

The Risk Factors of Diabetes Among Older Adults Aged Fifty Years and Over in China: Findings from the World Health Organization Study on Global Ageing and Adult Health (SAGE)

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Abstract: Background: Increasing numbers of older adults develop diabetes, which is predicted to become more common. This study aimed to identify the risk factors associated with diabetes among older adults aged fifty years and over. Methods: the World Health Organization Study on Global AGEing and Adult Health (SAGE) Wave 1 data in China were used. Descriptive and multivariate logistic regression were used in statistical analysis. Results: This study shows that age, falls, smoking, BMI, and income quintile had significantly associated with higher diabetes prevalence. In contrast, older adults from rural areas with sufficient fruit and vegetable intake had a lower diabetes prevalence in this study. Surprisingly, older adults with lower vision, stroke, hypertension, and angina were at lower risk of diabetes. Conclusion: public health programs should target older adults aged over sixty and individuals in higher-income quintiles, who have fallen, are smoking, overweight, and obese. That may help to provide the necessary support to bridge diabetes-related inequities. In the meantime, promoting sufficient fruit and vegetable intake might reduce diabetes among older adults aged fifty years and over in China.

Keywords: Diabetes, older adults, risk factors, China

1. Introduction

Diabetes is a chronic non-communicable disease that causes a significant challenge to global development (1). Diabetes is the most significant cause of mortality, disability, and economic burden (1–3). The prevalence of diabetes has been described as mainly due to the aging population (4), socioeconomic changes (5), and unhealthy lifestyles (6), especially in low and middle-income countries (LMICs) (7). Diabetes has also been identified as a medical emergency of the twenty-first century (3). Meanwhile, it can lead to heart disease, stroke, respiratory disease, and blindness (7, 8). Diabetes killed 6.7 million adults, and 32.6% of those under sixty years died (1). In 2021, 537 million adults had diabetes, with more than 60 million of those over fifty years suffering from the disease (1). Although most countries reported a decrease in diabetes prevalence, 10.6% and 6.2% of adults still live with impaired glucose tolerance and impaired fasting glucose worldwide (1). The presence of any of these or both is defined as prediabetes (9), leading to diabetes in the future (10). Moreover, nearly 90% of individuals in LMICs are undiagnosed with diabetes (1). Those who have diabetes for an extended period suffer from many complications (11).

In LMICs, diabetes affects more than 60% of the global population (12). In India, one in every seven individuals has diabetes, whereas, in Bhutan, around 10.4% of adults suffer from the disease (1). In 2021, 140.9 million adults in China had diabetes (1). Despite diabetes deaths by 1.4 million each year, more than half of the individuals are undiagnosed with diabetes in China (1). Additionally, 16.8% of over fifty years in China experienced a diabetes-related burden (3). The prevalence of prediabetes in China has increased two times

higher than in the past decades (12). A study by T. Wang et al., (2021) shows prediabetes as a significant risk of diabetes prevalence among older adults. Besides that, the aging population in China has been increasing, with an annual growth rate of 6.2% (4). Therefore, it is urgent to examine diabetes prevalence among older adults, especially in China.

Older adults are more likely to develop diabetes because of variables such as age, educational level, marital status, diet quality, physical activity, body mass index (BMI), and genetic history, to mention a few (5, 12, 13). Gwatidzo & Stewart Williams, (2017) has stated that an unhealthy lifestyle, including physical inactivity, smoking, and excess alcohol consumption, can lead to diabetes. Higher socioeconomic status and educational attainment have been linked to an increased risk of diabetes (14). The disease was higher in older adults, urban residents, and overweight and obese individuals (12). A study conducted in Bangladesh indicated that diabetes was much more likely among respondents with hypertension (14). A study by Cosansu et al., 2018 suggested that women had a higher risk of diabetes. The risk of respiratory disorders like asthma was twice as high among individuals with diabetes who smoked (8). In addition, a higher prevalence of diabetes in the elderly was linked to insufficient sleep quality (10).

The healthcare system has achieved significant development in China during the last few decades. Diabetes varies across regions, and most research focused on gender, lifestyle, genetic, respiratory, and age-related variables in China (8, 10, 13, 15). Thus, to examine the risk factors for diabetes, this study used “The World Health Organization (WHO) Study on Global AGEing and Adult Health (SAGE) ”

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datasets (16). This study looks at diabetes risk factors in people over fifty years, including socio-demographic and humanlike characteristics. Diabetes epidemic prevention and intervention strategies will be more effective with an awareness of the causes of the disease.

