factors. Furthermore, the absence of an exercise routine emerged as a significant correlate of hypertension. Participants who reported no exercise routines exhibited the highest prevalence of hypertension (inclusive of both pre-existing and newly detected cases), underscoring the protective role of physical activity against hypertensive states.

Table 2A: Comparison of the demographic and behavioral characteristics of participants based on their hypertension status (N=66496)[#]

		Normotensive ^		**Pre-hypertensive^^**		**Hypertensive**			
	N					**Pre-existing hypertension^^^**		**Newly detected hypertension ^^^^**	
						[Old Cases]		**[New Cases]**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Age Category									
below 20 years	52	15	28.8%	26	50.0%	4	7.7%	6	11.5 %
20 to 29 Years	1663	493	29.6%	1034	62.2%	54	3.2%	78	4.7%
30 to 39 years	29296	5590	19.1%	19721	67.3%	1874	6.4%	2058	7.0%
40 to 49 Years	14910	2060	13.8%	9905	66.4%	1263	8.5%	1646	11.0 %
50 to 59 Years	9437	1128	12.0%	5983	63.4%	878	9.3%	1419	15.0 %
60 and above	11138	1090	9.8%	6378	57.3%	1493	13.4%	2157	19.4 %
Gender									
Female	35822	6750	18.8%	22139	61.8%	3098	8.6%	3749	10.5 %
Male	30548	3592	11.8%	20836	68.2%	2462	8.1%	3601	11.8 %
Caste									
Scheduled Tribes	3711	631	17.0%	2055	55.4%	673	18.1%	343	9.2%
Scheduled Castes	6991	1310	18.7%	4444	63.6%	430	6.2%	792	11.3 %

		Normotensive ^		Pre-hypertensive^^		Hypertensive			
	N					Pre-existing hypertension^^^		Newly detected hypertension ^^^^	
						[Old Cases]		[New Cases]	
		n	%	n	%	n	%	n	%
Other Backward Castes	25524	4328	17.0%	17067	66.9%	1438	5.6%	2630	10.3%
Other Castes / General Castes	30327	4113	13.6%	19518	64.4%	3031	10.0%	3607	11.9%
Pregnancy Status (among women)									
Non-Pregnant	28602	4763	16.7%	17683	61.8%	3163	11.1%	2926	10.2%
Pregnant	946	273	28.9%	532	56.2%	75	7.9%	65	6.9%
Smoking									
Currently smoking	8126	1291	15.9%	5244	64.5%	664	8.2%	914	11.2%
Not currently smoking but used to consume in the past	1743	150	8.6%	732	42.0%	719	41.3%	140	8.0%
Never smoked	35550	5738	16.1%	22435	63.1%	3938	11.1%	3358	9.4%
Alcohol Consumption Status									

		Normotensive ^		Pre-hypertensive^^		Hypertensive			
	N					Pre-existing hypertension^^^		Newly detected hypertension ^^^^	
						[Old Cases]		[New Cases]	
		n	%	n	%	n	%	n	%
Currently consuming	1151	96	8.3%	746	64.8%	70	6.1%	238	20.7 %
Not currently consuming but used to consume in the past	628	58	9.2%	321	51.1%	163	26.0%	86	13.7 %
Never consumed	41885	6563	15.7%	26248	62.7%	5096	12.2%	3887	9.3%
Physical activity									
No exercise routine reported	20727	3248	15.7%	11774	56.8%	3518	17.0%	2145	10.3 %
Some exercise routine reported	18807	3011	16.0%	12637	67.2%	1777	9.4%	1347	7.2%

Values and percentages may not sum to total or 100% due to missing and rounded numbers

