

# Sex differences in stroke: a socioeconomic perspective

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**Background:** A number of studies have explored the issue of sex differences in stroke from biomedical perspective; however, there are still large gaps in the existing knowledge. The purpose of this study was to assess whether the differences in socioeconomic status and living conditions between men and women may explain the part of the sex differences in incidence and outcomes of stroke.

**Methods:** All stroke participants aged  $\geq 60$  years admitted in Vaseie Hospital in Sabzevar, Iran, from March 21, 2013, until March 20, 2014, were included in this study. Computerized tomography and magnetic resonance imaging were used to confirm stroke. A series of  $\chi^2$  tests were performed and Statistical Program for Social Sciences, Version 21.0, was used to investigate the potential differences between older men and women in stroke incidence and outcomes.

**Results:** A total of 159 incident stroke cases were documented during 1 year. The annual rate of stroke was statistically significantly higher in elderly women than in elderly men (401 vs 357 per 100,000;  $P < 0.001$ ). Female elderly participants had significantly lower socioeconomic status, poorer living conditions, and higher lifetime history of depression, hypertension, and diabetes mellitus than their male counterparts.

**Conclusion:** The findings from this study showed that elderly women are more adversely affected by stroke in terms of incidence and outcomes of stroke than elderly men. The most noticeable result is that sex differences in socioeconomic status and living conditions may result in increased incidence of stroke and poorer outcomes in elderly women. Therefore, it is imperative to identify vulnerable elderly women and provide them appropriate treatment and services.

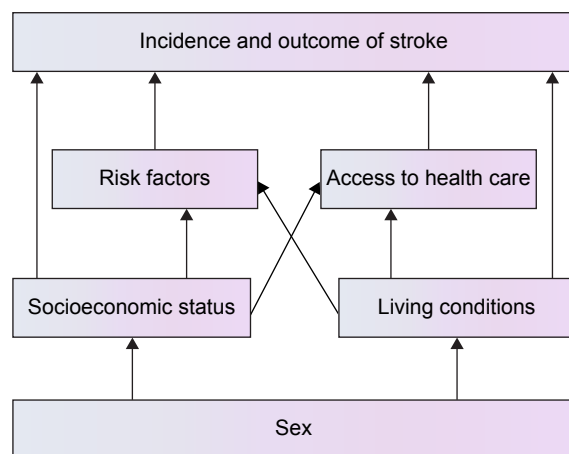
**Keywords:** aged, incidence, mortality, outcome, sex differences, socioeconomic disparities, vascular disease

## Introduction

Currently, stroke is an emerging major public health problem and the cause of 9% of overall mortality.<sup>1</sup> It is estimated that by 2020 stroke will be the second leading cause of death.<sup>2</sup> The results from several studies show that incidence and burden of stroke are mostly different for women and men,<sup>3-5</sup> and elderly women are more likely affected by stroke than men. Some studies show an increased incidence of stroke and poorer outcomes, such as disability and quality of life, in elderly women than in elderly men.<sup>1,4,6-9</sup> Although sex differences in stroke have increasingly been explored from biomedical perspectives, and several explanations such as pregnancy complications, genetic factors, clinical presentation, steroid hormones, hemoglobin levels, oral contraceptives, and menopause have been provided to explain the observed sex differences in stroke,<sup>4,10-12</sup> there are still large gaps in the existing knowledge.<sup>4,7,13</sup> It seems that the reasons for sex disparities in stroke are multifactorial, and the mechanisms that increase the risk of stroke in elderly women are not well understood.<sup>4,14</sup> Therefore, a

greater understanding of the differences in stroke between men and women may enhance the development of effective prevention and treatment strategies to improve stroke care and quality of life in the rapidly aging populations. As mentioned earlier, some studies reported sex differences in stroke from physiological perspectives and found that intrinsic sex differences may explain some of the differences in stroke between men and women, but there are still considerable gaps in our understanding of sex differences in stroke.<sup>4</sup>

