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Effect of Multiple Health Risk Factors on Non-Communicable Diseases among Older Adults: Insights from the SAGE Wave-1

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Abstract

The rise in health risk factors is a serious concern, adding to the worldwide burden of chronic diseases and affecting public health, particularly among older people. This explores the multidimensional nature of multiple health risk parameters and their relationship with non-communicable diseases (NCDs) in older adults in SAGE nations. We used data from the WHO's study of Global Ageing and Adult Health (SAGE) Survey Wave-1 (2007-2010), and analysed the information of 33,922 (15,594 males and 18,328 females) people aged 50 years or above in six SAGE countries. We created a composite score of multiple health risk factors and NCDs by socioeconomic characteristics using bivariate and multivariate statistics models. The study finds that 5 per cent have no health risk factors and about 70 per cent are living with 2-5 health risk factors in all SAGE countries. The older adults living with six or more health risk factors were found to be the highest in South Africa (26%) followed by India (22%). The findings also highlight the relatively low burden of health risk factors among Chinese older adults. The increase in a number of health risk factors increases the NCDs. Prioritizing health education and socioeconomic upliftment can lower the health risk factors and enhance health outcomes for older persons.

Keywords: Multiple risk factors, non-communicable diseases, older adults, SAGE wave-1.

I. Introduction

Today, the rise in health risk factors has become a major concern, adding to the growing burden of chronic diseases globally and affecting public health and well-being, particularly among the older population. These risk factors, which often work together and amplify each other's effects, include a range of biological, environmental, psychosocial and lifestyle factors that directly or indirectly affect our health. As individuals age, they become increasingly susceptible to multiple health issues, necessitating a comprehensive understanding of the factors contributing to these challenges. While ageing itself is a natural process, the accumulation of health risk factors can significantly affect the burden of chronic diseases and compromise overall well-being. Additionally, the global population has increased significantly in the past few decades, with the elderly population (60 years and above) also rising rapidly. According to the UN World Population Ageing Report 2017, 12.7 per cent of the global population is aged 60 years and above.

The World Health Organization (WHO) identifies five major health risk factors: tobacco use, alcohol consumption, poor diet, physical inactivity, and overweight and obesity (WHO, 2009). It defines a risk factor as "any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury." Other risk factors include underweight, unsafe sex, high blood pressure, and unsafe water, sanitation, and hygiene (WHO, 2009). Additionally, sleep disorders and pollution are emerging risk factors that increase health-related problems (Lin et al., 2017; Cybulski et al., 2019). Phaswana-Mafuya and colleagues (2013) further identified multiple socio-demographic predictors of non-communicable health risk factors among older adults, such as

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inadequate physical activity, overweight, and hypertension. Risk factors are often considered in isolation and in relation only to specific diseases or injuries. Some risk factors often coexist and have significant effects on health.

The health risk factors might occur together and interact with one another, so having two or more may have a greater effect than might be expected from the effect of each factor (Lwader, 2010; Meader, 2016). Hence, multiple health risk factors (MHRFs) can be defined as "the presence of two or more health behaviours or conditions that increase an individual's likelihood of developing adverse health outcomes." The presence of MHRFs in a population will increase the number of diseases (mainly NCDs), and also affect the overall wellbeing of the population. The WHO Report, 2009 estimates that health risk factors contribute around 90 per cent of the total burden of disease in high-income country populations.

Addressing these challenges requires a multifaceted approach that encompasses both primary and secondary risk factors. Primary risk factors such as injury, social determinants and mental health disorders among older adults are critical focal points for preventative interventions. However, the complexity of the health landscape is further compounded by secondary factors like sleep disorders and pollution which increases health-related issues (Cybulski et al., 2019; Lin et al., 2017). Social determinants, including loneliness and social isolation, have emerged as significant contributors to poor health outcomes among older adults (Shankar et al., 2011). Environmental factors such as air pollution play an important role in the development and maintenance of healthy behaviour, whereas behavioural and lifestyle factors help in maintaining healthy lifestyle throughout the lifespan, particularly eating a balanced diet, engaging in regular physical activity and refraining from tobacco use. They all contribute to reducing the risk of NCDs and improving physical capacity. However, exposure to health risks during adulthood also influences health in older age. For example, exposure to toxic substances at the workplace or at home, arduous physical work, smoking, alcohol consumption, diet and physical activity may have long-term implications for older adults (WHO, 2011).

Furthermore, socio-demographic factors and geographical variations underscore the intricate interplay between risk factors and health outcomes (Avendano et al., 2009). Avendano and colleagues found that Americans reported worse health conditions than individuals in England and Europe, highlighting the impact of various lifestyle behaviours. Europeans had higher rates of current smoking, but Americans had a higher prevalence of ever smoking, indicating greater cumulative health risks for them.

