



# Exploring Nontraumatic Brain Hemorrhage in Sudden and Unexpected Deaths: A Novel Autopsy-Based Investigation

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Asian J Neurosurg 2025;20:126–131.

## Abstract

**Background** There has been a surge in sudden and unexpected deaths, presenting a significant challenge for health policymakers and researchers. These individuals showed no signs of recent or past illnesses and died suddenly during routine activities like walking, standing, or working.

**Objective** This study focuses on exploring nontraumatic brain hemorrhage as a cause of death in autopsies of individuals without prior illnesses. The research aims to explore patterns, prevalence, and risk factors associated with nontraumatic brain hemorrhage, specifically obesity in sudden and unexpected deaths.

**Materials and Methods** This retrospective, observational study was conducted using autopsy cases with nontraumatic brain hemorrhage as the identified cause of sudden and unexpected deaths. Information on demographic details, medical history, and circumstances surrounding the deaths was collected. The cases were classified based on the body mass index according to the classification of the World Health Organization.

**Results** From April 2023 to January 2024, 10 cases of sudden and unexpected deaths due to nontraumatic brain hemorrhage were identified. Key findings included predominantly cases of obesity or overweight, deaths occurring predominantly between 8 p.m. and midnight, and all cases being males.

**Conclusion** The study sheds light on the surge in sudden deaths, specifically attributed to nontraumatic brain hemorrhage. The findings reveal a significant association between obesity and brain hemorrhage in sudden deaths, especially among males. The study's temporal analysis adds depth to understanding these patterns.

## Keywords

- ▶ intracranial hemorrhage
- ▶ sudden deaths
- ▶ intracerebral hemorrhage
- ▶ obesity
- ▶ obesity paradox
- ▶ unexpected deaths
- ▶ cardiovascular diseases
- ▶ autopsy
- ▶ BMI

article published online  
December 2, 2024

DOI <https://doi.org/10.1055/s-0044-1800811>.  
ISSN 2248-9614.

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Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

## Introduction

Recently, there has been a noticeable surge in sudden and unexpected deaths in India.<sup>1</sup> These affected individuals showed no signs of recent or past illnesses and died suddenly during routine activities like walking, standing, or working. Due to the abrupt nature of these deaths, investigations and diagnoses are not possible, leading to postmortem examinations to determine the cause of death. Nontraumatic brain hemorrhages, such as intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH), are significant contributors to sudden and unexpected deaths. The 30-day mortality rate ranges from 35 to 52%, with nearly half of these deaths occurring within the initial 24 hours.<sup>2,3</sup> Recognized risk factors include arterial hypertension, hypercholesterolemia, diabetes mellitus, cardiomyopathy, excessive consumption of tobacco or alcohol, environmental air pollution, high-risk diet, and obesity.<sup>4–11</sup>

Globally, obesity, the second leading cause of preventable death, poses a public health concern due to the widespread prevalence of its risk factors and a considerable rise in associated consequences.<sup>9,11–14</sup> Some studies have shown that obesity predisposes individuals to a heightened risk of hemorrhagic and ischemic stroke,<sup>15–19</sup> with each unit increase beyond a BMI of 20 correlating with a 5% increase in ischemic stroke risk.<sup>15,16</sup> Contrary to these assumptions, other studies have suggested that obesity does not have any relationship with stroke.<sup>6,16,20–24</sup> Some studies have shown that extremes of body mass index (BMI; both low and high) are associated with an increased risk of ICH,<sup>25–29</sup> challenging any clear evidence of a higher prevalence or incidence of hemorrhagic stroke in obese individuals. The “obesity paradox theory” proposes that patients with a higher BMI may exhibit better prognoses than leaner patients in terms of clinical outcomes for cardiovascular diseases.<sup>7,9,23,30–32</sup>

The aim of this study is to identify nontraumatic brain hemorrhage in sudden and unexpected death and to investigate the patterns, prevalence, and possible risk factors such as obesity. This study was conducted on autopsies of sudden deaths in individuals without prior illnesses. By exploring factors such as obesity prevalence and temporal patterns, this study contributes valuable information to the ongoing discussion about unexpected sudden deaths recently. This study stands out as a pioneering and unique contribution to the existing literature as no autopsy-based investigations have been conducted on this topic to date.

## Materials and Methods

This prospective cross-sectional observational study was conducted using autopsy cases in a tertiary care hospital in Surat, India, from April 2023 to January 2024. This study included autopsies in which the cause of death was identified as nontraumatic brain hemorrhage (–**Fig. 1**). These cases were classified as sudden and unexpected deaths, occurring in various settings, including homes, workplaces, and public spaces.

