


# Temporal dynamics, patterns and correlates of single and multimorbidity in India, 1994–2018

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## Abstract

**Objective:** As a consequence of the epidemiological transition, multimorbidity has been identified as a critical public health challenge in India. The majority of the studies in the domain are grounded on hospital-based data or are based on small sample size, findings from which can only be generalized to a specific sub-group. These studies recommend exploring multimorbidity holistically at a national level to ensure adequate healthcare management in the country. Therefore, the present study examines the pattern and correlates of single and multimorbidity over the past two decades in India.

**Methods:** The study utilized data on 397901, 257519, and 399705 individuals from 52nd (1994–1995), 60th (2004–2005), and 75th (2018) rounds of cross-sectional data from the National Sample Survey (NSS). Univariate, bivariate, and multivariable statistical methods were applied to draw inferences from the data. The findings depict an increase in single and multimorbidity burden over individuals' age and NSS rounds.

**Results:** Hypertension and diabetes were the fastest-growing morbidities over time. Higher education, urban residence, and belonging to an affluent class were significantly associated with both single and multimorbidity occurrence over time.

**Conclusion:** The burden of single and multimorbidity increases over time among India's older adults. Therefore, there is an urgent need to recuperate chronic disease management strategies for older adults in the Indian healthcare infrastructure.

## Keywords

Chronic morbidity, communicable diseases, multimorbidity, non-communicable disease, older adults

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## Background

The coexistence of two or more chronic conditions<sup>1,2</sup> in an individual (multimorbidity) is an emerging public health concern in India. Especially during the COVID-19 era, multimorbidity has gained attention from the medical fraternity due to its widespread repercussions on the health of the infected individuals. Despite the existing literature, which highlights critical implications of multimorbidity, like, declining functional status, poor quality of life,<sup>3,4</sup> higher mortality risks,<sup>5</sup> increased healthcare utilization,<sup>6</sup> and economic liability on the patients' family<sup>5</sup> the trajectory of multimorbidity is inadequately explored in the national context.

The recent report from the Longitudinal Ageing Study in India (LASI) suggested that around eighteen and twenty-three

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percent of the individuals above the age of 45 years and 60 years were affected with multiple chronic conditions in the country, respectively.<sup>2</sup> By far, aging has been identified as the primary phenomenon responsible for disease burden and multimorbidity.<sup>7,8</sup> Nevertheless, a recent study conducted by Mohanty et al. (2021) highlighted morbidity expansion, especially for non-communicable diseases in India.<sup>6</sup> Morbidity expansion refers to a situation where the life expectancy increases, and the proportion of life spent with diseases and disability also increases simultaneously.<sup>6,9</sup> Morbidity expansion occurs when medical advances are successful in reducing the case fatality and mortality rates; however, the existing burden and pattern of morbidities (diseases) remain unchanged. This in turn, increases the life expectancy of the individuals (due to reduced mortality) but they continue to live with morbidity. Thus, morbidity burden on whole increases or “expands.”<sup>9</sup> Given this, age-invariance paradox<sup>10</sup> and premature morbidity<sup>6</sup> are the harsh realities of India’s current health scenario, which might increase the load on the existing healthcare infrastructure.<sup>11</sup> Thus, it becomes essential to explore, if not for aging, what are the other factors responsible for accelerating the multimorbidity burden in the country. Moreover, it would be interesting to explore the course of multimorbidity for India’s population.

India’s rigid social structure plays a vital role in rationalizing the existing disease burden.<sup>12</sup> Till date, social forces have been scrutinized in isolation; however, the effect of social influences on the environmental and behavioral factors is undeniable. Consequently, studying multimorbidity burden in the light of social factors becomes essential from the policy perspective.<sup>10</sup> Studies indicate that India is experiencing an upswing in the morbidity levels from the last two decades,<sup>13</sup> however, there are no shreds of evidence illustrating the temporal changes in multimorbidity burden. With an infrastructure primarily designed to cater to maternal and child health requirements, India needs to prepare its health system to support the complexities arising in the individuals affected by multimorbidity.<sup>14,15</sup> Thus, it ascends an urgent need to formulate well-informed policies and programs to address the intricacies that arise with multimorbidity. Hence, identifying trends in the prevalence of multimorbidity may assist policymakers by generating evidence that gives critical insights on the issue. Thus, the present study examines the temporal trends, patterns, and correlates of multimorbidity in India.

## Methods

### Data

The present study utilizes data from three completely independent rounds of the National Sample Survey (NSS), namely, 52nd round-Morbidity and Treatment of Ailments (July 1995–June 1996), 60th round-Morbidity, Health care and the Condition of the Aged (January–June 2004), and

75th round-Key indicators of Social Consumption in India: Health (July 2017–June 2018). NSS is conducted under the Ministry of Statistics and Programme Implementation (MoSPI) tutelage, Government of India (GoI), to provide data on various dimensions of health and healthcare in India.<sup>16</sup>

In the 52nd round, a two-stage stratified sampling was utilized considering census villages/panchayat (in rural areas) and urban frame survey (UFS) (in urban areas) as first-stage sampling units (FSU), and households were considered as second stage sampling unit in both the cases.<sup>16</sup> In the 60th and 75th round, a multi-stage sampling design was utilized, considering villages/panchayat in the rural sector and UFS blocks in the urban sector as FSU. Households were considered to be the ultimate sampling unit (USU) in both sectors. In large FSU, two sub-FSU were selected (which were hamlet group in the rural sector and sub-block UFS in the urban areas) as an intermediary stage.<sup>16</sup> All the estimates produced by the NSS data are representative at national and sub-national levels, this includes States/Union territories and regional level (agro-climatic and political regions).<sup>16</sup>

To fulfill the overall study objective, we utilized data on 107,836 (52nd (1994–95)), 81,146 (60th (2004–05)), and 130,553 (75th (2018)) older adults (45 years and above) from the different rounds of NSS. A description of sample selection is presented in [Table 1](#).