2. Methods

• Study design, sampling, and procedures

China-SAGE Wave 1 data was used in this study. The survey is a longitudinal study of a nationwide sample of older adults (16, 17). The survey involved a stratified multistage cluster sample design (17). First, eight provinces and sixteen strata were selected (17). Second, one district and one county were selected randomly from each province (17). The selection details are provided in a previous study (17). The research sample comprises 64 primary sample units, 127 secondary sample units, and 10, 278 tertiary sample units. Respondents aged over fifty years were interviewed for the survey. However, the survey also included respondents aged 18 and 49 years using a Kish Grid method (17). Data collection for China-SAGE Wave 1 involved two phases using a structured questionnaire. The details are provided in previous studies (17, 18). Face-to-face interviews for the survey were completed in 2010, comprising 15, 050 individual respondents. The response and cooperation rates were 93 percent and 98 percent, respectively. Data analysis in this study is restricted to older adults aged fifty years and over. This study excluded missing data and analyzed a total sample size of 11, 055.

• Study Variables

Diabetes status is the dependent variable for this study. Diabetes is defined as a failure of insulin production or an inability to utilize the produced insulin (1). The outcome is self-reported diagnosed diabetes, and the response was recorded as "yes" and "no". The following question was

asked to the respondents: "Has [NAME] ever been told by a health professional that s/he has diabetes (high blood sugar)?" (18). Types of diabetes are not differentiated, and diabetes-related to pregnancy is omitted in the survey.

Socio-demographic variables comprise age, gender, residence, marital status, education, and income quintiles (3, 19, 20). Humanlike characteristics included vision difficulties, hearing difficulties, falls, chronic illnesses like arthritis, stroke, lung disease, asthma, depression, hypertension, angina, and others like smoking/tobacco, alcohol, fruit and vegetable intake, and BMI (3, 5, 13–15). Age is divided into four groups such as 50 to 59 years; 60 to 69 years; 70 to 79 years; and 80 years and over (3). Levels of education were divided into six groups (19). The quintiles of income are based on the ownership of a collection of assets and several residential properties (20). They are categorized into five groups (3, 14). In measuring BMI, weight and height were assessed. The BMI was categorized into three groups, normal weight ("BMI \geq 18.50 < 25.00 kg/m²"), overweight ("BMI 25.00 < 30.00 kg/m²"), and obese ("BMI \geq 30 kg/m²") (3, 21).

• Statistical analysis

For this study, descriptive statistics were used. This study employed a multivariable logistic regression to identify the risk factors for diabetes among older adults. Diabetes correlation odds ratios (OR) were computed with 95% confidence intervals (CI) (14). It was determined that the findings were significant at $p < 0.05$ (5, 14). To conduct this study, STATA version 14.2 was used.

3. Results

A total of 11, 055 older individuals aged fifty years and over from China were analyzed in this study.

Table 1: Socio-demographic And Humanlike Characteristics of This Study.

Characteristics	Total n	%	Non-Diabetic n	%	Diabetic n	%
Age in years						
50–59	4, 780	43.34	4, 587	95.96	193	4.04
60–69	3, 374	30.59	3, 104	92.00	270	8.00
70–79	2, 304	20.89	2, 088	90.63	216	9.38
80+	570	5.17	524	91.93	46	8.07
Gender						
Male	5, 351	48.40	5, 029	93.98	322	6.02
Female	5, 704	51.60	5, 299	92.90	405	7.10
Residence						
Urban	5, 580	50.47	5, 017	89.91	563	10.09
Rural	5, 475	49.53	5, 311	97.00	164	3.00
Marital status						
Never married	122	1.10	119	97.54	3	2.46
Currently married	9, 175	82.99	8, 570	93.41	605	6.59
Cohabiting	19	0.17	18	94.74	1	5.26
Separated/ divorced	205	1.85	196	95.61	9	4.39
Widowed						
Education level						
No formal education	2, 590	23.43	2, 446	94.44	144	5.56
Less than Primary School	2, 021	18.28	1, 935	95.74	86	4.26
Primary school completed	2, 155	19.49	2, 021	93.78	134	6.22
Secondary school completed	2, 341	21.18	2, 154	92.01	187	7.99
High school completed	1, 441	13.03	1, 319	91.53	122	8.47