## Inclusion Criteria

- Sudden and unexpected deaths, irrespective of age or gender, occurring in nontraumatic circumstances.
- Autopsies where the primary cause of death was identified as nontraumatic brain hemorrhage.

## Exclusion Criteria

- Autopsies where the cause of death was due to trauma, external injuries, or poisoning.
- Cases where the autopsy findings were inconclusive, or the cause of death could not be definitively attributed to brain hemorrhage.
- Decomposed body.

Demographic details, medical history, and circumstances surrounding the death were collected during the autopsy from inquiries, relatives, and any available medical records. The height and weight were recorded in centimeter and kilogram, respectively. We classified the cases according to the World Health Organization (WHO) BMI classification as follows:

- Underweight: BMI of less than 18.5.
- Normal weight: BMI of 18.5 to 24.9.
- Overweight: BMI of 25 to 29.9.
- Obesity (class 1): BMI of 30 to 34.9.
- Obesity (class 2): BMI of 35 to 39.9.
- Obesity (class 3): BMI of  $\geq 40$ .

## Results

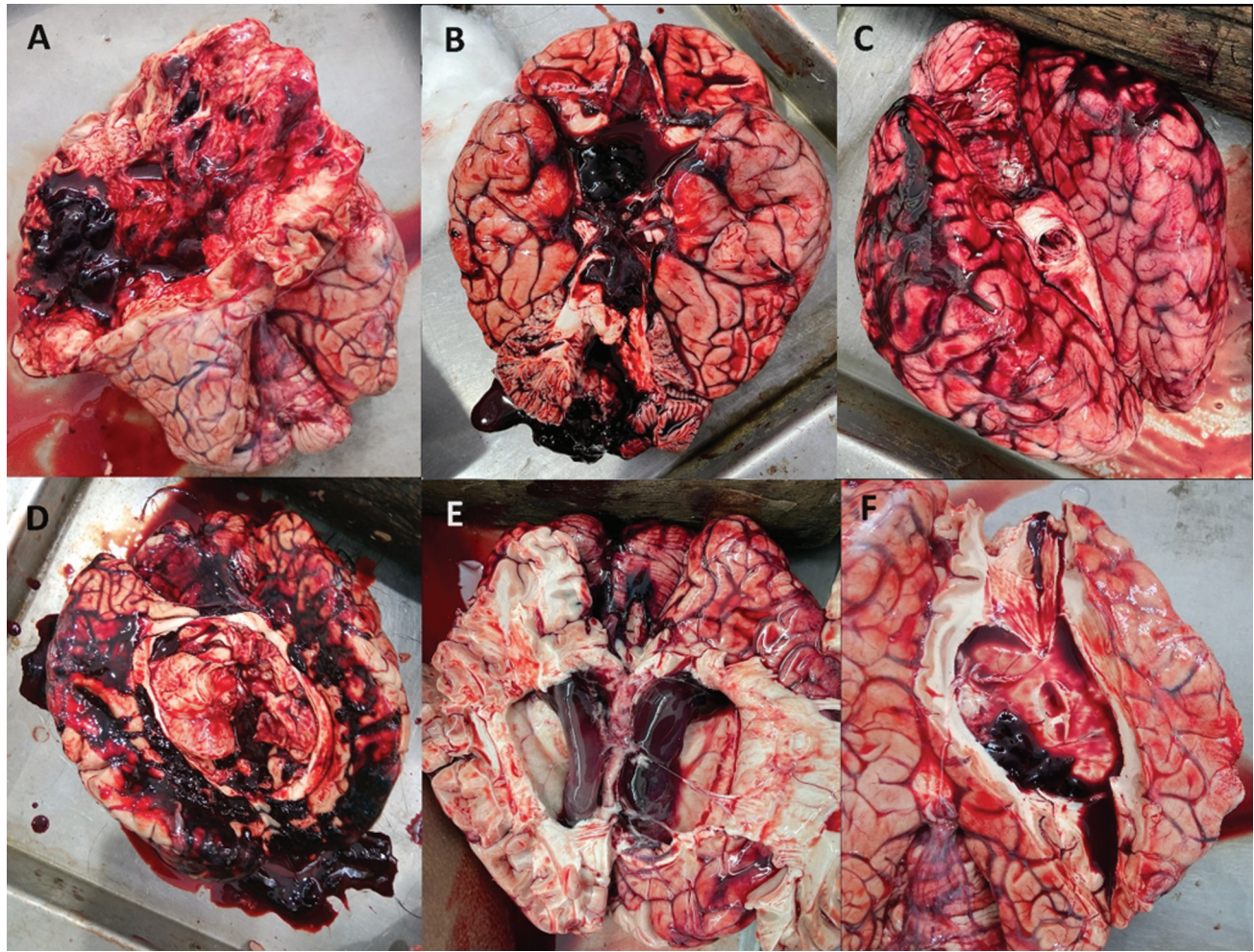
During the study period, we identified 10 cases (–**Table 1**) in which nontraumatic brain hemorrhage (–**Fig. 1**) was the cause of sudden and unexpected death. The key findings are summarized in the following subsections