### Outcome and predictors

The present study utilized ten chronic morbidities: cancer, diabetes, goiter/thyroid disorder, heart disease, hypertension, hearing disorder, mental disorder/retardation, neurological disorder, tuberculosis, and vision disorder. A condition was considered chronic if, on the date of the survey, the ailment symptoms persisted for more than a month or the individual is undergoing treatment for the ailment for more than a month.<sup>16</sup> All the chronic morbidities included in the survey were self-reported and were recoded into binary form, i.e., present/absent. A chronic disease score was generated by summing up all the selected chronic morbidities, which resulted in the total number of chronic conditions for all individuals. The outcome of interest: chronic disease score was further classified into three categories: no morbidity, single morbidity, and multimorbidity (simultaneous occurrence of two or more chronic morbidities).

The study is based on the framework proposed by the World Health Organization’s (WHO) Commission on Social Determinants of Health (CSDH).<sup>17</sup> CSDH aimed to present a holistic framework to promote equity in global public health, keeping social justice at the core.<sup>17</sup> The framework was built to identify major correlates, including socioeconomic and political context, structural and intermediary determinants of health, and related events.<sup>17</sup> The study included all possible variables available in the NSS dataset. These variables include sex (men/women), residence (rural/urban), level of education

**Table 1.** Selection of sample size from various rounds of National Sample Survey, India, 1994–2018

Age range	National Sample Survey (NSS) Round		
	52nd (1994–95)	60th (2004)	75th (2017–18)
All ages	633408	383338	555352
15 years and above	397901	257519	399705
45 years and above	107836	81146	130553

(no education/ primary/ higher secondary and above), age-group (45–49 years/50–54 years /55–59 years/60–64 years/ 65–69 years/ 70 years and above), household size (one/two/ 3–5/6–8/9 or more), religion (Hindu/non-Hindu), social group (socially derived/socially accepted), Monthly per capita Consumption-Expenditure-MPCE (poor/middle/rich), and current marital status (married/not in union).

### Analysis

The study computed the prevalence (per 100000 population) of multimorbidity over age and time, i.e., for three NSS data rounds, 1994–2018. The prevalence (per 100000 population) was calculated using the equation below

$$\text{Prevalence} = \frac{\text{All new and existing cases during a given time period}}{\text{Surveyed individuals during the same time period}} * 100000$$

The computed estimates from above were utilized to identify the age after which the multimorbidity prevalence starts to rise (45 years or older).

Additional analysis was done on this selected sub-group from the total sampled individuals. A descriptive analysis, including unweighted frequency and weighted percentages, was done to describe the sample (45 years or older) under consideration for all NSS rounds. Further, the prevalence (per 100000 population) of selected chronic morbidities, both single and in combination (dyad and triad), were calculated to study these diseases' variation and progression. A p-trend value supplemented all these findings for the prevalence of single chronic conditions over time and chi-square ( $\chi^2$ ) p-value for chronic disease combinations.

A bivariate analysis was performed to apprehend the burden of single and multimorbidity by background characteristics over two decades; these findings were also supplemented by chi-square ( $\chi^2$ ) p-value. For multivariable analysis, a set of multinomial logistic regression models were fitted to identify the predictors of single and multimorbidity, respectively.

Stata version 15.0 (StataCorp™, Texas) and R version 1.1.463 (R Studio, Inc.) were used for the data wrangling, analysis, and visualization. All the estimates computed in this

study are derived by applying the National Sample Survey's sampling weights. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline (supporting document 1).

## Results

### *Burden and number of chronic morbidities over time (1994–2018)*

Figures 1 and 2 depicts the prevalence of single and multimorbidity over two decades, i.e., over three rounds of NSS, namely, 52nd (1994–1995), 60th (2004–05), and 75th (2018) for all adult population in India. Figure 1 shows the prevalence (per 100000 population) of single chronic condition by age over time. The figure illustrates that the prevalence of single morbidity increases with age. The prevalence rises after 45 years and increases further after the individual reaches 60 years of age. A similar pattern was observed in all the rounds of NSS.

The prevalence of single morbidity ranged between 73.31 per 100000 population to 995.38 per 100000 population, 516.28 per 100000 population to 5102.01 per 100000 population, and 161.51 per 100000 population to 17283.01 per 100000 population during the year 1994–95, 2004–05, and 2018, respectively (Figure 1).

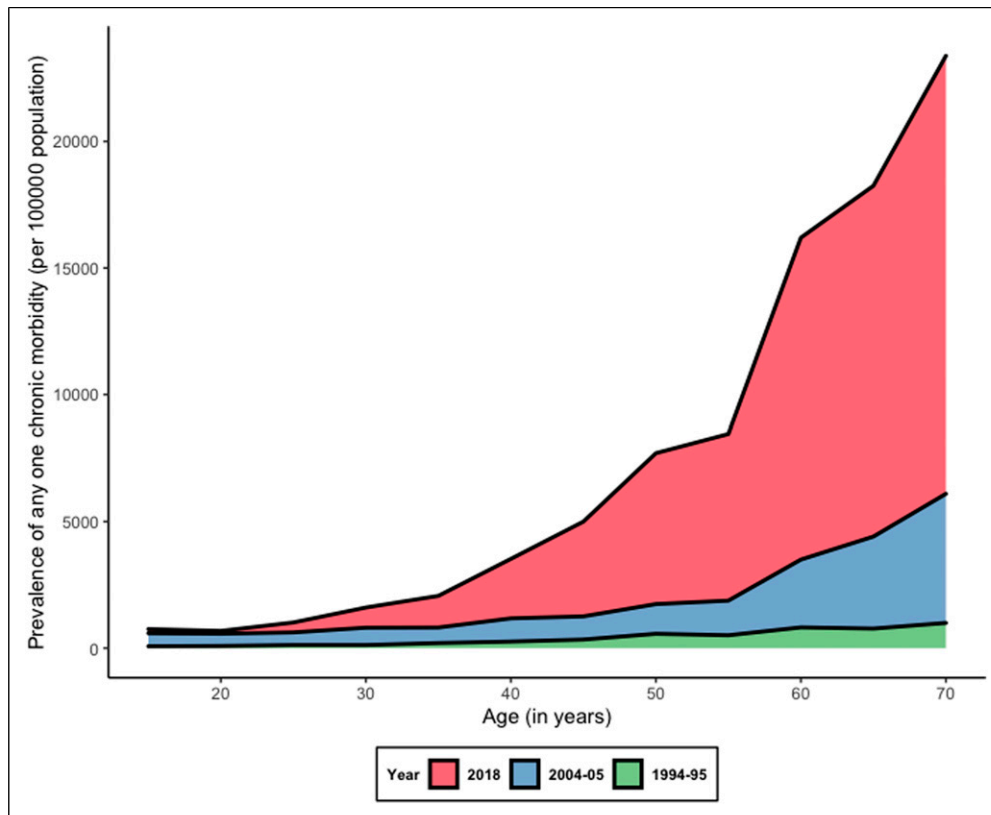
The prevalence of multimorbidity ranged between 0.03 per 100000 population to 0.05 per 100000 population, 1.67 per 100000 population to 302.68 per 100000 population, and 0.06 per 100000 population to 2333.12 per 100000 population during the year 1994–95, 2004–05, and 2018, respectively (Figure 2).

