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Changing trends of the diseases burden attributable to high BMI in Asia from 1990 to 2019: results from the global burden of disease study 2019

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ABSTRACT

Objective To analyse the trends of diseases burden attributed to high body mass index (BMI), including overweight and obesity, in Asia from 1990 to 2019.

Design Observational study.

Setting The data of 45 countries and regions in Asia were obtained from the Global Burden of Disease Study 2019 database.

Main outcome measures Numbers, age-standardised rate (ASR) of deaths and disability-adjusted life years (DALYs), and the corresponding estimated annual percentage changes (EAPCs), attributable to high BMI in Asia from 1990 to 2019, were analysed by regions, genders and age. We also analysed changes in the causes of deaths and DALYs that are attributable to high BMI over this period.

Results In 2019, all causes deaths attributable to high BMI in Asia were 2 329 503, with increases by 265% compared with 1990. Over three decades, DALYs related to high BMI have increased by 268%. The ASRs of deaths and DALYs in Asia both showed continuous upward trends during this period (EAPC 1.39; 95% certainty interval [95% CI] 1.35 to 1.43 for deaths; EAPC 1.8; 95% CI 1.76 to 1.84 for DALYs), while both were declined in high-income areas (EAPC −2.03 and −1.26). By geographical regions, disease burden in Central Asia and West Asia have been fluctuating at high levels, but high-income Asia Pacific showed decreasing trends of ASR of deaths (EAPC −2.03) and DALYs (EAPC −1.26). Over this period, disease burden in Asia was changing from women to men, and tends to ageing. In addition, diabetes were the diseases most affected by high BMI, and cancer burden was high in middle-aged and elderly people.

Conclusions The disease burden attributed to high BMI in Asia has experienced great changes. It is necessary to promote the prevention of obesity and chronic diseases in a comprehensive manner, especially in low-income areas, men and elderly.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ In this study, a risk factor, rather than a disease, was the main object of study.
⇒ We also analysed trends in disease burden for several specific diseases associated with body mass index (BMI).
⇒ The burden of diseases attributed to overweight or obesity, could not be distinguished.
⇒ Data on the burden of disease associated with low BMI are not available.

INTRODUCTION

With the increasing prevalence of obesity, it has become a worldwide health issue.[1] In accordance with the standards of the WHO, obesity and overweight were estimated based on body mass index (BMI). Adults over 20 years of age with BMI between 25 kg/m^2 and 30 kg/m^2 were defined as overweight, and those with BMI over 30 kg/m^2 were defined as obesity.[2] In 2020, about 2.6 billion people worldwide were overweight of obese, accounting for about 38% of the world's population and is expected to reach 51% by 2035, with over 4 billion people.[3] Obesity has become an independent risk factor for a variety of chronic diseases, including diabetes and kidney disease,[4] cardiovascular and cerebrovascular diseases[5] and multiple neoplasms.[6] The further worsening of this phenomenon and concerns about increased health risks are common global challenges.

In 2008, the highest prevalence of obesity was found in North Africa and the Middle East, Central and Southern Latin America, where prevalence rate ranged from 27.4% to 31.1%.[7] The regions with the lowest prevalence were South and Southeast Asia and Central and East sub-Saharan Africa, and high-income Asia Pacific, with prevalence rate ranging from 2.2% to 5.4%.[7] In recent years, there has been increasing studies focusing on the trends of obesity.[8 9] These studies revealed changes in global obesity patterns. The issues of obesity or overweight are on the sharp rise in low-income and middle-income countries in recent years, while which used to occur in high-income countries.

As the continent with the largest population, most countries in Asia, such as China, are developing countries and have seen accelerated increases in obesity and overweight, which has become a by-product of rapid economic growth and the recent industrialisation.[10] There is evidence that Asians have higher percentages of body fat than whites or Europeans at the same BMI,[11] which means a greater tendency to adverse metabolic consequences. Asians appear to be prone to abdominal obesity, which is usually associated with an increased risk of cardiovascular disease.[12 13] These findings indicated that the risk of disease caused by high BMI in Asians may differ from that in other regions of the world. However, there are still no reports about long-term trends in the epidemiology of disease burden attributed to high BMI in Asia until now.