Table 2B provides a cogent depiction of the association between demographic and behavioral characteristics with the prevalence of hypertension—encompassing both pre-existing and newly diagnosed cases. Age stratification elucidates a statistically significant positive association between increasing age and the prevalence of hypertension, culminating in a prevalence of about one-third (32.8%) in individuals aged 60 years and above, a finding that aligns with the widely recognised age-related progression of hypertensive risk ($p < .0001$). A marginally but statistically significant higher prevalence of hypertension was noted in males (19.8%) compared to females (19.1%) ($p = 0.0213$). This indicates a gender-specific divergence in hypertension manifestation, potentially attributable to biological, sociocultural, or

behavioral factors that merit further exploration. Caste distinctions revealed a substantial variance in hypertension prevalence, with the ST population displaying a significantly higher prevalence than the rest, suggesting that sociodemographic factors may exert a pronounced influence on hypertension risk ($p < .0001$). Among women, non-pregnant women exhibited a significantly higher prevalence than the pregnant ($p < .0001$). This contrast may reflect the physiological and hemodynamic changes inherent in pregnancy. Behavioral characteristics manifest notable associations with hypertension prevalence. Individuals with past history of smoking or alcohol consumption demonstrated a significantly higher prevalence of hypertension, suggesting that past smoking/ alcoholism behavior may have a lasting impact on hypertension risk ($p < .0001$). As expected, individuals reporting no exercise routines exhibited a significantly higher prevalence than those reporting some form of exercise ($p < .0001$).

Table 2B: Association of the demographic and behavioral characteristics of participants with hypertension (N=66496)[#]

	All diagnoses of hypertension [old + new cases]^			**p-value (Chi square)$**
	n	**N**	**%**	
Age Category				
below 20 years	10	52	19.2%	**<.0001**
20 to 29 Years	132	1663	7.9%	
30 to 39 years	3932	29296	13.4%	
40 to 49 Years	2909	14910	19.5%	
50 to 59 Years	2297	9437	24.3%	
60 and above	3650	11138	32.8%	
Gender				
Female	6847	35822	19.1%	**0.0213**
Male	6063	30548	19.8%	
Caste				
Scheduled Tribes	1016	3711	27.4%	**<.0001**
Scheduled Castes	1222	6991	17.5%	
Other Backward Castes	4068	25524	15.9%	
Other Castes / General Castes	6638	30327	21.9%	
Pregnancy Status (among women)				
Non-Pregnant	6089	28602	21.3%	**<.0001**
Pregnant	140	946	14.8%	

	All diagnoses of hypertension [old + new cases]^			p-value (Chi square)$
	n	N	%	
Smoking				
Currently smoking	1578	8126	19.4%	**<.0001**
Not currently smoking but used to consume in the past	859	1743	49.3%	
Never smoked	7296	35550	20.5%	
Alcohol Consumption Status				
Currently consuming	308	1151	26.8%	**<.0001**
Not currently consuming but used to consume in the past	249	628	39.6%	
Never consumed	8983	41885	21.4%	
Physical activity				
No exercise routine reported	5663	20727	27.3%	**<.0001**
Some exercise routine reported	3124	18807	16.6%	

Values and percentages may not sum to total or 100% due to missing and rounded numbers

^ Having pre-existing hypertension or measured BP above hypertension cut-off (SBP≥140 mm Hg or DBP>90 mm Hg)

$ Statistically significant associations ($p < 0.05$) depicted in bold fonts

The **Tables 3A** and **3B** elucidate the demographic and behavioral associations with diabetes status among the survey participants - stratified into non-diabetic, pre-diabetic, and diabetic (either with pre-existing diabetes or newly diagnosed cases of diabetes). We found a statistically significant ($p < .0001$) dose response in diabetes prevalence with advancing age, with the highest prevalence observed in the 60 and above age group. Females exhibited a marginal but significantly higher prevalence of diabetes (8.1%) compared to males (7.3%) ($p = 0.0009$). Assessment across caste categories reveals significant disparities in diabetes prevalence, with the ST participants showing a higher prevalence compared to the rest. Pregnant women demonstrated a lower prevalence of diabetes (6.1%) compared to non-pregnant women (9.5%), indicating potential physiological protective effects during gestation ($p < .0001$). Similar to hypertension, behavioral characteristics conveyed a substantial association with diabetes status. Individuals with a prior smoking or alcohol consumption history showed significantly elevated prevalence of diabetes than the rest, implying long-term consequences of these abusive substance on glycemic control ($p < .0001$). Exercising emerged