Some studies have found that socioeconomic status contributes to stroke;<sup>2,15,16</sup> however, only limited studies that investigated the differences in stroke between elderly men and women from a socioeconomic perspective are available. There are significant differences in socioeconomic status and living conditions between elderly men and women, wherein older women have lower socioeconomic status and living conditions.<sup>11,17–19</sup> A growing body of literature indicates that lower socioeconomic status and living conditions contribute to some risk factors for stroke such as hypertension, diabetes mellitus, and depression.<sup>20–24</sup> Participants with low socioeconomic status are less likely to receive specific processes of care after stroke compared with participants with high socioeconomic status.<sup>22,25</sup> Some studies have found that older adults living alone, being unmarried, and living in deprived areas are less likely to receive stroke care.<sup>26,27</sup> Some other studies have found that access to health care may affect both incidence and recovery from stroke. Low access to health care for various prevention and therapeutic services is related to higher rates of stroke incidence and mortality.<sup>2,21</sup> In addition, low socioeconomic status and poor living conditions decrease the willingness to seek medical care among older adults.<sup>28–30</sup> Figure 1 presents the model of hypothesized relationships. Elderly women, compared to elderly men, have



**Figure 1** Socioeconomic mechanism underlying sex differences in stroke.

lower socioeconomic status and living conditions before stroke, which result in differences in risk factor distribution, availability of stroke prevention interventions, and provision of care that consequently increase the incidence of stroke and result in poorer outcomes of stroke.

According to the aforementioned possible underlying mechanism, the present study aimed to assess whether the differences in socioeconomic status and living conditions between men and women may explain part of the sex differences in incidence and outcomes of stroke.

## Methodology

This hospital-based study was conducted in Sabzevar (a region in the northeast of Iran, with a population of ~500,000) from March 21, 2013, until March 20, 2014. All the participants aged  $\geq 60$  years admitted in Vaseie Hospital in Sabzevar, Iran, were included in this study. Computerized tomography scan and magnetic resonance imaging were used to confirm stroke. All participants were followed up until a definite outcome was determined. Permission was obtained from hospital administration and Ethical Committee, and then, data such as sociodemographic characteristics and prestroke risk factors were collected.

## Ethical approval

This study was conducted in accordance with the 1964 Declaration of Helsinki and its later amendments and was approved by the Ethics Committee of the Sabzevar University of Medical Sciences, Iran. Written informed consent was obtained from all participants or from their relatives; the objectives of this study were explained, and confidentiality of information was assured to them.

Statistical Program for Social Sciences for Windows, Version 21.0 (IBM Corporation, Armonk, NY, USA), was used for data analysis. Descriptive statistics including percentages, measures of central tendency, and measures of variability were used to present the sample. A series of  $\chi^2$  tests were conducted to investigate the potential differences between older men and women in stroke incidence and outcomes. A two-tailed  $P$ -value  $\leq 0.05$  was used to determine the statistical significance.

## Results

A total of 159 incident strokes among participants aged  $\geq 60$  years were observed during a period of 12 months from January 2013 to January 2014. The mean age of the participants was 76.38 years (standard deviation = 8.50; range 60–95 years), 52.2% were female, 69.2% were unemployed,

**Table 1** Descriptive characteristics of the sample

Variable	Category	n	%	M	SD
Age				76.38	8.50
	Young-old (60–74 years)	65	40.9		
	Old-old (75–84 years)	57	35.8		
	Oldest-old ( $\geq 85$ years)	37	23.3		
Sex	Male	76	47.8		
	Female	83	52.2		
Marital status	Unmarried	43	27.0		
	Married	116	73.0		
Education	No formal education	123	77.4		
	Formal education	36	22.6		
Employment status	Unemployed	110	69.2		
	Employed	49	30.8		
Stratum	Urban	57	35.8		
	Rural	102	64.2		
Living arrangement	Spouse	79	49.7		
	Family/children	52	32.7		
	Living alone	28	17.6		
Medical conditions	Hypertension	126	79.2		
	Diabetes mellitus	42	26.4		
	Depression	25	15.7		
HAT				22.31	29.16
	Within 4 hours	66	41.5		
	Within 24 hours	61	38.4		
	After 24 hours	32	20.1		
Mortality		8	5.0		