### *Descriptive statistics of the study variables*

Findings from the above section suggests that individual aged 45 years and older hold higher burden of single and multimorbidity. Table 2 provides the older adults' (individuals aged 45 years or older) socio-demographic profile from three rounds of the National Sample Survey (NSS).

### *Time trends of selected chronic conditions*

Table 3 provides the burden of selected morbidities, single and multimorbidity the past two decades. According to the



**Figure 1.** Prevalence of single chronic condition (per 100000 population) over age and time, National Sample Survey, India, 1994–2018

findings cancer ( $p$ -trend = .025), diabetes ( $p$ -trend = .000), goitre/thyroid disorder ( $p$ -trend = .002), heart disease ( $p$ -trend = .000), hypertension ( $p$ -trend = .000), and neurological disorder ( $p$ -trend = .000), were found to show a significantly increasing trend over time.

In the 60th round, hypertension, mental retardation/disorder and vision disorder were found to be the three most commonly occurring morbidities. Whereas, in the 52nd and 75th round hypertension, diabetes, and heart disease were found to be the three most commonly occurring diseases. Hypertension and diabetes were found to be the two fastest-growing morbidities over time in India.

### The burden of single and multimorbidity by background characteristics

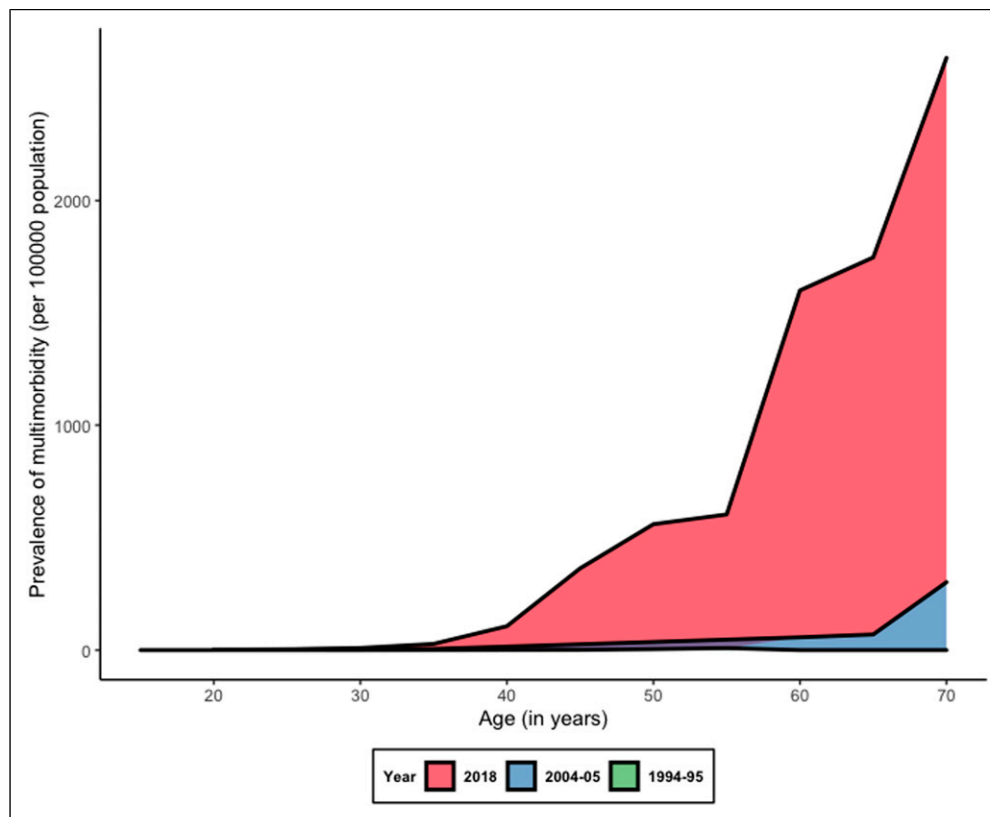
Table 4 illustrates the burden of single and multimorbidity by the sample's background characteristics under consideration over the three NSS rounds. Additionally, the bivariate associations were comprehended utilizing the  $\chi^2$ -statistics. The findings suggest that the prevalence of single morbidity was 1431, 2105, and 8085 per 100000 population for 1994–1995, 2004–2005, and 2018, respectively. Similarly, the prevalence of multimorbidity was 39, 53, and 898 per 100000 population for 1994–1995, 2004–2005, and 2018, respectively.

Findings suggest that place of residence, level of education, age of the respondents, MPCE and currently married were found to be significantly associated with single and multimorbidity in all the NSS rounds ( $\chi^2$   $p$ -value < .000). Whereas, household size, religion, caste, were found to be significantly associated with single and multimorbidity in NSS rounds 52nd and 75th ( $\chi^2$   $p$ -value < .000). Women reported higher burden of single and multimorbidity in the 75th round of NSS ( $\chi^2$   $p$ -value < .050).

### Correlates of single and multimorbidity among older adults

The results from multivariable analysis are presented in Table 5. Three multinomial models were executed for three-time points. Model 1, 2, and 3 illustrates the correlates associated with the single and multimorbidity for 1994–95, 2004–05, and 2018. For the present analysis, the base outcome is “no morbidity.”