as a critical modifiable factor, with individuals reporting no exercise routines having the highest diabetes prevalence (15.2%), affirming the protective role of physical activity in diabetes management and prevention ($p < .0001$). These data illuminate the multifactorial nature of diabetes prevalence and underscore the necessity for targeted public health interventions to address the identified demographic disparities and modifiable lifestyle factors within this population.

Table 3A: Comparison of the demographic and behavioral characteristics of participants based on their diabetes status (N=66496)[#]

		Non-Diabetic*		**Pre-diabetic****		**Diabetic**			
	N					**pre-existing diabetes^**		**Newly detected Diabetes Mellitus^^**	
						[Old Cases]		**[New Cases]**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Age Category									
below 20 years	52	49	94.2%	1	1.9%	1	1.9%	1	1.9%
20 to 29 Years	1663	1466	88.2%	171	10.3%	20	1.2%	4	0.2%
30 to 39 years	29296	25995	88.7%	1546	5.3%	1511	5.2%	203	0.7%
40 to 49 Years	14910	12618	84.6%	1027	6.9%	972	6.5%	277	1.9%
50 to 59 Years	9437	7697	81.6%	860	9.1%	585	6.2%	285	3.0%
60 and above	11138	8546	76.7%	1288	11.6%	910	8.2%	379	3.4%
Gender									
Female	35822	30290	84.6%	2585	7.2%	2242	6.3%	660	1.8%
Male	30548	25964	85.0%	2308	7.6%	1748	5.7%	489	1.6%
Caste									
Scheduled Tribes	3711	2946	79.4%	189	5.1%	533	14.4%	37	1.0%
Scheduled Castes	6991	6065	86.8%	503	7.2%	288	4.1%	125	1.8%
Other Backward Castes	25524	22231	87.1%	1992	7.8%	927	3.6%	339	1.3%
Other Castes / General Castes	30327	25172	83.0%	2219	7.3%	2253	7.4%	650	2.1%
Pregnancy Status (among women)									

		Non-Diabetic*		Pre-diabetic**		Diabetic			
	N					pre-existing diabetes^		Newly detected Diabetes Mellitus^^	
						[Old Cases]		[New Cases]	
		n	%	n	%	n	%	n	%
Non-Pregnant	28602	23363	81.7%	2469	8.6%	2234	7.8%	497	1.7%
Pregnant	946	827	87.4%	60	6.3%	51	5.4%	7	0.7%
Smoking									
Currently smoking	8126	6742	83.0%	873	10.7%	349	4.3%	147	1.8%
Not currently smoking but used to consume in the past	1743	995	57.1%	126	7.2%	603	34.6%	18	1.0%
Never smoked	35550	29659	83.4%	2482	7.0%	2876	8.1%	491	1.4%
Alcohol Consumption Status									
Currently consuming	1151	927	80.5%	149	12.9%	31	2.7%	42	3.6%
Not currently consuming but used to consume in the past	628	436	69.4%	57	9.1%	124	19.7%	11	1.8%
Never consumed	41885	34395	82.1%	3185	7.6%	3675	8.8%	576	1.4%
Physical activity									
No exercise routine reported	20727	15849	76.5%	1703	8.2%	2835	13.7%	323	1.6%
Some exercise routine reported	18807	16322	86.8%	1238	6.6%	998	5.3%	215	1.1%

Values and percentages may not sum to total or 100% due to missing and rounded numbers

* No history of diabetes, and random blood suger below 140 mg / dL

** No history of diabetes, but current random blood sugar between 140-199 mg /dL

^ Having history of diabetes, irrespective of current random blood sugar level

^^ Having no history of diabetes, but current random blood sugar 200 mg / dL or above