In SAGE countries (China, Ghana, India, Mexico, Russian Federation and South Africa), common risk factors disproportionately affecting the older population include tobacco use, alcohol consumption, physical inactivity, pollution, poor nutrition, sleep disorders and diabetes (Avendano et al., 2009; Torres et al., 2014; Lin et al., 2017; Cybulski et al., 2019). Additionally, loneliness and social isolation (Shankar et al., 2011) are significant contributors to depression among the elderly. Arokiasamy and others (2015) found notable variations in health conditions within SAGE countries, with Russia showing the highest prevalence of multi-morbidity at 34.7 per cent, compared to 20.3 per cent in China. They also reported 5.7 per cent prevalence of depression, 11.6 per cent of self-rated poor health and the mean quality of life score was 54.4 on a scale of 0-100. Interestingly, multi-morbidity was more common among those with better socioeconomic status. Patel and others (2019) emphasized the role of alcohol consumption, smoking and tobacco use as major health risk factors in low- and middle-income countries. Their study in SAGE countries revealed that 43 per cent of people used tobacco products, 17 per cent consumed alcohol and 22 per cent were physically inactive, indicating significant health risks.

MHRFs is an emerging concept that assesses all the health risk factors together and tries to predict health and quality of life among the elders. No single study has focused on multiple health risk factors among older adults as a leading cause of unhealthy life or morbidity. However, much of the burden of unhealthy life among older adults can be reduced by preventing and addressing specific

health risk factors. Therefore, the present study aims to conceptualize the multi-dimensional concept of MHRFs and their prevalence and association with NCDs among older adults in SAGE countries.

II. Data Source and Methods

Data source

The World Health Organization's (WHO) Study of Global Ageing and Adult Health (SAGE) Wave-1 (2007-10) is the first longitudinal study on health and ageing carried out in six low- and middle-income countries. Hence, the present study uses the data from it which includes detailed information on health behaviour, use of health services and health outcomes, as well as a varied set of socio-economic items for a nationally representative household population aged 50 years and above in six countries. The six country surveys have nationally representative samples, and results are comparable with similar ageing surveys in high-income countries.

Across these six countries, the total comprises of 42,236 (18,243 males and 23,993 females) with a smaller number of respondents aged 18-49 years included for comparison. SAGE sampling methods are based on the design developed for the 2003 World Health Survey where a probability sampling design was employed using multi-stage, stratified, cluster random samples. The survey instrument was conducted using an interviewer-administered questionnaire in the native language of the respondent using local, commonly understood terms (Kowel et al., 2012). This study analysed the information of 33,922 (15,594 males and 18,328 females) people aged 50 years or above in the SAGE countries: China (n=13,157), India (n=6,560), Mexico (n=2,301), Russia (n=3,763), South Africa (n=3,836) and Ghana (n=4,305), which reported any type of health risk factors and NCDs. The countries reflect a wide range of geographic and socio-economic variability.

Methods

The study encompasses various factors relevant to health risk, each represented by distinct variables. Nutrition intake is gauged by the number of servings of fruits and vegetables per day, categorised into "sufficient" (5 or more servings) and "insufficient" (0-4 servings). Body mass index (BMI) is calculated using weight and height, and the total score is classified as "normal" (BMI < 25) and "obese" (BMI ≥ 25) adhering to WHO guidelines. Tobacco use and alcohol consumption were dichotomised based on whether participants have ever used tobacco products or consumed alcohol-containing drinks respectively. Smoking status was denoted as current use or non-use of smoking tobacco products. Physical activity levels were assessed by categorising individuals as "active" or "inactive" according to the duration and type of daily activities. Limitations in activities of daily living (ADLs) were indicated by a dichotomous variable, reflecting difficulties in performing essential tasks. Indoor air pollution was dichotomised based on household cooking fuel and the presence of a chimney.

Feelings of loneliness were captured through self-reported experiences, yielding a dichotomous variable. Social isolation was assessed based on participation in public meetings, group gatherings and neighbourhood activities dichotomised to indicate presence or absence of social engagement. Perceptions of safety within the community and workplace are dichotomously categorised as "safe" or "unsafe." Trust from others was evaluated through feelings of safety from crime and violence, also dichotomised. Participation in religious activities ware denoted by attendance at services, while involvement in social gatherings reflects participation in various events or visits to friends or relatives. Finally, the presence of friends at home was indicated by the frequency of social visits, categorised dichotomously. These variables collectively provide a comprehensive overview of factors influencing health and psychosocial well-being within the studied population.

Construction of MHRFs

The risk factors were categorised into four major domains named as *Biological Health Risk Factors, Behavioural Health Risk Factors, Environmental Health Risk Factors,* and *Psycho-Social Health Risk Factors*. Further, the number of health risk factors variable was created, using row-total count of 15 health risk factors and later these number of health risk factors were categorised into four major groups: 0-1 health risk factors (HRFs), 2-3 HRFs, 4-5 HRFs and 6 and above (6+) HRFs.