In the present study, we analysed the trends of all-cause deaths and disability-adjusted life years (DALYs) attributed to high BMI in Asia from 1990 to 2019 based on data from the Global Burden of Disease Study 2019 (GBD 2019) in the online Global Health Data Exchange (GHDx) Query Tool (http://ghdx.healthdata.org/gbd-results-tool),[14] hoping to reveal the changing trend of disease spectrum attributed to high BMI in Asia, to help policymakers in Asian countries building a more targeted public health system.

MATERIALS AND METHODS

Data source

The specific data analysed in this study were obtained from the GBD 2019 in the GHDx Query Tool, which provides the estimated data of disease burden from 286 causes of death, 369 diseases and injuries and 87 risk factors on global, regions and/or countries around the world. The data sources of the GBD database include monitoring data, survey data, disease registration data, medical records, literature reports, health insurance claims, etc. By using a uniform methodology and standardised statistical analysis model, the GBD database provide comparable and consistent data, which is released per 2 years. The latest data has been updated to 2019 (GBD 2019). As studies published previously,[15–17] the detailed calculation information can be found on http://ghdx.healthdata.org/gbd-results-tool.

In GBD 2019, adults with a BMI of over 25 kg/m^2, or children (aged 1–19) exceeding the corresponding standards threshold set by the International Obesity Task Force, is defined as high BMI.[2]

According to GBD 2019, diseases and injuries are defined into four different levels, ranging from the three broadest terms at level 1 to the most specific terms at level 4. The GBD used Bradford Hill's standard of causality and the World Cancer Research Fund's evidence grading standard to systematically assess the epidemiological evidence supporting a causal relationship between high BMI and a variety of disease endpoints in adults.[1] As is shown in online supplemental table S1, death attributed to high BMI was identified to be correlated with six causes in grade 2 aetiologies in Asia in GBD 2019, while DALYs related with eight causes. In grade 3 aetiologies, the numbers of causes attributable to high BMI resulting in death burden in women and men were 22 and 19, respectively (online supplemental table S1). The numbers of causes contributing to DALYs burden in women and men were 26 and 23, respectively (online supplemental table S1).

DALYs, a measure of disease burden assessment, represent the total number of healthy life years lost from onset to death,[18] which were counted by summing years of life lost and years lived with disability.[19] Socio-demographic Index, as described in previous studies,[20] is a comprehensive index that is used to evaluate the degree of health-related development at the national or regional level, ranging from 0 to 1. Based on geographical location, the 45 countries in Asia were divided into 6 regions (online supplemental table S2), which is consistent with previous studies.[21]

Statistical analysis

Numbers and rate of deaths and DALYs attributable to high BMI were the main indicators of disease burden. GBD 2019 calculates the age-standardised rates (ASRs) of death (ASDR) and DALYs (with the associated 95% uncertainty intervals (UIs)) to eliminate the confounding of age between comparison groups to ensure comparability between most rates, and quantify the disease burden.

The attributable fraction of deaths and DALYs related to high BMI was measured by the population attributable fraction (PAF), which was defined as the proportion of all cases of a specific disease or other undesirable condition in a populace that is attributable to a specified risk factor.[2]

As described previously, we denote the temporal trend of ASRs over a specific time interval by calculating the estimated annual percentage change (EAPC).[22] Briefly, the natural logarithm of the ASR is supposed to have a linear relationship with time, that is, $y=\alpha+\beta x+\varepsilon$, where y is ln (ASR), x is the time variable and ε is the error term. The equation $EAPC=100\times(\exp(\beta)-1)$ was used to calculate the EAPC. Linear model was performed to obtain the 95% confidence interval (95% CI) for the EAPC.[22] If both the EAPC and its 95% CI lower limit are above 0, the ASR was considered as upward. Conversely, an ASR less than 0 was considered to indicate a decrease.

In the present study, we analysed the general trend of deaths and DALYs burden attributable to high BMI in the total Asia, or across the 6 regions, or 45 countries, respectively. Then, we calculated the ratios of disease burden (numbers or ASRs of deaths and DALYs) between two genders (females to males), to explore the gender difference and the corresponding changing trend. Next, the disease burden related to high BMI among different age groups and their corresponding changing trends were also analysed. Furthermore, the changing trends of disease profile, especially cancers, attributed to high BMI, were also investigated.