Table 3B: Association of the demographic and behavioural characteristics of participants with diabetes (chi-square p-value) (N=66496)#

	All diagnoses of diabetes [old + new cases]*			**p-value (Chi square)$**
	n	**N**	**%**	
Age Category				
below 20 years	2	52	3.8%	**<.0001**
20 to 29 Years	24	1663	1.4%	
30 to 39 years	1714	29296	5.9%	
40 to 49 Years	1249	14910	8.4%	
50 to 59 Years	870	9437	9.2%	
60 and above	1289	11138	11.6%	
Gender				
Female	2902	35822	8.1%	**0.0009**
Male	2237	30548	7.3%	
Caste				
Scheduled Tribes	570	3711	15.4%	**<.0001**
Scheduled Castes	413	6991	5.9%	
Other Backward Castes	1266	25524	5.0%	
Other Castes / General Castes	2903	30327	9.6%	
Pregnancy Status (among women)				
Non-Pregnant	2731	28602	9.5%	**<.0001**
Pregnant	58	946	6.1%	
Smoking				
Currently smoking	496	8126	6.1%	**<.0001**
Not currently smoking but used to consume in the past	621	1743	35.6%	
Never smoked	3367	35550	9.5%	

	All diagnoses of diabetes [old + new cases]*			p-value (Chi square)$
	n	**N**	**%**	
Alcohol Consumption Status				
Currently consuming	73	1151	6.3%	**<.0001**
Not currently consuming but used to consume in the past	135	628	21.5%	
Never consumed	4251	41885	10.1%	
Physical activity				
No Exercise routine reported	3158	20727	15.2%	**<.0001**
Some Exercise routine reported	1213	18807	6.4%	

Values and percentages may not sum to total or 100% due to missing and rounded numbers

* Having history of diabetes or measured random blood sugar (RBS) value of 200 mg/dL or above

$ Statistically significant associations ($p < 0.05$) depicted in bold fonts

The associative trends between demographic and behavioral variables with the presence of either or both NCDs (hypertension and diabetes) are presented in **Table 4**. As is widely reported in published literature and as depicted individually for hypertension and diabetes, age emerged as a significant determinant of the prevalence of either or both NCDs, exhibiting an increasing trajectory with advancing years. Specifically, participants aged 60 and above demonstrate the highest prevalence of any NCD (35.3%) and co-morbidity (9.1%), substantiating a statistically significant age-related gradient in disease manifestation ($p < .0001$ for both categories). Gender variation did not yield a statistically significant variance in the prevalence of any single NCD; however, when assessing for co-morbidity, females presented a slightly (but significantly) lower prevalence (6.3%) compared to males (5.9%), suggesting nuanced gender dynamics in disease intersectionality. Similar to individual analyses, caste classification revealed marked disparities: ST group displayed the highest prevalence rates for any NCD (29.0%) and co-morbidity (7.6%), compared to other caste categories, a variation that was statistically significant ($p < .0001$ for both outcomes). Pregnant women again presented with a lower prevalence of any NCD and co-morbidity compared to non-pregnant women, with statistical significance ($p < .0001$), possibly indicating the influence of physiological adaptations during pregnancy on disease profiles. As with the individual NCDs, past history of smoking and alcohol consumption also displayed higher prevalence of both any NCD and co-morbidity than current smokers and never smokers ($p < .0001$ for both), suggesting lasting impacts of smoking and alcohol on health. A similar pattern was observed for physical activity as well, with individuals not engaging in any exercise routine presented with the highest prevalence of any NCD (29.3%) and co-morbidity (13.2%) ($p < .0001$ for both).