Non-communicable diseases (NCDs)

The questions on NCDs (arthritis, angina, asthma, diabetes, hypertension, lung disease, stroke and vision problems) were used to create the NCDs variable. These health issues were assessed by asking the respondent, "Have you ever been told by a health professional/doctor that you have [disease name]?" We converted the replies into two dichotomous variables (0 for "no problem" and 1 for "problem"). This sum was utilized to generate a single variable, NCDs, which represents the number of diagnosed diseases. For analysis, we further divided NCDs into three categories: 0 NCDs, 1 NCD, and 2+ NCDs.

Background characteristics

The socio-economic status such as *age* (50-59, 60-69, 70-79 and 80+ years), *sex* (male and female), *place of residence* (rural and urban), *marital status* (never married, currently married/cohabiting and widow/divorced/separated), *educational status* (no education, primary, secondary and higher secondary & above), *work status* were created with using three questions and classified into never work, currently working and currently not working and *wealth quintile* (poorer to richest) were taken for analysis.

Statistical techniques

Bivariate and multivariate analyses were carried out to understand the association between MHRFs and NCDs among older adults. We used logistic regression to examine the association between health outcomes and predictor variables, whereas multinomial logistic regression was done obtain the relative risk ratio for NCDs by MHRFs and socioeconomic characteristics. Pooled weight has been used for bivariate analysis. All analyses were carried out in SPSS version 20, Stata-14 and Microsoft Packages.

III. Results

The socioeconomic and demographic profile of studied counties are presented in Table 1. Approximately 50 per cent respondents in South Africa and 40 per cent in Ghana are aged 50-59 years. Ghana has the highest proportion of those aged 80+ at 9.7 per cent, compared with India (4.5%) and China (4.6%). Females make up 52 per cent of total respondents in SAGE countries, with Russia having the highest female population at 61.1 per cent among older adults. India has the largest rural population at 71.1 per cent, while Mexico has the highest urban population at 78.8 per cent. About 75.5 per cent respondents are currently married with China leading at 85 per cent. On the other hand, South Africa has the highest proportion of never married respondents at 14.3 per cent and India the lowest at 0.7 per cent.

In terms of education, 34 per cent respondents had no formal education, while 30 per cent had higher secondary education or above. Almost 43 per cent respondents were economically productive, while 14 per cent never worked. Ghana had the highest working population at 69 per cent and South Africa the lowest at 30 per cent. Households in the poorest wealth quintile included 18 per cent in India, 16 per cent in China, 18 per cent in Ghana, 15 per cent in Mexico, 21 per cent in South Africa and 16 per cent in Russia. Overall, 23 per cent respondents across SAGE countries belonged to the richest wealth quintile.

Table 1: Pooled per cent distribution of older adult respondents by background characteristics in WHO-SAGE countries, 2007-10

Socio-economic status	China	India	Mexico	Russian Federation	South Africa	Ghana	All six countries
Age group (years)							
50-59	44.9	48.6	48.1	45.2	49.9	39.7	46.4
60-69	31.9	30.9	25.6	24.6	30.6	27.5	30.0
70-79	18.6	16.0	17.8	21.8	14.0	23.1	18.2
80+	4.6	4.5	8.6	8.4	5.5	9.7	5.4
Sex							
Male	49.8	51.0	46.8	38.9	44.1	52.4	47.9
Female	50.2	49.0	53.2	61.1	55.9	47.6	52.1
Place of residence							
Rural	52.7	71.1	21.2	27.3	35.1	58.9	53.8
Urban	47.3	28.9	78.8	72.7	64.9	41.1	46.2
Marital status							
Never married	1.1	0.7	7.0	2.7	14.3	1.3	1.8
Currently married	85.0	76.9	73.0	58.3	55.9	59.3	75.5
Others*	13.8	22.3	20.0	39.0	29.8	39.4	22.8
Education							
No education	28.5	57.0	28.0	0.7	32.1	60.2	33.6
Primary	25.9	16.5	38.9	5.6	30.0	12.2	17.8
Secondary	24.5	11.3	16.1	20.5	19.1	4.5	18.2
Higher secondary & above	21.1	15.3	17.0	73.2	18.7	23.1	30.4
Work status							
Never worked	8.9	27.0	38.5	0.8	14.6	1.6	14.1
Currently working	43.6	43.2	37.4	40.1	29.8	69.0	42.6
Currently not working	47.4	29.8	24.1	59.1	55.6	29.4	43.3
Wealth quintile							
Q 1	16.3	18.2	15.3	16.2	20.7	18.2	17.1
Q 2	18.1	19.5	24.7	19.6	19.9	19.1	19.0
Q 3	20.5	18.8	16.8	19.1	18.2	20.5	19.5
Q 4	23.4	19.6	16.6	20.5	19.8	20.7	21.3
Q 5	21.8	23.9	26.6	24.6	21.3	21.6	23.1
Total (N)	13157	6560	2301	3763	3836	4305	33922

Note: *Others include widowed/divorced/separated.