All other analyses and visualisations were performed using GraphPad Prism V.8 (California, USA) and R software V.4.1.2 (Vienna, Austria).

Patient and public involvement

Patients or the public were not involved in this study.

RESULTS

General trend of death and DALYs burden attributable to high BMI in Asia

Overall trend

In 2019, there were estimated 2 329 503 deaths (95% UI, 1 355 956 to 3 508 455) attributable to high BMI in Asia, which increased by 265% (95% UI, 179% to 465%) compared with 1990 (table 1, figure 1A). The DALYs also increased from 21.84 million in 1990 to 80.36 million in 2019 (table 1, figure 1B). The ASDR (EAPC, 1.39; 95% CI, 1.35 to 1.43) and ASR of DALYs (EAPC, 1.8; 95% CI, 1.76 to 1.84) also showed increasing trends (table 1, online supplemental table S3).

Geographical regional trends

Geographically, over this period, the ASRs of both deaths and DALYs in Central Asia and West Asia have been fluctuating at high levels (figure 1A,B). From 1990 to 2019, most regions shown upward trend, with the fastest-growing were both found in Southeast Asia (EAPC for deaths 3.05, 95% CI, 2.97 to 3.12; EAPC for DALYs 3.08, 95% CI, 2.99 to 3.16), while high-income Asia Pacific was the only region showing decreasing trends of ASDR (EAPC, −2.03; 95% CI, −2.1 to −1.96) and ASR of DALYs (EAPC, −1.26; 95% CI, −1.34 to −1.18) (figure 1A,B; table 1; online supplemental table S3).

National trends

In 2019, China has the most deaths (764.7 thousand) and DALYs (24 830.04 thousand) attributable to high BMI. Uzbekistan was the country with highest ASDR (228.74 per 100 000; 95% UI, 140.09 to 333.45). The lowest ASDR was Japan (12.68 per 100 000; 95% UI, 4.76 to 23.67) (figure 1C, online supplemental table S4). From 1990 to 2019, the EAPC of ASDRs increased in 25 countries with the most increasement in Viet Nam (EAPC, 4.14; 95% CI, 3.82 to 4.47), while decreased in 12 countries with the most decrease in Republic of Korea (EAPC, −2.95; 95% CI, −3.13 to −2.77). The Asian countries with the highest ASR of DALYs were the United Arab Emirates (5732.92 per 100 000; 95% UI, 4111.71 to 7383.33), while Japan (503.28 per 100 000; 95% UI, 199.93 to 888.74) had the lowest ASR of DALYs (figure 1D). The ASR of DALYs in Bangladesh has the largest increase (EAPC, 4.42; 95% CI, 4.02 to 4.81). The Republic of Korea has the largest decrease (EAPC, −2.95; 95% CI, −3.13 to −2.77). From 1990 to 2019, the ASR of DALYs increased in the majority countries and territories during this period, with 26 countries or regions shown increased trends, 13 countries shown decreased trends (online supplemental table S4).

Gender difference and the corresponding changing trend

In 1990, the disease burden attributed to high BMI in Asia was higher in women than in men (figure 2A). Over the past three decades, both ASDR and ASR of DALYs for both genders showed increasing trends (figure 2A), and the disease burden in men has gradually surpassed that of women since 1995 (figure 2A,B).

From 1990 to 2019, the ASDR for men increased from 32.71 (95% UI, 11.14 to 66.66) per 100 000 in 1990 to 53.59 (95% UI, 28.57 to 83.97) per 100 000 in 2019 (EAPC, 1.79; 95% CI, 1.76 to 1.83) (table 1). The ASDR for women increased from 33.91 (95% UI, 13.75 to 63.17) per 100 000 to 45.33 (95% UI, 26.6 to 69.46) per 100 000 (EAPC, 1.02; 95% CI, 0.95 to 1.08) (figure 2A, table 1, online supplemental table S3). Over this period, the ASR of DALYs associated with high BMI in men increased from 955.1 per 100 000 to 1732.67 per 100 000 (EAPC, 2.16; 95% CI, 2.13 to 2.19), and in women changed from 984.41 to 1475.33 per 100 000 (EAPC, 1.43; 95% CI, 1.37 to 1.49) (figure 2A, table 1, online supplemental table S3). From 1990 to 2019, both the burden of death and DALYs were tends to serious in men, especially in high-income Asia Pacific and East Asia (figure 2C). Although the disease burden attributed to high BMI in West Asia in women was higher than that in men, most regions of Asia showed a much greater disease burden in men in 2019 (figure 2D). The results suggested that the disease burden attributed to high BMI was unbalanced between genders. If there is no urgent action, the gap between the two genders is widening with time.