College/ post-graduate degree completed	507	4.59	453	89.35	54	10.65
Income quintile						
Poorest	2, 180	19.72	2, 106	96.61	74	3.39
Poorer	2, 203	19.93	2, 089	94.83	114	5.17
Middle	2, 210	19.99	2, 044	92.49	166	7.51
Richer	2, 299	20.80	2, 111	91.82	188	8.18
Richest	2, 163	19.57	1, 978	91.45	185	8.55
Vision difficulties						
No	10, 198	92.25	9, 565	93.79	633	6.21
Yes	857	7.75	763	89.03	94	10.97
Hearing difficulties						
No	10, 342	93.55	9, 660	93.41	682	6.59
Yes	713	6.45	668	93.69	45	6.31
Fall						
No	10, 729	97.05	10, 033	93.51	696	6.49
Yes	326	2.95	295	90.49	31	9.51
Chronic illnesses						
Arthritis						
No	8, 548	77.32	8, 036	94.01	512	5.99
Yes	2, 507	22.68	2, 292	91.42	215	8.58
Stroke						
No	10, 677	96.58	10, 006	93.72	671	6.28
Yes	378	3.42	322	85.19	56	14.81
Lung disease						
No	10, 090	91.27	9, 429	93.45	661	6.55
Yes	965	8.73	899	93.16	66	6.84
Asthma						
No	10, 788	97.58	10, 091	93.54	697	6.46
Yes	267	2.42	237	88.76	30	11.24
Depression						
No	11, 021	99.69	10, 295	93.41	726	6.59
Yes	34	0.31	33	97.06	1	2.94
Hypertension						
No	8, 011	72.46	7, 670	95.74	341	4.26
Yes	3, 044	27.54	2, 658	87.32	386	12.68
Angina						
No	10, 076	91.14	9, 477	94.06	599	5.94
Yes	979	8.86	851	86.93	128	13.07
Smoking/ tobacco						
No	7, 306	66.09	6, 754	92.44	552	7.56
Yes	3, 749	33.91	3, 574	95.33	175	4.67
Alcohol						
No	7, 596	68.71	7, 041	92.69	555	7.31
Yes	3, 459	31.29	3, 287	95.03	172	4.97
Fruit and vegetable intake						
Insufficient	1, 355	12.26	1, 260	92.99	95	7.01
Sufficient	9, 700	87.74	9, 068	93.48	632	6.52
Bmi						
Normal weight	7, 359	66.57	6, 988	94.96	371	5.04
Over weight	3, 062	27.70	2, 781	90.82	281	9.18
Obese	634	5.73	559	88.17	75	11.83

Table 1) shows that about 49 percent (48.40%) of the respondents were male, while more than half (51.60%) were female. Diabetes was more prevalent among older adult women (7.10%) than men (6.02%). Older adults with older age and those living in urban areas had a higher prevalence of diabetes than their counterparts. Older adults who were married formed the majority of the respondents (82.99%). Further, diabetes was more prevalent among older adults in China with higher education and higher income than those with lower education and lower income. This study revealed

that diabetes was more prevalent among older adults with vision problems and those who had ever experienced a fall. Apart from depression, all the chronic diseases listed in the analysis (arthritis, stroke, lung disease, asthma, hypertension, and angina) were prevalent among older adults diagnosed with diabetes. Diabetes was not prevalent among older adults who were currently smoking and consuming alcohol. A high percentage of older adults who had overweight (9.18%) and obese (11.83%) were found to have diabetes compared with those who had normal weight (5.04%). In the meantime, insufficient (7.1%) fruit and

vegetable intake among older adults was a higher risk of vegetable intake. diabetes than those with sufficient (6.52%) fruit and

Table 2: Multivariate Logistic Regression Analysis for Different Correlates of Diabetes Among Older Adults Aged Fifty Years And Over in China.