Distribution of MHRFs in SAGE countries

We created a composite score of MHRFs that included fifteen biological, behavioural, environmental and psychosocial health risks factors. Out of these fifteen risk factors, there was a maximum of 12 health risk factors which were found among the older persons in SAGE nations, specifically in South Africa (supplementary table 1). Approximately 5 per cent older adults have not reported any type of health risk factors, while the majority (40%) lived with three/four risk factors (Figure 1).

We categorised the number of MHRFs into four broad domains of health risk factors (Figure 2). In China 37.5 per cent older adults lived with not more than one health risk factor and whereas only 2 per cent reported 6 plus health risk factors, which indicates a healthy lifestyle compared with other nations. On the other hand, almost half of the older adults in Ghana lived with 4-5 health risk factors, which is the highest among all SAGE countries. In addition, the older adults living with 6+ MHRFs were the highest in South Africa (26%), followed by Ghana (20.3%) and India (20.1%), indicating an unhealthy lifestyle. Moreover, 13.5 per cent older adults lived with six and more health risk factors, whereas about 70 per cent lived with 2-5 health risk factors.

Figure 1: Number of health risk factors among the older adults in the WHO-SAGE counties, 2007-10.

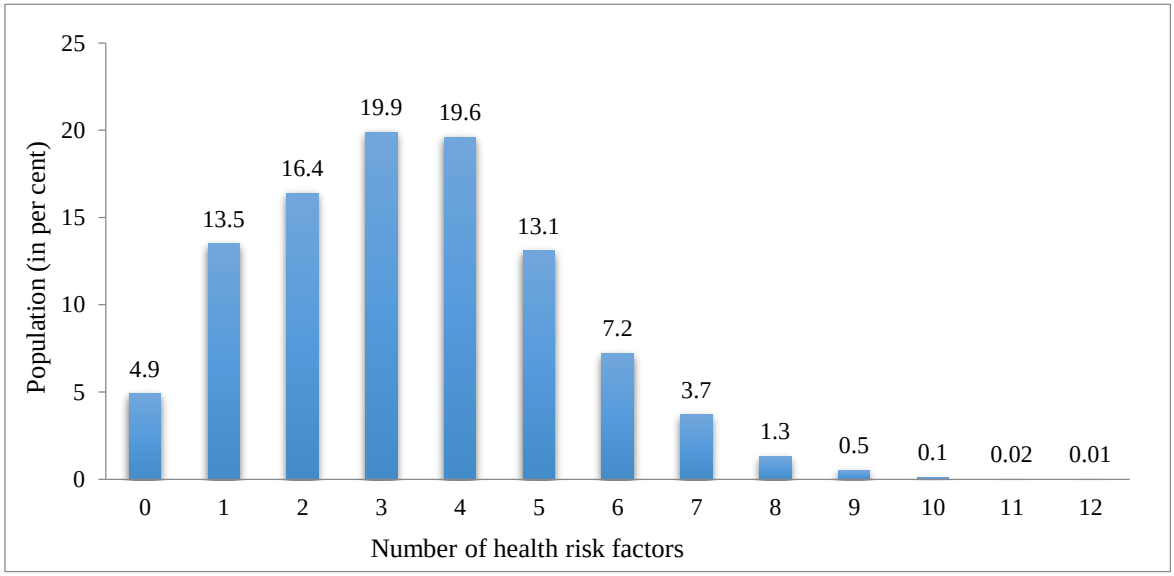


Table 2 shows the prevalence of NCDs by selected socioeconomic characteristics. It shows higher prevalence among females with 2+ NCDs (24%), compared with males (19%) in SAGE countries. The prevalence of 2+ NCDs was almost double in the urban area (29%) as compared with the rural area (15%). Those who fall under other marital status categories had higher prevalence of 2+ NCDs compared with never or currently married. The prevalence of 2+ NCDs is higher among the older adults in 5th quintile (24%) compared with those in the lowest quintile (18%). As educational levels and the number of MHRFs increase, the prevalence of 2 or more NCDs also rises.