Considering the findings from Table 5, level of education, age of the respondent, household size, religion, social group, and MPCE were found to be significantly associated with single morbidity. Respondents who were educated till primary level [RRR (CI): 52nd = 1.72 (1.35, 2.18); 60th = 1.53 (1.34, 1.74); 75th = 1.41 (1.27, 1.60)]; and secondary



**Figure 2.** Prevalence of multimorbidity (per 100000 population) over age and time, National Sample Survey, India, 1994–2018.

level [RRR (CI): 52nd = 1.66 (1.16, 2.37); 60th = 1.80 (1.54, 2.09); 75th = 1.44 (1.25, 1.64)] were more likely to be affected with single morbidity as compared to respondents with no education. Respondents who belonged to higher age-groups were more likely to be affected with single morbidity as compared to individuals in the age range 45–49 years. For instance, respondents aged 70 years or older [RRR (CI): 52nd = 1.87 (1.63, 2.20); 60th = 1.80 (1.54, 2.09); 75th = 6.16 (5.15, 7.37)], were more likely to report suffering from single morbidity than respondents individuals in the age range 45–49 years (Table 5).

Respondents from non-Hindu religion [RRR (CI): 52nd = 1.65 (1.28, 2.12); 60th = 1.37 (1.21, 1.55); 75th = 1.35 (1.21, 1.51)] were more likely to report suffering from single morbidity as compared to respondents following Hindu faith. Similarly, respondents belonging to socially accepted groups [RRR (CI): 60th = 1.23 (1.22, 1.55); 75th = 1.28 (1.13, 1.45)] were more likely to report suffering from single morbidity than respondents with socially deprived sections. Individuals from rich MPCE [RRR (CI): 52nd = 2.45 (1.36, 4.41); 60th = 2.07 (1.78, 2.41); 75th = 2.66(2.27, 3.11)] were more likely to be affected with single morbidity as compared to those belonging to poor MPCE (Table 5). Whereas, sex and place of residence were significantly associated single morbidity in 60th and 75th round. Women

respondents [RRR (CI): 60th = 1.25 (1.11, 1.41); 75th = 1.22 (1.09, 1.37)] and urban residents [RRR (CI): 60th = 1.43 (1.27, 1.60); 75th = 1.22 (1.09, 1.37)] were more likely to report suffering from single morbidity than their counterparts (Table 5).

Considering the findings from Table 5, age and social group were found to be significantly associated with multimorbidity in 52nd round. In addition, level of education, religion and MPCE were found to be significantly associated with multimorbidity in 60th and 75th round. Sex of the respondent, household size was associated with multimorbidity in 75th round (Table 5). Respondents who were educated till primary level [RRR (CI): 60th = 1.79 (1.22, 2.63); 75th = 1.41 (1.24, 1.60)] and secondary level [RRR (CI): 60th = 2.27 (1.45, 3.58); 75th = 2.52 (1.74, 3.65)] were more likely to be affected with multimorbidity as compared to respondents with no education (Table 5). Respondents from non-Hindu religion [RRR (CI): 60th = 1.48 (1.10, 2.02); 75th = 1.76 (1.38, 2.24)] were more likely to report suffering from multimorbidity as compared to respondents following Hindu faith. Individuals from rich MPCE [RRR (CI): 60th = 3.06 (1.91, 4.89); 75th = 4.59 (2.55, 8.24)] were more likely to be affected with multimorbidity as compared to those belonging to poor MPCE. In addition, women [RRR (CI): 75th = 1.49 (1.16, 1.91)] (Table 5).

**Table 2.** Descriptive statistics (Unweighted Frequency(Weighted Percentage)) of the study variables among older adults (45 years and over), National Sample Survey (NSS), India, 1994–2018

Correlates	National Sample Survey Round (Year)		
	52nd (1994–95)	60th (2004)	75th (2017–18)
Sex of the respondent			
Men	54924 (50.91)	40080 (50.49)	65184 (50.75)
Women	52912 (49.09)	41066 (49.51)	65369 (49.25)
Place of residence			
Rural	65292 (76.41)	51913 (73.75)	74185 (68.75)
Urban	42544 (49.09)	29233 (26.25)	56368 (31.25)
Education			
No education	65532 (65.88)	43487 (57.21 )	55242 (47.65)
Primary	24280 (20.35)	17846 (20.72)	27107 (20.27)
Higher secondary and above	18024 (13.77)	19783 (22.07)	48204 (32.07)
Age-group (in years)			
45–49	26962 (25.54)	17136 (24.60)	29668 (25.67)
50–54	22910 (21.13)	14164 (19.47)	27286 (21.46)
55–59	23942 (22.18)	15015 (19.47)	30837 (23.36)
60–64	11044 (9.91)	12526 (13.20)	15124 (10.66)
65–69	10080 (9.58)	10020 (10.58)	12645 (8.86)
70 and above	12856 (11.67)	12285 (12.68)	14993 (9.99)
Household size			
One	2666 (3.38)	1973 (3.07)	1746 (2.66)
Two	8022 (9.70)	7803 (10.71)	11530 (13.01)
3 to 5	38155 (38.62)	30700 (41.03)	57175 (47.64)
6 to 8	39224 (33.94)	28034 (31.96)	45391 (29.32)
Nine or more	19769 (14.36)	12636 (13.23)	14711 (7.37)
Religion			
Hindu	101634 (94.10)	64853 (84.54)	100521 (83.40)
Non-Hindu	6202 (5.90)	16293 (15.46)	30032 (16.60)
Social group			
Socially deprived	28540 (25.37)	21006 (25.49 )	35418 (26.26)
Socially accepted	79296 (73.63)	60140 (74.51)	95135 (73.74)
MPCE			
Poor	29800 (33.34)	20864 (30.78)	38249 (35.80)
Middle	33710 (33.33)	25990 (33.11)	40421 (30.90)
Rich	44326 (33.33)	34292 (36.11)	51883 (33.30)
Currently married			
Yes	81754 (75.16)	61226 (75.75)	105920 (80.23)
No	26082 (24.84)	19920 (24.25)	24633 (19.77)
Total	107836 (100.00)	81146 (100.00)	130553 (100.00)

## Discussion

Multimorbidity, defined as the simultaneous occurrence of two or more chronic conditions, is an emerging public health challenge in India. Individuals above the age of 45 years possess the highest-burden of multimorbidity in the country.<sup>11,15,18</sup> Although multimorbidity is becoming an extensively common phenomenon in the World, there are limited studies that extensively explore the domain. The

majority of the past studies are grounded on hospital-based data or are based on a small sample size, findings from which can only be generalized to a specific sub-group of the population. These studies recommend exploring multimorbidity holistically at a national level to ensure adequate healthcare management.<sup>18</sup> Thus, the present study was designed to present empirical findings in the multimorbidity domain to examine the burden and pattern of single and multimorbidity over age and time. Further, the study

**Table 3.** Prevalence (per 100000 population) of selected chronic morbidities among older adults over time, National Sample Survey (NSS), India, 1994–2018.