Table 4: Association of demographic and behavioral characteristics of participants with diagnosis of <u>any morbidity</u> (either hypertension or diabetes), or <u>co-morbidity</u> (both hypertension and diabetes) (N=66496)#

	N	All cases with diagnoses of <u>either</u> hypertension or diabetes [old + new cases]^*		p-value (Chi square)$		All cases with diagnoses of <u>both</u> hypertension and diabetes (co-morbidity of hypertension and diabetes) [old + new cases]^*		p-value (Chi square)$
		n	%			n	%	
Age Category								
below 20 years	52	10	19.2%	**<.0001**		2	3.8%	**<.0001**
20 to 29 Years	1663	147	8.8%			9	0.5%	
30 to 39 years	29296	4189	14.3%			1457	5.0%	
40 to 49 Years	14910	3204	21.5%			954	6.4%	
50 to 59 Years	9437	2527	26.8%			640	6.8%	
60 and above	11138	3930	35.3%			1009	9.1%	
Gender								
Female	35822	7487	20.9%	0.2773		2262	6.3%	**0.045**
Male	30548	6499	21.3%			1801	5.9%	
Caste								
Scheduled Tribes	3711	1077	29.0%			509	13.7%	
Scheduled Castes	6991	1312	18.8%			323	4.6%	
Other Backward Castes	25524	4474	17.5%	**<.0001**		860	3.4%	**<.0001**
Other Castes / General Castes	30327	7160	23.6%			2381	7.9%	
Pregnancy Status (among women)								
Non-Pregnant	28602	6651	23.3%	**<.0001**		2169	7.6%	**<.0001**
Pregnant	946	143	15.1%			55	5.8%	

	N	All cases with diagnoses of <u>either</u> hypertension or diabetes [old + new cases]^*		p-value (Chi square)$		All cases with diagnoses of <u>both</u> hypertension and diabetes (co-morbidity of hypertension and diabetes) [old + new cases]^*		p-value (Chi square)$
		n	%			n	%	
Smoking								
Currently smoking	8126	1696	20.9%	**<.0001**		378	4.7%	**<.0001**
Not currently smoking but used to consume in the past	1743	911	52.3%			569	32.6%	
Never smoked	35550	7890	22.2%			2773	7.8%	
Alcohol Consumption Status								
Currently consuming	1151	336	29.2%	**<.0001**		45	3.9%	**<.0001**
Not currently consuming but used to consume in the past	628	258	41.1%			126	20.1%	
Never consumed	41885	9690	23.1%			3544	8.5%	
Physical activity								
No exercise routine reported	20727	6081	29.3%	**<.0001**		2740	13.2%	**<.0001**
Some exercise routine reported	18807	3413	18.1%			924	4.9%	

Values and percentages may not sum to total or 100% due to missing and rounded numbers

^ Having pre-existing hypertension or measured BP above hypertension cut-off (SBP≥140 mm Hg or DBP>90 mm Hg)

* Having history of diabetes or measured random blood sugar (RBS) value of 200 mg/dL or above

$ Statistically significant associations ($p < 0.05$) depicted in bold fonts

Table 5 delineates the patterns of clinical referral following the diagnosis of the concerned NCDs in the study population. The referral patterns, as discerned by the project nurses to higher-level healthcare facilities or providers, have been statistically analysed using chi-square tests for significance across the different NCD groups. A substantial proportion of newly diagnosed hypertension cases (49.3%) resulted in referrals, which notably exceeds the referral rates for individuals with pre-existing hypertension. This might indicate an immediate clinical action triggered by the new diagnosis. For diabetes, the referral rate for newly diagnosed cases (89.8%) was exceptionally high, reflecting perhaps both the urgency of treatment initiation and the potential for acute complications associated with unmanaged diabetes. Also, the criterion used for determining diabetes (RBS ≥ 200 mg/dL) could have been considered a confirmatory diagnosis of diabetes (in the absence of oral glucose tolerance test and HbA1c), unlike that for hypertension (where a transient rise in BP could take SBP or DBP beyond the cut-off, resulting in false positive diagnosis). Individuals with pre-existing conditions of either hypertension or diabetes exhibited considerable referral rates as well, suggesting ongoing clinical management or complications necessitating further specialist consultation. Overall, the referral possibly underscores the perceived need for escalated care following an NCD diagnosis in this population. In stratified analyses, referrals for all types of morbidities were found to be statistically significant, indicating non-random associations between NCD diagnosis and subsequent healthcare referrals.