Figure 2: Prevalence of multiple health risk factors in WHO-SAGE counties (2007-10)

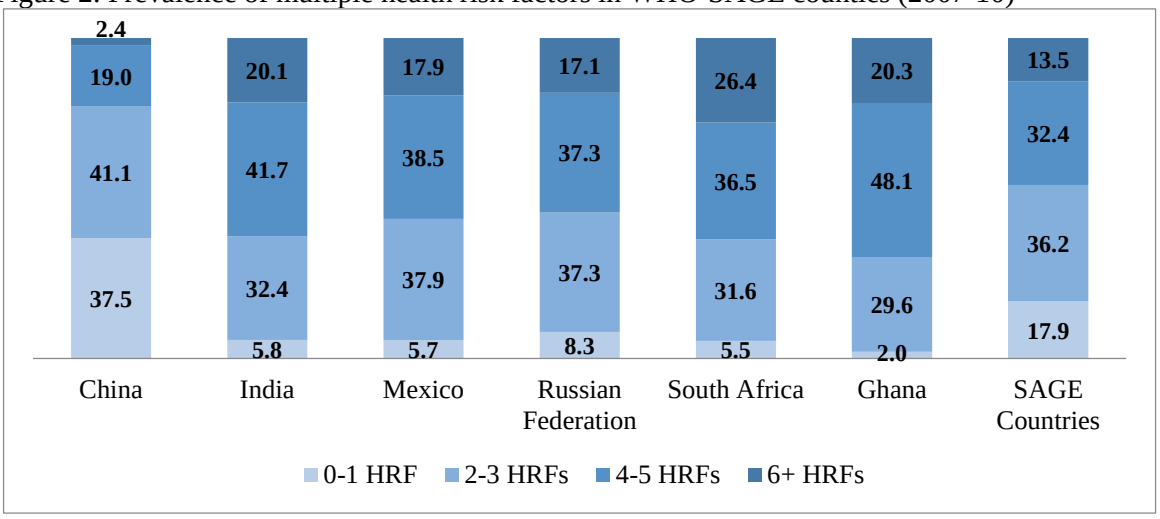


Figure 3 shows the prevalence of MHRFs on NCDs in the SAGE countries. The Russian Federation stands out with the highest prevalence of 2+ NCDs (66%) among those with six and more MHRFs, significantly higher than in other countries, followed by Mexico (27%) and South Africa (25.6%), indicating substantial health burdens. In contrast, Ghana (12%) exhibited relatively lower increases in NCDs prevalence.

Table 2: Prevalence of the NCDs by MHRFs and selected socioeconomic characteristics among the older adults in SAGE countries

Socioeconomic characteristics	No NCDs W (%)	1 NCDs W (%)	2+ NCDs W (%)
MHRFs			
0-1 HRF	48.0	32.0	19.9
2-3 HRFs	51.7	29.5	18.8
4-5 HRFs	51.4	25.6	23.0
6+ HRFs	44.7	26.1	29.2
Socio-economic factors			
Age (years)			
50-59	57.5	27.6	14.9
60-69	47.7	29.7	22.6
70-79	37.8	28.3	33.8
80+	40.2	26.0	33.9
Sex			
Male	54.7	26.4	18.9
Female	45.8	30.0	24.2
Marital status			
Never married	54.5	25.4	20.1
Currently married/cohabiting	52.0	28.8	19.2
Others*	43.1	26.9	30.1
Place of residence			
Rural	57.6	27.1	15.3
Urban	41.2	29.6	29.1
Educational status			
No education	58.8	26.0	15.2
Primary	51.3	30.6	18.1
Secondary	45.1	29.3	25.5
Higher secondary and above	40.8	28.9	30.3
Work status			
Never worked	53.8	29.7	16.4
Currently working	58.9	27.6	13.5
Currently not working	39.4	28.8	31.8
Wealth quintile			
Q 1	55.2	27.1	17.7
Q 2	52.4	26.2	21.4
Q 3	50.0	26.4	23.6
Q 4	47.3	31.3	21.4
Q 5	46.8	29.6	23.6