Chronic Diseases	National Sample Survey Round (Year)				Change per unit time		
	52nd (1994–95)	60th (2004)	75th (2017–18)	p-trend	52–60	52–75	60–75
Cancer	46.77	48.22	86.53	.025	0.15	1.73	2.95
Diabetes	318.93	113.8	3837.7	.000	-20.51	152.99	286.45
Goitre/Thyroid disorder	35.87	103.45	357.14	.002	6.76	13.97	19.51
Heart disease	210.99	466.62	906.14	.000	25.56	30.22	33.81
Hearing disorder	32.87	411.40	35.03	.000	37.85	0.09	-28.81
Hypertension	465.45	617.56	4088.06	.081	15.21	157.50	266.96
Mental disorder	38.25	359.85	101.02	.909	32.16	2.73	-19.91
Neurological disorder	103.83	93.26	472.31	.000	-1.06	16.02	29.16
Tuberculosis	122.60	26.41	74.44	.142	-9.62	-2.09	3.69
Vision disorder	135.32	343.78	348.50	.184	20.85	9.27	0.36
Single morbidity	1430.64	2105.74	8084.68	.016	67.51	289.31	459.92
Multimorbidity	38.94	53.28	897.50	.061	1.43	37.33	64.94

explored the burden of selected chronic morbidities and identified correlates of single and multimorbidity among older adults in India.

To study the burden of single and multimorbidity over time and age, the data on 397901, 257519, and 399705 individuals aged 15 years and above was utilized during NSS 52nd (1994–1995), 60th (2004–2005), and 75th (2018), respectively. The findings depict an increase in the level of single and multimorbidity burden over age and time, which increases sharply (statistically significant) as the individual crosses 45 years of age. Findings suggest that multimorbidity was a relatively rare concept until 1994–1995; however, it has become relatively common as time passed, especially among older adults in India (45 years and above). Therefore, the study included information on individuals above 45 years of age from three NSS rounds to study the epidemiology of single and multimorbidity among older adults in India. The estimates generated for 2018 suggest that 8085 and 898 individuals per 100000 older population were affected by single and multimorbidity among older adults in India.

Existing studies based on various community setup have identified age as one of the critical predictors of chronic disease burden (one or more), with a preponderance of multimorbidity in the individual above the age of 60 years.<sup>11,14,15</sup> Also, the increasing probability of NCDs onset at the age of 45 years was reported by other studies.<sup>19,20,21</sup> Both of these findings are analogous to the results exhibited in the present study. However, the estimates (prevalence per 100000 population) generated by the present study are slightly lower than the estimates presented in the studies bygone. This could be owed to the differences in the study setting, sample size and study design. The existing studies in India are based on smaller sample sizes,

most of which are conducted in selected geographical regions with data collected from healthcare setup. The estimates generated by these studies can only be generalized for a specific sub-group of the population.<sup>11,18,22</sup> On the other hand, all the chronic conditions included in the study were based on a nationally representative self-reported data, which might have resulted in a lower prevalence in the present study. The primary reason for increasing disease burden over age is the changes that an individual undergoes over their lifetime, which include genetic, environmental, social, and behavioral influences.<sup>23</sup> However, there are variations in the exposure to these influences between individuals; moreover, these declining body functions can be altered with healthier lifestyle choices.<sup>24</sup> This stipulates the inclusion of early interventions to improve the overall health scenario for the coming generations.

Findings suggest that hypertension, and diabetes were two fastest increasing morbidities over time. The burden of heart disease, thyroid disorder, cancer and neurological disorders has also increased over the past two decades. In contrast, the prevalence of hearing disorder reduced after 2004. These findings illustrate a transition in disease burden towards NCDs. This rise in the NCD-related disease burden was highlighted in the literature, which suggested that NCDs burden is increasing without replacing the communicable disease burden in India. This means that the prevalence of NCDs has increased over time; however, even after a substantial reduction in the level of communicable diseases, they still exist in specific geographical locations among selected sub-groups of the population in the country.<sup>13</sup> The present study's findings can result from the rising westernization and globalization in the country which stimulates a sedentary lifestyle with unhealthy dietary practices.<sup>25, 26</sup>

**Table 4.** Prevalence (per 100000 population) of the single and multimorbidity among older adults by background characteristics, National Sample Survey (NSS), India, 1994–2018.