**Abbreviations:** SD, standard deviation; HAT, hospital arrival time after the onset of stroke.

and 77.4% reported not having formal education. The annual rate of stroke was 378 cases per 100,000 persons. There was a significantly higher incidence of stroke in elderly women than in elderly men (401 vs 357 per 100,000;  $P < 0.001$ ); ~41% of stroke victims were in young-old (60–74) group. As shown in Table 1, ~16% of participants reported a history of depression, 26.4% diabetes, and 79.2% hypertension. The mean of hospital arrival time after the onset of stroke was 22.31 hours (standard deviation = 29.16).

Table 2 presents the sociodemographic and health characteristics of the sample with respect to sex. There was a strong association between marital status and sex ( $\chi^2[1] = 17.05$ ;  $P < 0.001$ ), with 88.2% of elderly male participants with stroke compared to 59.0% of elderly female participants with stroke being married. Slightly more than one-fourth of elderly women were living alone, whereas only a minority of the men (7.9%) were living alone. This sex difference was highly significant ( $\chi^2[2] = 17.22$ ;  $P < 0.001$ ). Majority (77.3%) of stroke participants in this sample had no formal education. Male stroke participants had significantly higher level of education than their female counterparts ( $\chi^2[2] = 13.8$ ;  $P < 0.001$ ).

As shown in Table 2, statistically significant differences were observed in risk factors for stroke between men and

**Table 2** Sociodemographic and health characteristics of the sample with respect to sex

Variable	Category	Male		Female		$\chi^2$
		n	%	n	%	
Age	Young-old (60–74 years)	26	34.2	39	47.0	3.64
	Old-old (75–84 years)	28	36.8	29	34.9	
	Oldest-old ( $\geq 85$ years)	22	28.9	15	18.1	
Marital status	Unmarried	9	11.8	34	41.0	17.05***
	Married	67	88.2	49	59.0	
Education	No formal education	49	64.5	74	89.2	13.8***
	Formal education	27	35.5	9	10.8	
Employment status	Unemployed	43	56.6	67	80.7	10.85**
	Employed	33	43.4	16	19.3	
Stratum	Urban	34	44.7	23	27.7	5.00*
	Rural	42	55.3	60	72.3	
Living arrangement	With spouse	50	65.8	29	34.9	17.22***
	With family/children	20	26.3	32	38.6	
	Living alone	6	7.9	22	26.5	
Medical conditions	Hypertension	55	72.4	71	85.5	4.19*
	Diabetes mellitus	14	18.4	28	33.7	
	Depression	7	9.2	18	21.7	
HAT	Within 4 hours	32	42.1	34	41.0	7.22*
	Within 24 hours	35	46.1	26	31.3	
	After 24 hours	9	11.8	23	27.7	
Death	Yes	2	2.6	6	7.2	1.76
	No	74	97.4	77	92.8	

**Notes:** \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ .

**Abbreviation:** HAT, hospital arrival time after the onset of stroke.

women. Significantly more number of women reported lifetime history of depression ( $\chi^2[1] = 4.66$ ;  $P \leq 0.05$ ), hypertension ( $\chi^2[1] = 4.19$ ;  $P \leq 0.05$ ), and diabetes mellitus ( $\chi^2[1] = 4.79$ ;  $P \leq 0.05$ ) than men. In addition, hospital arrival time after the onset of stroke was longer in women ( $\chi^2[1] = 7.22$ ;  $P \leq 0.05$ ) than in men. Women were more likely to be unemployed than men ( $\chi^2[1] = 10.85$ ;  $P \leq 0.05$ ). Although no significant association was observed between sex and mortality rate, elderly women had higher mortality rate after stroke than men. In female participants, in-hospital mortality rate was 7.2%, while in male participants it was 2.6%. No significant difference in age was observed between elderly male and female survivors with stroke.