Age difference and the corresponding changing trend

In 2019, the all-cause disease burden attributed to high BMI increased with age in Asia, with the peak death burden in the 65–69 age group and the peak DALYs burden in the 55–59 age group. Then, the effect of high BMI on elderly individuals gradually decreased with age (figure 3A,B). Interestingly, the disease burden attributed to high BMI in people under 70 years of age was much more severe in men, while the disease burden of people over 70 years of age was mainly in women (figure 3C,D).

From 1990 to 2019, disease burden proportions of different age groups in general Asia did not change greatly, with mainly concentrated in 50–70 age groups. But in high-income Asia Pacific, proportions of burden related with high BMI in people over 80 years of age continues to increase during this period (figure 3E; online supplemental figure S1). The results suggested that, over the past three decades, the disease burden of high BMI-related deaths and DALYs in high-income Asia Pacific has progressively turned to ageing (online supplemental figure S1).

Changing trend of disease profile attributed to high BMI

We further analysed the disease burden of the causes attributable to high BMI in Asia from 1990 to 2019. Disease burden of all the six reasons for death and eight reasons for DALYs, attributed to high BMI, in GBD grade

Table 1 Numbers and ASRs of death and DALYs attributable to high-BMI in Asia in 1990 and 2019

	Death burden				DALYs burden			
	1990		2019		1990		2019	
Characteristics	Death cases (×10^6) (95% UI)	ASDR (per 100 000) (95% UI)	Death cases (×10^6) (95% UI)	ASDR (per 100 000) (95% UI)	DALYs numbers (×10^6) (95% UI)	ASR of DALYs (per 100 000) (95% UI)	DALYs numbers (×10^6) (95% UI)	ASR of DALYs (per 100 000) (95% UI)
Asia	0.64 (0.25 to 1.21)	33.59 (12.6 to 64.88)	2.33 (1.36 to 3.51)	49.51 (28.28 to 75.85)	21.84 (8.64 to 40.59)	973.39 (381.21 to 1832.68)	80.36 (48.86 to 116.4)	1606.54 (969.72 to 2339.04)
Gender								
Male	0.31 (0.11 to 0.62)	32.71 (11.14 to 66.66)	1.22 (0.67 to 1.86)	53.59 (28.57 to 83.97)	10.9 (3.97 to 21.08)	955.1 (341.55 to 1871.41)	42.93 (24.98 to 62.83)	1732.67 (996.2 to 2554.3)
Female	0.33 (0.14 to 0.6)	33.91 (13.75 to 63.17)	1.11 (0.66 to 1.69)	45.33 (26.6 to 69.46)	10.93 (4.67 to 19.45)	984.41 (419.01 to 1769.29)	37.43 (23.13 to 54.09)	1475.33 (907.46 to 2136.86)
Geographical regions								
Central Asia	0.05 (0.03 to 0.08)	118.8 (73.02 to 169.76)	0.11 (0.07 to 0.15)	163.15 (107.72 to 223.58)	1.59 (1.02 to 2.2)	3263.44 (2091.11 to 4521.03)	3.41 (2.39 to 4.45)	4303.56 (2988.64 to 5696.91)
East Asia	0.25 (0.06 to 0.54)	30.12 (7.5 to 67.41)	0.79 (0.34 to 1.35)	40.27 (17.44 to 70.19)	8.26 (2.17 to 17.46)	861.76 (225.28 to 1839.12)	25.6 (12.12 to 41.9)	1226.16 (574.62 to 2015.61)
High-income Asia Pacific	0.05 (0.02 to 0.09)	24.97 (8.6 to 47.69)	0.07 (0.03 to 0.14)	14.74 (6.04 to 26.21)	1.58 (0.58 to 2.87)	779.24 (283.72 to 1422.15)	2.09 (0.91 to 3.62)	576.33 (255.45 to 972.41)
West Asia	0.21 (0.13 to 0.29)	127.14 (79.24 to 181.31)	0.54 (0.37 to 0.71)	133.59 (90.04 to 179.03)	6.67 (4.37 to 9.14)	3488.84 (2262.5 to 4798.46)	17.89 (12.87 to 23.13)	3777.18 (2692.63 to 4943.28)
South Asia	0.14 (0.05 to 0.26)	24.74 (8.83 to 49.03)	0.73 (0.44 to 1.06)	52.79 (30.93 to 77.93)	4.93 (1.91 to 9.28)	742.73 (283.42 to 1415.51)	26.62 (16.08 to 37.39)	1729.74 (1043.52 to 2440.57)
Southeast Asia	0.08 (0.03 to 0.15)	29.96 (10.29 to 59.22)	0.41 (0.25 to 0.59)	66.46 (39.68 to 97.55)	2.98 (1.14 to 5.47)	977.08 (363.81 to 1823.91)	15 (9.55 to 20.9)	2201.98 (1382.81 to 3086.51)