National Sample Survey Round (Year)						
Correlates	52nd (1994–95)		60th (2004)		75th (2017–18)	
	Single morbidity	Multimorbidity	Single morbidity	Multimorbidity	Single morbidity	Multimorbidity
Sex of the respondent						
Men	1369.19 (1366.58, 1371.81)	51.81 (51.30, 52.33)	2030.53 (2027.65, 2033.42)	58.88 (58.39, 59.38)	7715.09 (7714.77, 7715.40)	797.85 (797.75, 797.96)
Women	1494.36 (1491.58, 1497.14)	25.59 (25.23, 25.96)	2182.43 (2179.42, 2185.45)	47.57 (47.12, 48.02)	8465.55 (8465.21, 8465.89)	1001.10 (1000.98, 1001.22)
	$\chi^2$ p-value = .471		$\chi^2$ p-value = .797		$\chi^2$ p-value = .006	
Place of residence						
Rural	1176.33 (1174.35, 1183.10)	33.34 (33.01, 33.68)	2175.48 (2173.02, 2177.95)	63.32 (62.89, 63.75)	6206.80 (6206.56, 6207.05)	660.06 (660.52, 660.69)
Urban	2254.54 (2249.64, 2259.46)	57.08 (56.29, 57.87)	1909.84 (1905.97, 1913.73)	25.09 (24.64, 25.54)	12216.38 (12215.89, 12216.88)	1420.16 (1419.98, 1420.33)
	$\chi^2$ p-value = .000		$\chi^2$ p-value = .000		$\chi^2$ p-value = .000	
Education						
No education	1100.08 (1098.02, 1102.15)	22.54 (22.25, 22.84)	2276.82 (2273.96, 2279.69)	77.70 (77.17, 78.24)	6297.81 (6297.51, 6298.11)	447.30 (447.22, 447.39)
Primary	2041.60 (2036.57, 2046.64)	27.54 (26.95, 28.14)	2129.75 (2125.14, 2134.36)	31.57 (31.01, 32.14)	9086.75 (9086.21, 9087.29)	1344.13 (1343.91, 1344.35)
Higher secondary and above	2109.36 (2103.15, 2115.59)	134.27 (132.69, 135.86)	1629.23 (1625.32, 1633.15)	10.44 (10.13, 10.76)	10106.30 (10105.85, 10106.75)	1285.51 (1285.34, 1285.68)
	$\chi^2$ p-value = .000		$\chi^2$ p-value = .000		$\chi^2$ p-value = .000	
Age-group (in years)						
45–49	818.24 (815.38, 821.11)	2.14 (1.96, 4.43)	916.39 (913.61, 919.19)	5.10 (4.75, 6.78)	3743.72 (3743.41, 3744.04)	363.04 (362.94, 363.14)
50–54	1013.40 (1009.91, 1016.91)	15.00 (14.75, 27.09)	1173.93 (1170.39, 1177.48)	18.96 (9.68, 11.53)	5960.90 (5960.47, 5961.33)	556.61 (556.47, 556.74)
55–59	1090.71 (1087.17, 1094.26)	20.13 (1.98, 2.30)	1369.43 (1365.91, 1373.56)	25.07 (22.10, 28.09)	6579.95 (6579.51, 6580.38)	595.21 (595.07, 595.34)
60–64	2947.02 (2938.40, 2955.67)	105.87 (104.23, 107.55)	2679.14 (2672.70, 2685.60)	57.10 (56.15, 58.06)	12699.96 (12699.09, 12700.82)	1542.83 (1542.51, 1543.15)
65–69	2049.84 (2042.50, 2057.20)	106.44 (104.96, 108.35)	3635.42 (3627.07, 3643.79)	69.72 (68.55, 70.91)	13840.19 (13839.21, 13841.17)	1677.28 (1676.92, 1677.65)
70 and above	2374.61 (2367.47, 2381.77)	151.98 (150.16, 153.82)	5102.01 (5093.04, 5111.00)	302.68 (300.45, 304.93)	17283.01 (17282.00, 17284.02)	2333.12 (2332.72, 2333.52)
	$\chi^2$ p-value = .000		$\chi^2$ p-value = .000		$\chi^2$ p-value = .000	
Household size						
One	1103.03 (1093.95, 1112.20)	26.35 (24.97, 27.80)	2445.74 (2432.98, 2458.58)	90.65 (88.19, 93.18)	13270.99 (13269.23, 13272.75)	3116.73 (3115.83, 3117.63)

(continued)



Table 4. (continued)

		National Sample Survey Round (Year)			
		60th (2004)		75th (2017–18)	
Correlates	52nd (1994–95)	Single morbidity	Multimorbidity	Single morbidity	Multimorbidity
Two	2205.44 (2197.88, 2213.03)	2520.41 (2513.47, 2527.38)	3.18 (2.90, 3.48)	104.39 (102.97, 105.83)	10571.81 (10571.09, 10572.53)
3 to 5	1658.39 (1655.09, 1661.69)	1946.10 (1942.97, 1949.23)	55.85 (55.24, 56.46)	312.60 (308.60, 316.60)	8276.98 (8276.64, 8277.32)
6 to 8	1101.76 (1098.89, 1104.64)	2088.58 (2084.91, 2092.26)	38.13 (37.60, 38.68)	590.60 (584.40, 596.80)	6733.51 (673.12, 6733.90)
Nine or more	1149.25 (1144.74, 1153.77)	2227.67 (2221.79, 2233.57)	22.50 (21.87, 23.14)	575.70 (566.20, 585.40)	5953.82 (5953.08, 5954.55)
Religion	$\chi^2$ p-value = .000	$\chi^2$ p-value = .0941			$\chi^2$ p-value = .000
Hindu	1305.66 (1303.79, 1307.55)	2089.10 (2086.84, 2091.36)	31.99 (31.70, 32.29)	56.56 (56.18, 56.93)	7636.37 (7636.12, 7636.61)
Non-Hindu	3423.77 (3411.76, 3435.81)	2196.78 (2191.37, 2202.20)	149.77 (147.24, 152.35)	35.37 (34.68, 36.07)	10336.71 (10336.07, 10337.34)
Social group	$\chi^2$ p-value = .000	$\chi^2$ p-value = .341			$\chi^2$ p-value = .000
Socially deprived	13.80 (13.44, 14.18)	2013.79 (2009.76, 2017.84)	13.80 (13.44, 14.18)	52.39 (51.74, 53.05)	5158.74 (5158.37, 5159.10)
Socially accepted	47.94 (47.54, 48.36)	2137.19 (2134.76, 2139.62)	47.94 (47.54, 48.36)	53.59 (53.20, 53.98)	9126.62 (9126.34, 9126.91)
MPCE	$\chi^2$ p-value = .000	$\chi^2$ p-value = .737			$\chi^2$ p-value = .000
Poor	736.60 (734.22, 738.98)	2072.29 (2068.57, 2076.03)	8.78 (8.52, 9.04)	64.50 (63.84, 65.17)	3844.80 (3844.53, 3845.07)
Middle	1089.72 (1086.84, 1092.61)	2014.37 (2010.83, 2017.92)	58.94 (58.27, 59.62)	61.00 (60.38, 61.63)	7600.95 (7600.55, 7601.36)
Rich	2466.11 (2461.80, 2470.43)	2218.01 (2214.46, 2221.58)	49.12 (48.50, 49.74)	36.64 (36.18, 37.10)	13092.54 (13092.04, 13093.03)
Currently married	$\chi^2$ p-value = .000	$\chi^2$ p-value = .000			$\chi^2$ p-value = .000
Yes	1315.97 (1313.86, 1318.08)	1734.12 (1731.94, 1736.30)	33.43 (33.09, 33.77)	22.88 (22.63, 23.13)	7392.38 (7392.13, 7392.62)
No	1777.65 (1773.40, 1781.92)	3266.79 (3261.55, 3272.04)	55.63 (54.87, 56.39)	148.27 (147.14, 149.41)	10893.91 (10893.32, 10894.50)
Total	$\chi^2$ p-value = .000 1430.64 (1428.73., 1432.55)	$\chi^2$ p-value = .000 2105.74 (2103.66, 2017.83)	38.94 (38.62, 39.26)	53.28 (52.95, 53.62)	8084.68 (8084.45, 8084.91)
					1822.83 (1822.63, 1823.02)
					248.59 (248.52, 248.66)
					653.74 (653.62, 653.87)
					1822.83 (1822.63, 1823.02)
					794.47 (794.39, 794.55)
					1317.84 (1317.63, 1318.06)
					897.50 (897.70, 898.30)