## Discussion

In order to identify sex differences in stroke and to explore sex disparities in terms of incidence and outcome of stroke in later life, the present study was conducted from a socioeconomic perspective. Although some epidemiological studies show that stroke is more common among men,<sup>31,32</sup> our finding that is in line with some studies showing increased incidence of stroke among postmenopausal women<sup>1,7,33</sup> revealed a significantly higher rate of stroke in older women than in their age-matched male counterparts. Although age as a nonmodifiable risk factor may explain higher rate of stroke in older women,<sup>31,34</sup> the finding from the current study showed no significant difference between elderly men and women in age.

In-hospital mortality rate among elderly women was three times more than that among men, which supports a growing body of evidence showing a greater in-hospital mortality in women than in men after stroke.<sup>4,35</sup> It seems that elderly women are not evaluated as elderly men and possibly not treated appropriately. The findings from a Swedish registry showed that older women were less likely to be treated with antithrombotic drugs and less likely to receive anticoagulation.<sup>36</sup> Similarly, another study showed that older women were less likely to have echocardiography or any carotid investigation after adjusting for other confounding factors such as age and initial stroke severity.<sup>37</sup>

Since the main aim of the present study was to investigate sex disparities in stroke, we explored these differences from a socioeconomic perspective. The findings from the current study showed that older women, compared to older men, had lower socioeconomic status and were more likely being unmarried and living alone. These findings are consistent with the results of previous studies showing sex differences in socioeconomic status<sup>38,39</sup> and living conditions.<sup>11,17,40</sup>

Multiple studies have found that people in low socioeconomic status and poor living conditions are more susceptible to acquiring chronic medical conditions and poorer health status.<sup>18,41</sup> In parallel with previous studies,<sup>23,27</sup> older women reported higher rates of past history of hypertension, diabetes mellitus, and depression, which might be associated with increased incidence of stroke.<sup>42-44</sup> Older women are more vulnerable to social risk factors for depression than men.<sup>45</sup> Some studies show that low socioeconomic status is more closely associated with diabetes in women than in men.<sup>46</sup> The prevalence of hypertension is greater in women after menopause than in men, especially those with a history of hypertension during pregnancy. In addition, socioeconomic determinants of hypertension are more prevalent among women.<sup>47,48</sup>

Other findings from the current study showed a sex disparity in delayed hospital arrival, that is, elderly women had longer prehospital delay. This finding is consistent with the results of previous studies that have demonstrated elderly women, compared to men, are less likely to be admitted to the acute stroke care unit within the eligible time that may potentially delay treatment and results in poor stroke outcomes.<sup>4,27,49,50</sup> In addition, some elderly female stroke participants might be managed at home by traditional techniques<sup>9</sup> that may lead to poor stroke outcomes.

In sum, in line with some previous studies demonstrating that low socioeconomic status and poor living conditions are associated with increased incidence and mortality from stroke,<sup>25,41,51</sup> this study hypothesized that differences in socioeconomic status and living conditions between elderly men and women may explain part of sex disparities in sex differences in stroke in terms of incidence rate and outcomes. Our findings showing lower socioeconomic status and poorer living conditions for older female participants with stroke may account for part of sex disparities in stroke.

Although, to our knowledge, this study is one of the first studies exploring sex differences in stroke from a socioeconomic perspective and found interesting results, it has some limitations. First, no data on household income status of participants were available. However, it is noteworthy to mention that level of education and employment status can reflect income effect.<sup>52</sup> Second, the cross-sectional nature of the study precludes any definitive conclusion; therefore, a longitudinal study with a large sample size is required to confirm the proposed mechanism. The third limitation of the current study is that a multivariate analysis was not feasible, which may affect the results.

## Conclusion

The findings from the current study supported some previous research studies showing that elderly women are more adversely affected by stroke in terms of incidence and in-hospital mortality of stroke than elderly men. The most noticeable result of our study was that sex differences in socioeconomic status and living conditions might result in higher rate of stroke incidence and poorer outcomes in elderly women. Therefore, it is imperative to identify vulnerable elderly women with stroke and provide them appropriate treatment and services.

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## Disclosure

The authors report no conflicts of interest in this work.

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