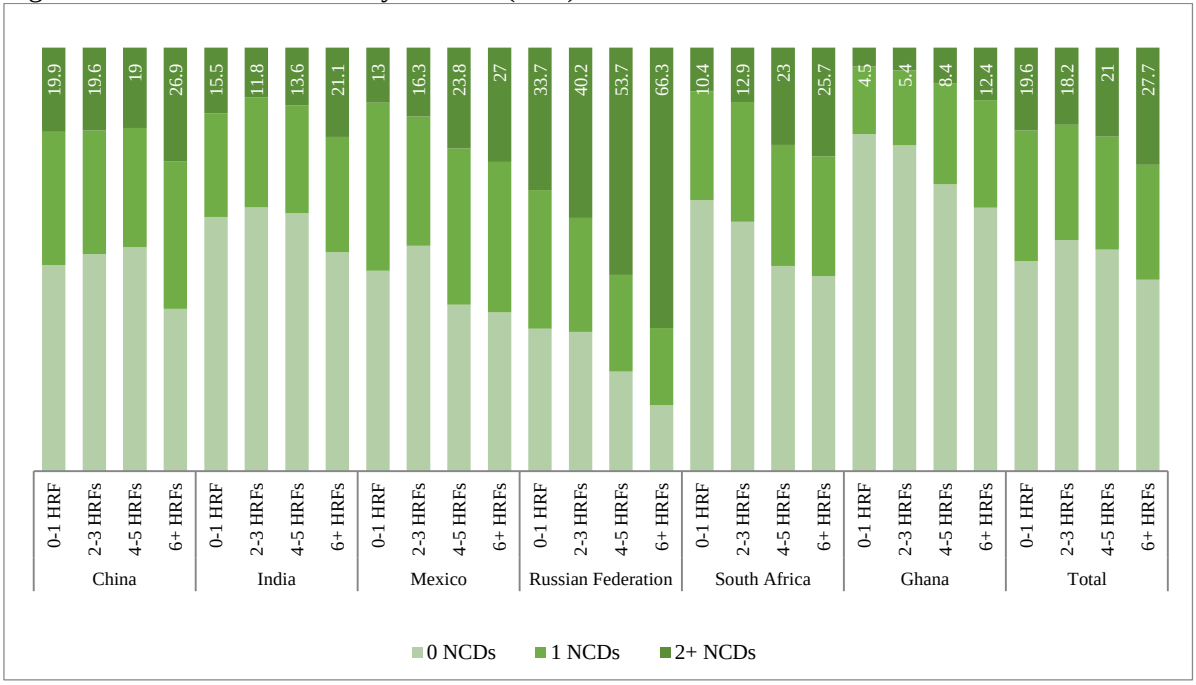
Note: *Others include Widowed/Divorced/ Separated; W% Pooled percentage.

Table 3 presents the results of multinomial logistic regression with relative risk ratio of NCDs by MHRFs and socioeconomic status. As MHRFs increase, the risk of NCDs also rises. For instance, among individuals with two or more NCDs, the RRR is 1.47 for those with 2-3 MHRFs, increasing significantly to 2.64 for older adults with 6 or more MHRFs across all the SAGE countries. This suggests that as the number of health risk factors increases, the prevalence of chronic diseases among the older adults will also increase. A similar pattern can be discovered in a country-specific analysis of SAGE countries. For example, Ghana (4.86, $p<0.001$) exhibits the highest RRR for 2+ NCDs among those with 6+ HRFs, followed closely by the Russian Federation with an (4.18, $p<0.001$).

The socioeconomic status shows that comparable effects in age has a substantial impact on NCD prevalence, with the 70-79 age range displaying the highest relative risk ratios (RRRs). China and Russia have the significantly highest RRRs for having more than 2 NCDs at 4.12 and 3.19 respectively. Females have a significantly higher RRRs for 2+ NCDs with ratios of 2.33 in Ghana

and 1.99 in South Africa. Non-working adults in SAGE nations are more likely to develop NCDs. Furthermore, when education levels rise, so does the RRR for NCDs in SAGE countries. However, this pattern is not consistent across all nations, including South Africa. For SAGE nations, the RRR for NCDs increases as wealth quintiles increase.

Figure 3: Prevalence of NCDs by MHRFs (W%) in WHO-SAGE counties, 2007-10



IV. Discussion

This study assesses the prevalence of MHRFs and their association with NCDs among older adults in SAGE countries. Its findings reveal variations in the distribution of health risk factors among the older adults across the SAGE countries. For example, nearly 40 per cent of Chinese older adults have less than two health risk factors, suggesting a relatively healthier ageing population. Conversely, only about 2 per cent of Chinese older adults have six or more health risk factors, indicating that a small proportion faces multiple health challenges. This differs sharply with the situation in India where 43 per cent of the older persons had 4-5 health risk factors, whereas 22 per cent had more than six risk factors, indicating a significantly higher risk of health concerns among Indian older adults.

These statistics reflect underlying differences in public health infrastructure, socioeconomic conditions, healthcare access and lifestyle factors between the two nations. Several other factors could contribute to these disparities (Stewart Williams et al., 2015; Arokiasamy et al., 2015). For example, in China the implementation of extensive public health campaigns and better access to healthcare services could explain the lower prevalence of multiple health risk factors among the older adults (Wu et al., 2015). Additionally, its rapid economic development has led to improved living conditions and healthcare facilities, which play a crucial role in managing health risks (Zeng et al., 2017). In contrast, India's higher incidence of health risk factors may be linked to socioeconomic inequality, restricted access to healthcare and risk factors such as poor food, physical inactivity and high stress levels (Patel et al., 2011).