Characteristics	OR	95 % CI	P-value
Age in years			
50–59	Ref		
60–69	1.77	[1.45; 2.17]	0.001
70–79	1.79	[1.42; 2.27]	0.001
80+	1.58	[1.08; 2.32]	0.019
Gender			
Male	Ref		
Female	0.92	[0.75; 1.12]	0.385
Residence			
Urban	Ref		
Rural	0.39	[0.32; 0.48]	0.001
Marital status			
Never married	Ref		
Currently married	2.18	[0.68; 7.01]	0.190
Cohabiting	1.55	[0.15; 16.48]	0.714
Separated/ divorced	1.23	[0.32; 4.84]	0.768
Widowed	1.97	[0.61; 6.45]	0.260
Education level			
No formal education	Ref		
Less than Primary School	0.83	[0.62; 1.11]	0.190
Primary school	1.01	[0.77; 1.33]	0.926
Secondary school	1.08	[0.83; 1.42]	0.570
High school	0.99	[0.74; 1.35]	0.987
College/post-graduate degree	0.92	[0.64; 1.35]	0.688
Income quintile			
Poorest	Ref		
Poorer	1.59	[1.17; 2.17]	0.003
Middle	1.99	[1.48; 2.68]	0.001
Richer	2.15	[1.59; 2.91]	0.001
Richest	1.98	[1.46; 2.69]	0.001
Vision difficulties			
No	Ref		
Yes	0.56	[0.44; 0.73]	0.001
Hearing difficulties			
No	Ref		
Yes	1.27	[0.91; 1.82]	0.169
Fall			
No	Ref		
Yes	1.78	[1.19; 2.67]	0.005
Chronic illnesses			
Arthritis			
No	Ref		
Yes	0.86	[0.73; 1.03]	0.095
Stroke			
No	Ref		
Yes	0.72	[0.53; 0.98]	0.042
Lung disease			
No	Ref		
Yes	1.33	[0.99; 1.76]	0.060
Asthma			
No	Ref		
Yes	0.72	[0.46; 1.09]	0.119
Depression			
No	Ref		
Yes	3.08	[0.42; 22.98]	0.272
Hypertension			
No	Ref		
Yes	0.46	[0.39; 0.55]	0.001
Angina			
No	Ref		
Yes	0.74	[0.59; 0.93]	0.008

Smoking/ Tobacco			
No	Ref		
Yes	1.27	[1.02; 1.58]	0.038
Alcohol			
No			
Yes	1.18	[0.96; 1.46]	0.112
Fruit and vegetable intake			
Insufficient	Ref		
Sufficient	0.75	[0.59; 0.95]	0.019
BMI			
Normal weight	Ref		
Over weight	1.46	[1.24; 1.73]	0.001
Obese	1.79	[1.35; 2.36]	0.001

Note. OR = Odds ratios

CI = confidence interval

Finally, a multivariate logistic regression analysis (

Table 2) revealed that older adult respondents 60 years and over had a significantly higher risk of diabetes than those between 50 and 59 years. In particular, older adults who were aged between 60 and 69 years (OR=1.77; 95% CI: 1.45-2.17), 70 and 79 years (OR=1.79; 95% CI: 1.42-2.27), and over 80 years (OR=1.58; 95% CI: 1.08-2.32) had a higher risk of diabetes prevalence. In contrast, older adult respondents living in rural areas (OR=0.39; 95% CI: 0.32-0.48) had a significantly lower risk of diabetes than those living in urban areas. In terms of income quintile, older adults with a higher income had a significantly higher chance of diabetes than the poorest. In particular, richer (OR=2.15; 95% CI: 1.59-2.91) households had two times higher likelihood of diabetes. Those who had ever experienced a fall (OR=1.78; 95% CI: 1.19-2.67) had a significantly higher risk of diabetes. Significantly lower risk of diabetes was found for older adults who had vision difficulties (OR=0.56; 95% CI: 0.44-0.73). Apart from arthritis, lung disease, asthma and depression, older adults who had stroke (OR=0.72; 95% CI: 0.53-0.98), hypertension (OR=0.46; 95% CI: 0.39-0.55) and angina (OR=0.74; 95% CI: 0.59-0.93) were significantly less likely to suffer from diabetes. In addition, older adults who had sufficient fruit and vegetable intake (OR=0.75; 95% CI: 0.59-0.95) had a significantly lower risk of diabetes. However, the results of this study showed that older Chinese adults who smoked (OR=1.27; 95% CI: 1.02-1.58) had a higher risk of diabetes. The likelihood of having diabetes among overweight (OR=1.46; 95% CI: 1.24-1.73) and obese (OR=1.79; 95% CI: 1.35-2.36) older adults was significantly higher than those with normal weight.

4. Discussion

Diabetes has been the most widespread public health issue. The disease is expected to become more prevalent among the aged fifty years and over. A study by Gwatidzo & Stewart Williams, (2017) has suggested that about one-third of the elderly population in China is above fifty years. Diabetes prevalence was 38.1% among those over eighty years (13). Diabetes preventive initiatives might benefit from identifying risk factors for diabetes among older adults, particularly those aged over fifty years in China. The findings of this study show that age, residence, income

quintile, vision, fall, stroke, hypertension, angina, smoking, fruit and vegetable intake, and BMI were significantly associated with diabetes among older adults in China.

This study shows that diabetes prevalence increases with increased age. The finding was similar to previous studies (12, 14). A possible explanation would be that older adults are less likely to seek out diabetes treatment. A study by Liu et al., (2018) suggested that treatment and control rates remain low despite the awareness of diabetes among the older elderly. Thus, this study supports Han et al., (2020) suggestion that health education, including diabetes management, should begin earlier in life to avoid diabetes.