**Table 5.** Adjusted Relative Risk Ratio (RRR) of having single or multimorbidity among older adults by background characteristics, National Sample Survey (NSS), India, 1994–2018.

Correlates	Model 1		Model 2		Model 3	
	52nd (1994–95)		60th (2004–05)		75th (2018)	
	Any One	Multimorbidity	Any One	Multimorbidity	Any One	Multimorbidity
Sex of the respondent						
Men (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Women	1.14 (0.92, 1.41)	0.81 (0.29, 2.22)	1.25 <sup>***</sup> (1.11, 1.41)	1.04 (0.74, 1.44)	1.17 <sup>***</sup> (1.06, 1.30)	1.49 <sup>***</sup> (1.16, 1.91)
Place of residence						
Rural (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Urban	1.08 (0.88, 1.32)	1.44 (0.55, 3.75)	1.43 <sup>***</sup> (1.27, 1.60)	2.18 <sup>***</sup> (1.58, 3.02)	1.22 <sup>***</sup> (1.09, 1.37)	0.90 (0.69, 1.17)
Education						
No education (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Primary	1.72 <sup>***</sup> (1.35, 2.18)	0.72 (0.26, 1.97)	1.53 <sup>***</sup> (1.34, 1.74)	1.79 <sup>***</sup> (1.22, 2.63)	1.41 <sup>***</sup> (1.24, 1.60)	1.66 <sup>***</sup> (1.27, 3.61)
Higher secondary and above	1.66 <sup>***</sup> (1.16, 2.37)	3.32 (0.34, 12.75)	1.80 <sup>***</sup> (1.54, 2.09)	2.27 <sup>***</sup> (1.45, 3.58)	1.44 <sup>***</sup> (1.25, 1.64)	2.52 <sup>***</sup> (1.74, 3.65)
Age-group (in years)						
45–49 (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
50–54	1.30 (0.98, 1.62)	1.43 (0.40, 1.56)	1.53 <sup>***</sup> (1.48, 1.93)	1.44 (0.98, 1.34)	1.68 <sup>***</sup> (1.40, 2.02)	1.66* (0.96, 2.86)
55–59	1.40 <sup>**</sup> (1.36, 1.45)	1.57 (0.43, 1.71)	1.66 <sup>**</sup> (1.53, 1.91)	0.53 (0.23, 0.73)	2.05 <sup>***</sup> (1.73, 2.44)	2.15 <sup>***</sup> (1.27, 3.62)
60–64	1.63* (1.45, 1.81)	1.63 (0.99, 1.81)	1.78 <sup>**</sup> (1.75, 1.81)	0.75 (0.67, 2.34)	4.07 <sup>***</sup> (3.39, 4.88)	5.50 <sup>***</sup> (3.39, 8.94)
65–69	1.79 <sup>***</sup> (1.57, 2.09)	1.48 <sup>***</sup> (1.18, 2.30)	1.93 <sup>***</sup> (1.34, 2.74)	1.01 (0.71, 1.43)	4.67 <sup>***</sup> (3.85, 5.65)	6.58 <sup>***</sup> (3.99, 10.84)
70 and above	1.87 <sup>***</sup> (1.63, 2.20)	1.92 <sup>**</sup> (1.28, 2.99)	1.80 <sup>***</sup> (1.54, 2.09)	1.41* (0.98, 2.01)	6.16 <sup>***</sup> (5.15, 7.37)	10.26 <sup>***</sup> (6.40, 16.43)
Household size						
One (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Two	1.69* (0.98, 2.92)	0.87 (0.12, 6.13)	1.37 <sup>**</sup> (1.06, 1.78)	1.16 (0.57, 2.36)	0.77* (0.59, 0.99)	0.36 <sup>***</sup> (0.18, 0.70)
3 to 5	1.49 (0.85, 2.61)	3.59 (0.80, 16.15)	1.49 <sup>***</sup> (1.18, 1.89)	1.40 (0.73, 2.65)	0.75 <sup>**</sup> (0.58, 0.97)	0.36 <sup>***</sup> (0.19, 0.66)
6 to 8	1.07 (0.65, 1.74)	0.94 (0.16, 5.34)	1.30 <sup>**</sup> (1.02, 1.66)	1.52 (0.78, 2.92)	0.65 <sup>***</sup> (0.49, 0.84)	0.24 <sup>***</sup> (0.12, 0.49)
Nine or more	1.24 (0.74, 2.08)	1.42 (0.21, 9.58)	1.17 (0.89, 1.52)	0.91 (0.43, 1.91)	0.56 <sup>***</sup> (0.42, 0.77)	0.11 <sup>***</sup> (0.04, 0.28)
Religion						
Hindu (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Non-Hindu	1.65 <sup>***</sup> (1.28, 2.12)	0.73 (0.27, 1.90)	1.37 <sup>***</sup> (1.21, 1.55)	1.48 <sup>***</sup> (1.10, 2.02)	1.35 <sup>***</sup> (1.21, 1.51)	1.76 <sup>***</sup> (1.38, 2.24)
Social group						
Socially deprived (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Socially accepted	1.41* (0.99, 2.00)	3.92* (0.96, 12.14)	1.23 <sup>***</sup> (1.22, 1.55)	1.43 (0.89, 2.27)	1.28 <sup>***</sup> (1.13, 1.45)	1.83 <sup>***</sup> (1.21, 2.78)
MPCE						
Poor (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	1.60 (0.91, 2.82)	0.75 (0.21, 2.63)	1.28 <sup>***</sup> (1.11, 1.49)	1.52* (0.93, 2.47)	1.82 <sup>***</sup> (1.57, 2.11)	2.15 <sup>***</sup> (1.17, 3.95)
Rich	2.45 <sup>***</sup> (1.36, 4.41)	0.42 (0.12, 1.45)	2.07 <sup>***</sup> (1.78, 2.41)	3.06 <sup>***</sup> (1.91, 4.89)	2.66 <sup>***</sup> (2.27, 3.11)	4.59 <sup>***</sup> (2.55, 8.24)
Currently married						
Yes (Ref.)	1.00	1.00	1.00	1.00	1.00	1.00
No	1.22 (0.94, 1.59)	0.47* (0.19, 1.14)	1.19 <sup>***</sup> (1.04, 1.34)	1.07 (0.89, 2.27)	1.01 (0.89, 1.15)	0.85 (0.63, 1.15)