### Case 1

A 48-year-old male suddenly became unconscious at home for an unknown reason and died. He was not suffering from any illness. He was transferred to the hospital where the duty doctor declared him brought dead. Postmortem examination revealed that the body was overweight, with a weight of 74 kg. Internal examination revealed ICH over the right temporal lobe and the basal surface. Further pathological examination revealed extensive areas of myocardial infarction with grade VII atherosclerosis. His BMI was 27.

### Case 2

A 69-year-old man was suffering from chest pain, difficulty in breathing, and weakness for 1 day. He was admitted to the hospital where he died within 6 hours despite receiving intensive medical care. His blood pressure was 114/82 mm Hg. His chest X-ray showed haziness over the lower zone bilaterally and mild cardiomegaly. Postmortem examination revealed a body weight of 62 kg, and internal examination revealed thickening of the coronary arteries. Pathological examination of the organs revealed myocardial infarction with grade VII atherosclerosis, pneumonia, SAH, and ICH. His BMI was 23.



**Fig. 1** (A–F) Intracerebral, subarachnoid, and intraventricular hemorrhage.

### Case 3

A 40-year-old man was suffering from fever for 5 days. The patient was unconscious in the morning and declared dead on arrival at the hospital. A postmortem examination was performed to determine the cause of death. An external examination revealed a weight of 98 kg. Internal examination revealed a large intraventricular hemorrhage (IVH) in

both the lateral ventricles. The coronary arteries were also thickened. His BMI was 38.

### Case 4

A 49-year-old man suddenly became unconscious during bathing. He was transferred to the hospital but died before treatment was started. During the autopsy, the external

**Table 1** Case details

Age	Sex	Height (cm)	Weight (kg)	Symptoms	Time of event	BMI	Obesity class
48	Male	165	74	Unconscious	14:30	27.2	Overweight
69	Male	165	62	Chest pain, dyspnea	20:00	22.8	Normal weight
40	Male	160	98	Fever	07:00	38.3	II
49	Male	170	88	Unconscious	21:00	30.4	I
61	Male	175	88	Unconscious	20:00	28.7	Overweight
28	Male	174	62	Unconscious	21:00	20.5	Normal weight
41	Male	170	98	Weakness	21:45	33.9	I
61	Male	164	78	Uneasiness	06:00	29.0	Overweight
58	Male	154	95	Unknown	Unknown	40.1	III
28	Male	176	94	Dyspnea	20:00	30.3	I

features showed a weight of 88 kg. Internal examination revealed ICH in both the frontal and parietal lobes, IVH, edematous lungs, and calcified coronaries. His BMI was 30.

#### Case 5

A 60-year-old man was found unconscious at home upon entering the house. He was transferred to the hospital, where the on-duty doctor declared him dead. He did not suffer from any illness in the past or recently. During the autopsy, his weight was 88 kg on external examination. Internal findings revealed a large ICH over both the parietal and occipital lobes. His BMI was 29.

#### Case 6

A 28-year-old man suddenly died at home. His relative transferred him to the hospital, but he did not survive, and his body was sent for postmortem. During the autopsy, no specific external findings were found. His weight was 62 kg. Internal examination revealed profuse SAH over both the temporal and parietal lobes, basal surface, and IVH in both lateral ventricles. His BMI was 20.

#### Case 7

A 41-year-old man was suffering from weakness for 4 days. Primary blood investigations were performed, but the results were inconclusive. He suddenly collapsed at home and was immediately transferred to the hospital, but he did not survive before the onset of treatment. During postmortem, his weight was 98 kg. In the internal examination, bilateral parietal, temporal, and occipital lobes showed SAH. The brain was edematous. His BMI was 34.