Table 5: Association of hypertension and diabetes diagnoses with case referral (participants who were referred by the project nurses to a healthcare facility/ provider) (N=66496)[#]

	Referred by the project nurse to a higher facility/ provider			**p-value (Chi square)$**
	n	**N**	**%**	
Hypertension [based on measured BP and pre-existing hypertension]				
Normotensive **[no pre-existing hypertension & current SBP <120 and DBP < 80 mm Hg]**	522	10382	5.0%	**<.0001**
Pre-hypertensive **(no pre-existing hypertension & SBP between 120 to 139 mm Hg or DBP between 80 to 89 mm Hg)**	2862	43084	6.6%	
Pre-existing hypertension (history of hypertension, irrespective of current SBP, DBP level) - **Old Cases**	2312	5572	41.5%	

	Referred by the project nurse to a higher facility/ provider			**p-value (Chi square)$**
	n	**N**	**%**	
Newly detected hypertension [no history of hypertension, but current SBP >=140 mm Hg or DBP>=90 mm Hg] -- **New Cases**	3637	7372	49.3%	
Diabetes [based on Random Blood Sugar and pre-existing diabetes]				
Non-Diabetic **[random blood suger below 140 mg / dL]**	5630	56414	10.0%	**<.0001**
Pre-diabetic **(no history of diabetes & random blood sugar between 140-199 mg / dL)**	1600	4903	32.6%	
Pre-existing diabetes (having history of diabetes, irrespective of current random blood sugar level) -- **Old Cases**	1088	4001	27.2%	
Newly detected diabetes [no history of diabetes, but current random blood sugar 200 mg / dL or above] -- **New Cases**	1034	1151	89.8%	
All diagnoses with either hypertension or diabetes [old + new cases]	6833	14023	48.7%	**<.0001**
All diagnoses with both hypertension and diabetes (co-morbidity of hypertension and diabetes) [old + new cases]	1238	4073	30.4%	**<.0001**

Values and percentages may not sum to total or 100% due to missing and rounded numbers

$ Statistically significant associations ($p < 0.05$) depicted in bold fonts

Conclusion and way forward

The meticulously conducted door-to-door NCD screening initiative has yielded vital epidemiological data on the prevalence and demographic as well as behavioral associations of hypertension and diabetes, in Risia and Huzoorpur blocks in Uttar Pradesh. The data compellingly highlight an age-progressive increase in the prevalence of both conditions, with a significant burden of undetected disease, accentuating the critical need for continuous, focused screening programs in these underserved populations.The project's findings also substantiate a correlation between lifestyle factors, such as physical inactivity, smoking, and alcohol consumption, with an increased incidence of these chronic ailments. Notably, the high rate of referrals for newly diagnosed hypertension and diabetes underpins the pivotal role of early detection and timely medical intervention, which could potentially mitigate the progression of these diseases and reduce the economic burden on the healthcare system.
These findings underline the urgency for culturally sensitive and behaviorally targeted public health interventions to mitigate the burgeoning burden of hypertension and diabetes, particularly focusing on high-risk groups identified through this investigation. Public health initiatives should also prioritise the integration of educational programs on lifestyle modifications, alongside expanding access to preventive and primary healthcare services. Such measures are imperative to arrest the silent escalation of NCDs in rural India.

This project serves as a harbinger, indicating the pressing demand for a robust, multi-tiered healthcare infrastructure that is capable of supporting an ageing population increasingly prone to NCDs. It underscores the indispensable value of primary healthcare workers as sentinels in identifying at-risk populations and facilitating their navigation through the healthcare continuum—from initial diagnosis to specialist care.