Table 3: Relative Risk Ratio of Non-Communicable Diseases (NCDs) by MHRFs and selected socioeconomic characteristics using the Multinomial Regression

Socio-demographic status	WHO-SAGE countries (All)		China		India		Mexico		Russian Federation		South Africa		Ghana	
	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR
0 NCDs ®	1 NCDs	2+ NCDs	1 NCDs	2+ NCDs	1 NCDs	2+ NCDs	1 NCDs	2+ NCDs	1 NCDs	2+ NCDs	1 NCDs	2+ NCDs	1 NCDs	2+ NCDs
MHRFs														
0-1 HRFs ®														
2-3 HRFs	1.07*	1.47***	1.19***	1.54***	1.35**	1.26	1.24	1.53	0.89	1.31*	1.59**	1.42	1.31	2.18
4-5 HRFs	1.12**	1.90***	1.20**	1.86***	1.61***	1.95***	1.57*	2.07**	1.09	2.55***	1.67**	2.84***	2.06**	3.39**
6+ HRFs	1.26***	2.64***	2.20***	3.61***	1.96***	3.60***	1.48	2.11**	1.17	4.18***	1.94***	4.09***	2.36**	4.86**
Age														
50-59 ®														
60-69	1.42***	2.08***	1.53***	2.57***	1.23***	1.51***	1.49**	1.65**	1.42***	2.07***	1.35**	1.56***	1.38***	2.22***
70-79	1.65***	3.43***	1.80***	4.12***	1.24**	1.89***	1.54**	2.54***	1.45**	3.19***	1.15	1.60***	1.69***	2.98***
80+	1.49***	2.91***	1.35**	3.67***	1.23	1.27	1.88**	1.91**	2.31***	4.43***	0.99	0.92	1.52***	1.86**
Sex														
Male ®														
Female	1.44***	2.06***	1.28***	1.56***	1.09	1.10	1.93***	2.63***	1.65***	2.42***	1.35***	1.99***	1.72***	2.33***
Marital status														
Never married ®														
Currently married/cohabiting	1.08	1.54***	1.37	1.31	1.55	1.91	1.67**	1.61	1.08	0.88	0.78	1.25	0.90	3.59
Others[#]	0.97	1.43***	1.23	1.12	1.45	1.67	1.22	1.86**	1.17	0.97	0.78	1.52**	1.03	4.34
Place of residence														
Rural ®														
Urban	1.33***	1.80***	1.40***	2.17***	1.33***	2.05***	1.04	1.56**	1.22*	1.25**	1.27**	1.88***	1.30***	1.58***
Educational status														
No education®														
Primary	1.39***	2.01***	0.88*	0.96	1.52***	1.49***	1.40*	1.26	2.35	0.48	1.21	1.6***	1.20	1.54**
Secondary	1.52***	2.79***	0.95	0.98	1.35***	1.77***	1.63**	1.33	1.49	0.51	1.28	1.38*	1.57**	1.60
Higher Secondary and Above	1.53***	3.37***	0.92	0.97	1.47***	1.97***	1.24	1.04	1.37	0.46	1.00	1.31	1.76***	2.24***
Work status														
Never worked ®														
Currently working	0.83***	0.67***	1.14*	0.95	0.67***	0.52***	0.93	1.09	1.78	1.03	0.85	0.38***	0.95	0.69
Currently not working	1.13***	1.47***	1.46***	1.74***	0.89	0.88	1.02	1.27	2.04	2.05	1.07	0.82	1.29	1.40
Wealth quintile														
Q 1 ®														
Q 2	1.08	1.10	1.18**	1.15	1.02	1.14	1.22	1.73**	1.18	1.64***	1.16	1.42	1.34**	1.24
Q 3	1.07	1.14**	1.12	1.3***	1.10	1.38**	0.97	1.95**	1.22	1.56***	1.45**	2.40***	1.52***	1.31
Q 4	1.23***	1.19***	1.4***	1.34***	1.29**	1.94***	1.04	1.98**	1.35*	1.81***	1.34*	2.89***	1.88***	2.18***
Q 5	1.16***	1.10	1.22**	1.31***	1.26**	1.91***	1.20	2.34***	1.31*	1.73***	1.57**	2.74***	2.29***	3.41***

Note: [#]Others include Widowed/Divorced/ Separated; level of significance at ***p<0.01, **p<0.05, *p<0.1. ®: reference category.

Around one-fourth (26.4%) older adults in South Africa lived with more than six health risk factors. The maximum number of risk factors (12 factors) were also found in this county, followed by India (11 factors), which shows very poor health and quality of life among the older adults living in these countries. South African and Indian older adults were more exposed to all kinds of health risk factors (Arokiasamy et al., 2015). On the other hand, South Africa and India have a high burden of health risk factors among the older adults, especially among those who are uneducated and fall into the bottom wealth quintile which may be attributed to persistent challenges in healthcare delivery caused by socioeconomic inequalities (Arokiasamy et al., 2015; Patel et al., 2015; Patel et al., 2019). This tendency is consistent with global evidence indicating that lower socioeconomic position and a lack of education are important predictors of health hazards (Williams et al., 2015). Moreover, the gap in health risk variables is greater in these two nations than in China, showing regional differences in health determinants (Mayosi et al., 2012).