#### Case 8

A 61-year-old man was feeling uneasiness in the morning and suddenly became unconscious within an hour. He was transferred to the hospital but died before the start of treatment. The patient had a 3-year history of diabetes and was on regular medication. During the autopsy, his weight was found to be 78 kg. Internal examination revealed a large SAH over the parietal, temporal, and occipital surfaces and an IVH in both lateral ventricles. His BMI was 29.

#### Case 9

An unknown male dead body of approximately 58 years of age was found by the roadside. A past or present history of illness could not be found because of the absence of relatives. During the autopsy, his weight was 85 kg. Internal examination revealed an ICH in both the temporal and parietal lobes. The brain was edematous. The coronary arteries were calcified and thickened. His BMI was 40.

#### Case 10

A 28-year-old man was suffering from shortness of breath for 6 to 8 hours. Suddenly, the patient deteriorated and was transferred to the hospital. He was in a gasping state at the time of admission and his blood pressure was not recordable. The patient suddenly collapsed and eventually died. During the autopsy, his weight was 94 kg. Internal examination

showed profuse SAH over the whole brain surface, with greater thickness over the frontal lobes. The brain was edematous. The coronary arteries were also thickened. His BMI was 30.

All these cases had no history of hypertension or incidence of hemorrhagic or ischemic stroke. A computed tomography (CT) scan or magnetic resonance imaging (MRI) examination was not performed due to the abrupt nature of the death. There was a lack of vital examination data, including pulse and blood pressure readings, as the majority of individuals were brought dead to the hospital.

#### Observations

- Eight out of 10 cases were obese or overweight.
- Deaths occurred predominantly between 8 p.m. and midnight.
- All cases were males, and nine cases were married.
- Age distribution was equal and nonspecific.
- All the individuals died without significant prior illness or medical history.
- The circumstances of death were sudden and uneventful, with no trauma to the body.

#### Discussion

Nontraumatic brain hemorrhages, such as ICH and SAH, are identified as important contributors to these sudden deaths and the 30-day mortality rate ranges from 35 to 52%, with nearly half of these deaths occurring within the initial 24 hours.<sup>3,4</sup> Obesity, the second leading cause of preventable death globally, has been associated with an increased risk of brain hemorrhage in some studies.<sup>9,11-19</sup> On the contrary, some studies showed that it does not have any relation to ischemic or hemorrhagic stroke.<sup>6,16,20-24</sup> The “obesity paradox theory” introduces the idea that patients with a higher BMI may have better prognoses in cardiovascular diseases.<sup>7,9,23,30-32</sup>

This study stands out as a unique contribution to the existing literature because no autopsy-based investigations have been conducted on this topic to date. This research explored nontraumatic brain hemorrhage as a cause of death in sudden and unexpected deaths without prior illnesses. During the study period, 10 cases were identified in which nontraumatic brain hemorrhage was the cause of sudden and unexpected death. The cases exhibited various characteristics, such as sudden unconsciousness, chest pain, fever, and weakness. Autopsy findings revealed ICH and SAH as major causes of death along with myocardial infarction, pneumonia, and other pathological conditions.

The demographic analysis showed that 8 out of the 10 cases were obese or overweight, deaths occurred predominantly between 8 p.m. and midnight, and all cases were males. This study provides valuable insights into the impact of obesity on brain hemorrhage in sudden death, along with a higher incidence in males. This emphasizes the need for further research on the relationship between obesity and nontraumatic brain hemorrhage. The results of this study

enhance our understanding of recent sudden deaths offering insights that could guide preventive measures particularly in the Asian population. This could involve the development of health policies aimed at identifying individuals with obesity and implementing weight loss programs. Additionally, raising awareness among this demographic about the potential risks and encouraging regular health checkups may prove effective in preventing the occurrence of brain hemorrhages and subsequent sudden deaths. The temporal pattern of deaths (predominantly occurring between late evening hours) suggests that circadian factors or daily routines may influence the onset of fatal brain hemorrhages. Further studies in the Asian population could investigate these patterns more closely to understand their implications and improve early detection strategies.

The study supports the need for updated clinical guidelines that incorporate obesity-related risk factors into the evaluation of patients, even those without prior illness, who might be at risk of sudden brain hemorrhages. The findings from this study underscore the importance of heightened awareness among emergency care physicians when dealing with sudden and unexpected deaths. In the cases where individuals present with symptoms such as sudden unconsciousness, chest pain, or unexplained weakness, particularly those with no significant prior medical history, physicians should consider nontraumatic brain hemorrhage (ICH or SAH) as a differential diagnosis. This is especially true in patients who are overweight or obese, given the observed association between obesity and brain hemorrhage in this study.