ASDR, age-standardized rate of death; ASR, age-standardised rate; BMI, body mass index; DALYs, disability-adjusted life years; 95% UI, 95% uncertainty interval.

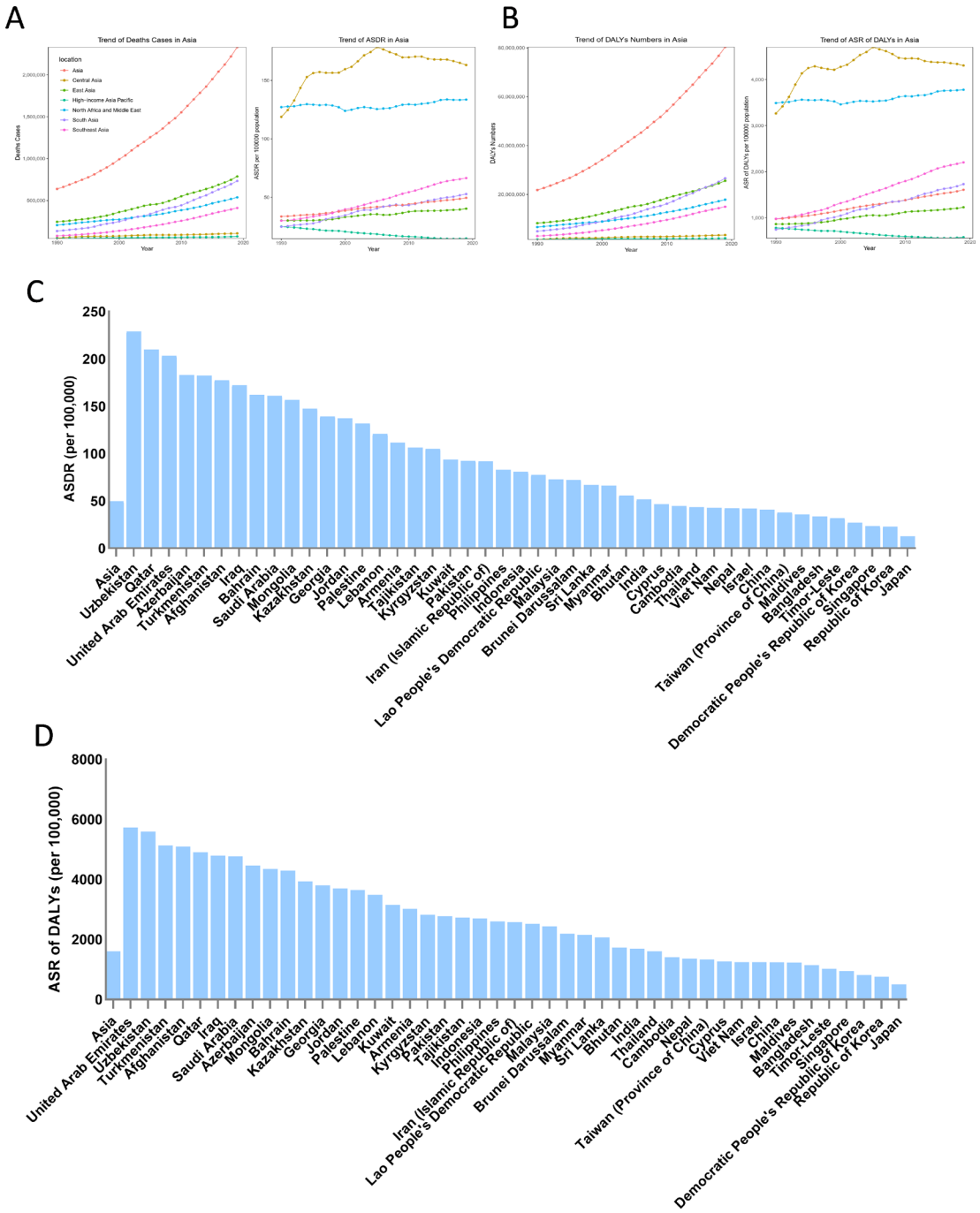

Figure 1 Numbers and ASRs of deaths and DALYs burden that related to high-BMI in geographical regions and 45 countries in Asia from 1990 to 2019. (A) Changing trends of death numbers and ASDRs in geographical regions in Asia from 1990 to 2019. (B) Changing trends of numbers and ASR of DALYs in regions in Asia from 1990 to 2019. (C) ASDR related to high BMI in 45 countries and territories in Asia in 2019. (D) ASR of DALYs related to high BMI in 45 countries and territories in Asia in 2019. ASDR, age-standardised deaths rate; ASR, age-standardised rate; BMI, body mass index; DALYs, disability-adjusted life years.

2 aetiologies increased from 1990 to 2019 in Asia (online supplemental figure S2A). As a risk factor, the disease burden of high BMI was mainly reflected in cardiovascular and cerebrovascular diseases, followed by diabetes and renal disease in GBD grade 2 aetiologies (online supplemental figure S2A). In GBD grade 3 aetiologies, stroke has been the leading cause of DALYs burden that is attributable to high BMI over the past 30 years (figure 4A, online supplemental table S5). But ischaemic heart disease has replaced stroke to be the leading cause of death burden attributable to high BMI (online supplemental table S6). In terms of causes, diabetes was the cause that was most affected by high BMI with the highest PAFs of age-standardised deaths and DALYs in both 1990 and 2019 (online supplemental tables S5 and S6).

Among men, ischaemic heart disease is the disease with the highest ASDR and ASR of DALYs attributable to high BMI in 2019. The highest ASDR in women were caused