This study also found that as the number of MHRFs increased, the likelihood of NCDs among the older adults also rises. This cumulative effect emphasizes the significance of addressing multiple risk factors concurrently to reduce the possibility of developing chronic diseases. Variations were found in country-specific analyses, such as Ghana having a greater relative risk ratio (RRR) for two or more NCDs followed by Russia. This could be attributed to lifestyle variables such as increased smoking and alcohol consumption, as well as inadequate healthcare access and low health literacy levels (de-Graft Aikins, 2007; Sidorenkov et al., 2015). India and China face significant multi-morbidity challenges, likely due to lifestyle factors and healthcare access issues typical in developing nations (Arokiasamy et al., 2015; Wu et al., 2015; Zeng et al., 2017). Indian older adults are more exposed to morbidity or mortality risk as compared with other SAGE countries, as it deals with more ongoing high burden of chronic diseases (Arokiasamy et al., 2015). On the other side, healthcare system in developing nations faces significant strain due to a large population and limited resources, which affects the management of chronic diseases and other health risk factors among the elderly (Bloom et al., 2015).

Socioeconomic factors also influence NCDs prevalence. Older persons, especially those aged 70 to 79 years, are more vulnerable to NCDs. This tendency is particularly noticeable in countries such as China and Russia where the ageing population can experience additional health issues as a result of lifestyle and environmental factors (Li et al., 2019). Gender differences complicate the picture with females having a higher risk for NCDs. However, females in low- and middle-income countries (LMICs) face particular vulnerabilities due to gender norms, biological variations, gender-specific health behaviours and access to healthcare services (Mendenhall & Weaver, 2014). The relationship between educational level and NCDs is particularly evident in LMICs where less educated older adults face higher health risks compared with their more educated counterparts (Bloom et al., 2015; Stewart Williams et al., 2015; Patel et al., 2019). This correlation underscores the importance of educational intervention in mitigating health risks and managing NCDs among the ageing population. However, this pattern is not consistent across all the countries, showing that regional factors have a role in these results. Similarly, higher income levels are frequently related with higher relative risk for NCDs due to lifestyle risk factors associated with increased affluence and urban living circumstances.

V. Conclusion and recommendations

This study demonstrates variations in the prevalence of MHRFs and their connection with NCDs among the older persons across SAGE nations. The findings highlight the relatively low burden of health risk factors among Chinese older adults which can be attributed to strong public health initiatives and improved healthcare infrastructure in contrast with the higher health risk burdens observed in India, which are driven by socioeconomic inequalities and limited healthcare resources. South Africa's older population has the most diverse set of health risk factors highlighting geographical differences. As the burden of NCDs increases with MHRFs, particularly in Russia and China, focused interventions addressing these factors are critical for managing health risks and increasing the quality of life for older adults worldwide.

Addressing these disparities requires targeted public health interventions focusing on improving education, socioeconomic conditions, promoting healthy lifestyles and improving healthcare access. Policies that prioritize health education and socioeconomic upliftment can significantly reduce the burden of health risk factors and improve the overall health outcomes of the older adults.

Limitations

There are a number of health risk factors which affect the health of the older adults. This study has focused only on the effect of multiple health risk factors on the NCDs from the SGAE data. However, there are other biological health risk factors of NCDs which we didn't include in this study such as waist-hip ratio and grip strength. Both are important biological health risk factors among older adults for NCDs. On the other side, due to some limitations in the WHO-SAGE data, we were not able to include outdoor air pollution, noise pollution, working conditions of workplaces, etc., which are important environmental health risk factors among older adults.

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Supplementary Table

Table 1: Percentage of Number of Risk Factors Present among Older Adults in the WHO-SAGE countries

Risk Factors	China	India	Mexico	Russian Federation	South Africa	Ghana	Total
0	11.46	0.47	0.61	1.3	0.83	0.09	4.83
1	26.06	5.32	5.08	6.99	4.67	1.95	13.03
2	22.16	13.09	17.43	17.57	13.61	9.06	16.95
3	18.93	19.31	20.47	19.74	18.01	20.51	19.03
4	13.61	23.25	21.90	21.95	19.11	26.53	19.22
5	5.37	18.45	16.64	15.36	17.41	21.56	13.19
6	1.76	11.74	10.60	9.35	11.39	11.99	7.52
7	0.50	5.55	4.56	5.16	8.37	5.37	3.78
8	0.13	1.98	2.00	1.78	3.75	2.21	1.47
9	0.01	0.69	0.61	0.74	2.03	0.60	0.57
10		0.12	0.09	0.05	0.57	0.14	0.12
11		0.03			0.16		0.02
12					0.08		0.01

Note: The table shows the weighted percentage of the number of risk factors presented in the individual out of a total of 15 risk factors in all SAGE countries.