## Limitations

The limitations of the study include the following:

- **Small sample size:** With only 10 cases included, the sample size is relatively small, limiting the ability to generalize the findings to a broader population. A larger study would provide a more robust assessment of the association between obesity and brain hemorrhage in sudden and unexpected deaths.
- **Short observation period:** The study was conducted over less than a year, which may limit the understanding of seasonal or temporal variations in the occurrence of sudden brain hemorrhages. A longer observation period could reveal more accurate trends and patterns.
- **Absence of imaging data:** Due to the abrupt nature of the death in many cases, no premortem imaging data (CT, MRI) were available. The lack of such diagnostic tools limits the ability to correlate the autopsy findings with the clinical presentations, which would have strengthened the study's conclusions.
- **Geographical limitation:** The study is based on cases from a single tertiary care hospital in Surat, India. As such, the findings may not be representative of other regions or countries, where genetic, environmental, or lifestyle factors may differ.

## Conclusion

This study sheds light on the significant association of obesity as risk factor with nontraumatic brain hemorrhages, particularly ICH and SAH, in sudden and unexpected deaths. This study stands out as a novel endeavor, being the first of its kind to specifically investigate the autopsies of individuals who died suddenly and unexpectedly without prior history or diagnosis of brain hemorrhage. The findings of this research reveal a strong association between brain hemorrhage and obesity, especially among males. Notably, the incidence of these occurrences peaked during late evening hours, adding a temporal dimension to the observed patterns. This result underscores the need for further in-depth studies to explore the complexities of sudden and unexpected deaths attributed to brain hemorrhage. The findings of this study have broad implications for public health policy, suggesting the importance of targeted strategies for preventing mortality, particularly within the Asian community.

### Authors' Contributions

All the authors have contributed toward writing, editing, and reviewing of this manuscript.

### Funding

None.

### Conflict of Interest

None declared.

## References

- 1 Ponnaiah M, Bhatnagar T, Abdulkader RS, et al; Sudden Adult Deaths Study Group. Factors associated with unexplained sudden deaths among adults aged 18–45 years in India: a multicentric matched case-control study. *Indian J Med Res* 2023;158(04): 351–362
- 2 Broderick J, Connolly S, Feldmann E, et al. Guidelines for the management of spontaneous intracerebral hemorrhage in adults: 2007 update—a guideline from the American Heart Association/American Stroke Association Stroke Council, High Blood Pressure Research Council, and the Quality of Care and Outcomes in Research Interdisciplinary Working Group: the American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists. *Stroke* 2007;38(06): 2001–2023
- 3 Elliott J, Smith M. The acute management of intracerebral hemorrhage: a clinical review. *Anesth Analg* 2010;110(05): 1419–1427
- 4 Guo Y, Yue XJ, Li HH, et al. Overweight and obesity in young adulthood and the risk of stroke: a meta-analysis. *J Stroke Cerebrovasc Dis* 2016;25(12):2995–3004
- 5 Hankey GJ. Stroke. *Lancet* 2017;389(10069):641–654
- 6 Haley MJ, Lawrence CB. Obesity and stroke: can we translate from rodents to patients? *J Cereb Blood Flow Metab* 2016;36(12): 2007–2021
- 7 Carbone S, Lavie CJ, Arena R. Obesity and heart failure: Focus on the obesity paradox. *Mayo Clin Proc* 2017;92(02):266–279
- 8 Mitchell AB, Cole JW, McArdle PF, et al. Obesity increases risk of ischemic stroke in young adults. *Stroke* 2015;46(06):1690–1692