Higher-income quintile had a higher risk of diabetes than the poorest income quintile. In addition, those overweight and obese had a significantly higher risk of diabetes than those with normal weights. The findings were similar to previous studies (5, 10, 12–14). The possible reason might be attributed to various causes, including lifestyle factors and limited health awareness, to mention a few. Previous studies in China indicated that rising income had increased an individual's BMI (22).

As a result, an increased number of older adults are overweight and obese (12). In the meantime, the usage of diabetic medication was found to be lower among older adults from high-income households than their counterparts (3). Therefore, the study supports a previous study suggesting that healthcare policy and guidelines should include lifestyle change interventions for diabetes prevention and management (3).

Although, many previous studies did not find an association between smoking and diabetes (10, 15). This study shows that older adults who smoked had a higher risk of diabetes. The finding was similar to a previous study (3). Meanwhile, smoking causes other diseases like cardiovascular disease and respiratory disorders (7, 8), especially among older adults. Therefore, a massive public awareness and education campaign are required related to smoking and preventing diabetes.

Furthermore, older adults who had fallen in their lifetime had a higher risk of diabetes than their counterparts. That is possibly linked to the higher percentage of falling and

physical inactivity among older adults in China (4). A previous study suggested that physical inactivity increases the likelihood of diabetes, especially among older adults (10). Thus, the government should prioritize creating an age-friendly environment, including renovating residential properties and unsuitable services for older adults (4).

Diabetes was less common in older adults in rural areas and those who consumed sufficient fruit and vegetable intake than their counterparts. The possible reason might be attributed to various causes, including lifestyle factors and diet quality, to mention a few. Previous studies suggested that older adults living in rural areas were more involved with physical activity than in urban areas in China (4). Those who live in rural areas had lower BMI than those in urban areas (14). Previous research shows that regular physical activity decreases diabetes prevalence (13). In addition, dietary guidelines reduced the risk of diabetes by 55% in China (6). Thus, policymakers should encourage them to follow appropriate dietary guidelines. Health awareness like physical exercise should be prioritized for older adults since over half of older persons do not do regular physical exercises (4, 6).

Surprisingly, those who had a vision problem, stroke, hypertension, and angina were significantly less at risk of diabetes than their counterparts in this study. This possibly older adult fifty years and over had awareness about diabetes and its related treatment. A significant association was found between combined chronic illnesses and diabetes treatment among the elderly in China (13).

Furthermore, gender, education level, marital status, hearing difficulties, arthritis, lung disease, asthma, depression, and alcohol had no significant association with diabetes among older adults aged fifty years and over in this study. The findings are similar to many previous studies (5, 10, 14). However, most previous studies suggested that males had a higher risk of diabetes (10, 13). While another study indicated that females over forty-five years had a higher risk of diabetes (5). In the meantime, higher education levels suggested a risk of diabetes (5, 13, 14). Other previous studies argued that older adults with lower education had a higher risk of diabetes (5, 10). In addition, divorced or widowed are suggested to be worse at diabetes management, resulting in a higher risk of diabetes (13). A study by George et al., (2018) suggested that those with diabetes had a higher risk of respiratory diseases like asthma. The result differs, possibly due to the differences in study design. However, to prevent diabetes prevalence, continuous research is needed since diabetes and its related complications are the leading cause of death among older adults in China.

5. Conclusions

In this study, older adults aged sixty years and over had a greater chance of developing diabetes. Policymakers thus should focus on older adults aged sixty years and over who had fallen, smoked, and had a higher BMI at the household level to decrease the risk of diabetes. Additionally, rising healthy lifestyles, an age-friendly environment, and

encouraging sufficient fruit and vegetable intake would help to reduce diabetes prevalence among older adults.

6. Future Scope

Although this study suggests that those with chronic illnesses like stroke and hypertension had lower diabetes, contradicting finding was found in many previous studies. Therefore, further research is needed to understand the association between chronic illnesses and diabetes, especially among older adults in China. This study had some limitations, such as being a cross-sectional study might weaken the construction of causality. Additionally, the information was self-reported, which may be recall bias. Lastly, the data used in this study were collected between 2007 and 2010. Hence future SAGE surveys will allow for a more comprehensive study of diabetes prevalence among older adults. However, SAGE WAVE 1 data have been used widely (3, 19, 23). Therefore, this study adds to that essential knowledge base and provides precise analysis for focused policy intervention.

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