Legend: \**p* < .1, \*\**p* < .05, \*\*\**p* < .01, \*\*\*\**p* < .001.

Hypertension and diabetes were highlighted as frequently occurring chronic conditions in other studies conducted in LMICs.<sup>15,27,28</sup> Our study findings highlighted that the prevalence of thyroid disorder, cancer, and neurological disorder is also booming over time. This increased disease prevalence could be caused by the cognizance that hypertension, diabetes, cardiovascular disease, and cancer have received amidst the national programme for prevention & control of cancer, diabetes, cardiovascular diseases & stroke (2010).<sup>29</sup>

Higher education, urban residence, and belonging to rich MPCE were found to be significantly associated with the occurrence of single and multimorbidity over time. All the three indicators, education, urban living and belonging to rich MPCE are widely identified as correlates of one or more chronic conditions by the existing studies in India.<sup>11,20,30</sup>

However, the information collected in the NSS survey was based on self-reporting, and all prevalent conditions and disease combinations identified by the present study are non-communicable, and therefore require a certain amount of health literacy to detect. Higher education, urban residence, and wealth are three major indicators which improves the awareness regarding overall health and well-being. Moreover, these indicators are directly associated with the affordability, availability, accessibility, accommodation and acceptability of healthcare services in any community.<sup>31</sup> Thus, the prevalence was higher among those with superior resources in the context of wealth, education, and consequently, health literacy and healthcare infrastructure. Another possible reason is the higher exposure of risky health behaviors, including low level of physical activity, higher body mass index, higher chances of increased adiposity, easy access and higher consumption to unhealthy diet (rich in carbohydrates and sugar) and alcohol among wealthier stratum in low-and-middle-income countries.<sup>12,32</sup>

In the NSS-75th round, women were more likely to suffer from multimorbidity, showing a shift of multimorbidity burden towards women over time. Our findings are in concordance with the existing literature, which suggests that women are less likely to be affected with morbidities in the purely biological sense.<sup>33</sup> However, owing to the deeply embedded gender and social inequity in low-and-middle-income societies, which overrides these biological advantages, women are more likely to be affected with multiple morbid conditions, this is generally known as “feminization of multimorbidity.”<sup>14,33,34</sup>

### **Strengths and limitations**

The present study is the first of its kind to explore multimorbidity in India’s context holistically. The study highlights the age group (45 years) after which the burden of multimorbidity rises. The study’s major strength is that the

study utilizes large-scale nationally represented data from NSS over two decades, thus enabling us to understand the changes in the burden over age and time. The study includes ten chronic conditions; however, all the diseases were self-reported, resulting in under-representing the issue at hand. In addition, to study trends, diseases which are available in all the NSS rounds were included in the analysis, which might have resulted in misclassification of an individual from morbid to healthy or the same might have affected the prevalence estimates of multimorbidity. Moreover, as the authors were keen on reporting only statistically significant disease combinations, no dyad or triad (a combination of two or three diseases) were identified from the study. As the study utilizes three rounds of completely independent cross-sectional data, no causal inferences were evaluated.

### **Implications**

The present study highlights that the burden of single and multimorbidity increases over age and time, with a preponderance among older adults in India. Multimorbidity among older adults is often linked with amplified functional decline, poor quality of life, and frequent use of healthcare services.<sup>15,34</sup> This accelerating disease burden among older adults could deteriorate the economic well-being of the individual and can further intensify the pressure on the already fragile healthcare infrastructure in the country. NCD management in India is traditionally based on the “single disease model,” which is not optimally oriented for multiple disease management among older adults.<sup>11,23,27</sup> Multimorbidity demands intricate healthcare needs, which are not adequately understood by a vast majority of physicians. A study in the domain suggests that multiple healthcare specialists’ visits could lead to polypharmacy.<sup>23</sup> This could source an increased risk of drug interaction in the form of reduced treatment efficacy and increased adverse effects.<sup>23</sup> As deteriorating body function is a vital component of aging, polypharmacy and drug interaction become serious distress for older adults. Therefore, there is an urgent requirement of a substantial shift from the tradition to a more patient-centered approach, keeping geriatric population at the core. Indian healthcare infrastructure should be redesigned to holistically cater to the geriatric population’s growing healthcare needs, keeping the out-of-pocket healthcare expenditure to a minimal level ensuring an adequate amount of personal competence.

### **Conclusion**

The burden of multimorbidity is increasing over time among the older adults in India. Therefore, there is an urgent need to recuperate chronic disease management strategies with enhanced personal competency by the service providers, keeping the women population at the core.

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## Author contributions

PP contributed in conceptualization, formal analysis, methodology, writing-original, draft preparation, writing-review and editing. SSK and PS contributed in writing-review and editing.

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## Availability of data and materials

The study utilizes de-identified data from three rounds of NSS health surveys, 1994-2018, held in the public repository of the MoSPI, and can be downloaded using the link: <http://www.mospi.gov.in/download-tables-data>.

## Ethics approval

The ethical clearance on the survey and its instrumentation were obtained from the National Sample Survey Office; further additional approvals were taken from the individuals who participated in the survey.

## Informed consent

A consent form, pre-approved by the Ethics Review Committee (ERC), NSS was signed by the individual, acknowledging that they fully understood the study purpose and agreed to participate in the survey.

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