- 9 Brzecka A, Ejma M. Obesity paradox in the course of cerebrovascular diseases. *Adv Clin Exp Med* 2015;24(03):379–383
- 10 Horwich TB, Fonarow GC, Hamilton MA, MacLellan WR, Woo MA, Tillisch JH. The relationship between obesity and mortality in patients with heart failure. *J Am Coll Cardiol* 2001;38(03):789–795
- 11 Doehner W, Schenkel J, Anker SD, Springer J, Audebert HJ. Overweight and obesity are associated with improved survival, functional outcome, and stroke recurrence after acute stroke or transient ischaemic attack: observations from the TEMPIS trial. *Eur Heart J* 2013;34(04):268–277
- 12 Bhurosy T, Jeewon R. Overweight and obesity epidemic in developing countries: a problem with diet, physical activity, or socio-economic status? *ScientificWorldJournal* 2014;2014:964236
- 13 Rodríguez-Castro E, Rodríguez-Yáñez M, Arias-Rivas S, et al. Obesity paradox in ischemic stroke: clinical and molecular insights. *Transl Stroke Res* 2019;10(06):639–649
- 14 Afshin A, Forouzanfar MH, Reitsma MB, et al; GBD 2015 Obesity Collaborators. Health effects of overweight and obesity in 195 countries over 25 years. *N Engl J Med* 2017;377(01):13–27
- 15 Guzik A, Bushnell C. Stroke epidemiology and risk factor management. *Continuum (Minneapolis)* 2017;23(1, Cerebrovascular Disease):15–39
- 16 Oesch L, Tatlisumak T, Arnold M, Sarikaya H. Obesity paradox in stroke: myth or reality? A systematic review. *PLoS One* 2017;12(03):e0171334
- 17 Wohlfahrt P, Lopez-Jimenez F, Krajcoviechova A, et al. The obesity paradox and survivors of ischemic stroke. *J Stroke Cerebrovasc Dis* 2015;24(06):1443–1450
- 18 Yoshida N, Ogawa M, Nakai M, et al. Impact of body mass index on in-hospital mortality for six acute cardiovascular diseases in Japan. *Sci Rep* 2022;12(01):18934
- 19 Pezzini A, Grassi M, Paciaroni M, et al; Multicentre Study on Cerebral Hemorrhage in Italy (MUCH-Italy) Investigators. Obesity and the risk of intracerebral hemorrhage: the multicenter study on cerebral hemorrhage in Italy. *Stroke* 2013;44(06):1584–1589
- 20 Dangayach NS, Grewal HS, De Marchis GM, et al. Does the obesity paradox predict functional outcome in intracerebral hemorrhage? *J Neurosurg* 2018;129(05):1125–1129
- 21 Bosello O, Donataggio MP, Cuzzolaro M. Obesity or obesities? Controversies on the association between body mass index and premature mortality. *Eat Weight Disord* 2016;21(02):165–174
- 22 Wang S, Ren J. Obesity paradox in aging: from prevalence to pathophysiology. *Prog Cardiovasc Dis* 2018;61(02):182–189
- 23 Antonopoulos AS, Tousoulis D. The molecular mechanisms of obesity paradox. *Cardiovasc Res* 2017;113(09):1074–1086
- 24 Lavie CJ, De Schutter A, Milani RV. Body composition and the obesity paradox in coronary heart disease: can heavier really be healthier? *Heart* 2015;101(20):1610–1611
- 25 Bazzano LA, Gu D, Whelton MR, et al. Body mass index and risk of stroke among Chinese men and women. *Ann Neurol* 2010;67(01):11–20
- 26 Song YM, Sung J, Davey Smith G, Ebrahim S. Body mass index and ischemic and hemorrhagic stroke: a prospective study in Korean men. *Stroke* 2004;35(04):831–836
- 27 Silventoinen K, Magnusson PKE, Tynelius P, Batty GD, Rasmussen F. Association of body size and muscle strength with incidence of coronary heart disease and cerebrovascular diseases: a population-based cohort study of one million Swedish men. *Int J Epidemiol* 2009;38(01):110–118
- 28 Cao Z, Liu X, Li Z, et al. Body mass index and clinical outcomes in patients with intracerebral haemorrhage: results from the China Stroke Center Alliance. *Stroke Vasc Neurol* 2021;6(03):424–432
- 29 Biffi A, Cortellini L, Nearnberg CM, et al. Body mass index and etiology of intracerebral hemorrhage. *Stroke* 2011;42(09):2526–2530
- 30 Chaudhary D, Khan A, Gupta M, et al. Obesity and mortality after the first ischemic stroke: is obesity paradox real? *PLoS One* 2021;16(02):e0246877
- 31 Soffer S, Zimlichman E, Glicksberg BS, et al. Obesity as a mortality risk factor in the medical ward: a case control study. *BMC Endocr Disord* 2022;22(01):13
- 32 Lavie CJ, De Schutter A, Parto P, et al. Obesity and prevalence of cardiovascular diseases and prognosis: the obesity paradox updated. *Prog Cardiovasc Dis* 2016;58(05):537–547