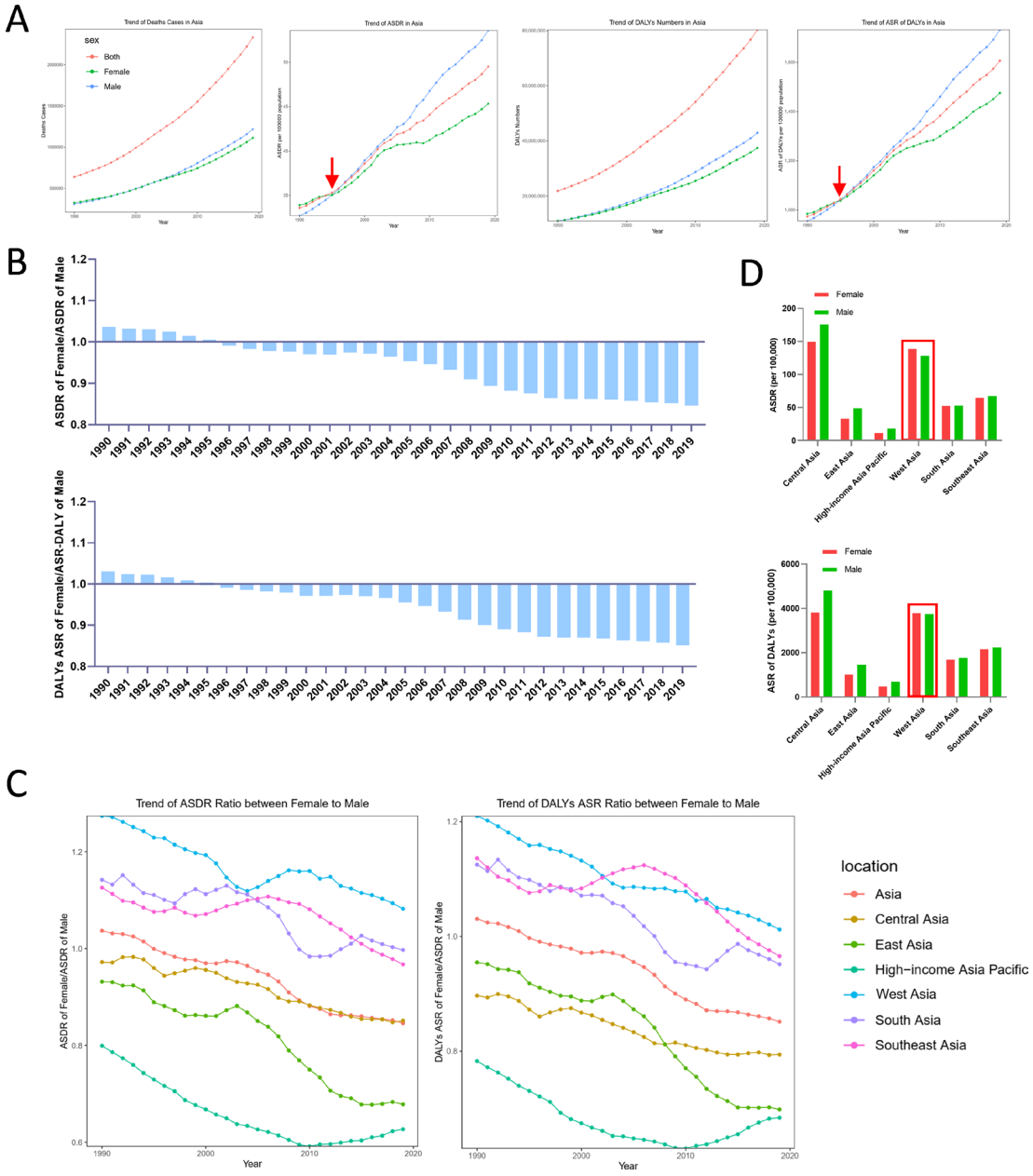

Figure 2 Numbers and ASRs of deaths and DALYs burden that related to high-BMI in men and women in geographical regions and 45 countries in Asia from 1990 to 2019. (A) Changing trends of numbers or ASRs for deaths and DALYs in men and women in Asia, 1990 to 2019. (B) The ratios of ASDR or DALYs of female-to-male in Asia from 1990 to 2019. (C) The ratios of ASDR or DALYs of female-to-male in geographical regions in Asia from 1990 to 2019. (D) The ratios of ASDR or DALYs of female-to-male in geographical regions in Asia 2019. ASDR, age-standardised deaths rate; ASR, age-standardised rate; BMI, body mass index; DALYs, disability-adjusted life years.

by ischaemic heart disease, but the highest ASR of DALYs were by stroke (figure 4B).

As mentioned above, the disease burden attributed to high BMI differs across regions in Asia. Central Asia showed the highest ASR of DALYs for both ischaemic heart disease and stroke in 2019, while West Asia had the highest ASR of DALYs for diabetes (figure 4C).

Cancer burden attributable to high BMI

With the development of the conception of 'obesity-related cancers',[23] the risk of obesity for cancers has attracted growing concern. Therefore, we further analysed the disease burden of several cancers attributed to high BMI.

High BMI-associated oesophageal cancer has been the major disease burden in the last 30 years (figure 4D). Disease burden caused by liver cancer which is attributed to high BMI, peaked in 1996 and then began to decrease and remained stable after 2004. The disease burden of colon and rectal cancer has shown a significant increase in the last three decades. Disease burden of high BMI-associated oesophageal cancer, kidney cancer, colon and rectal cancer, liver cancer and non-Hodgkin's lymphoma was notably

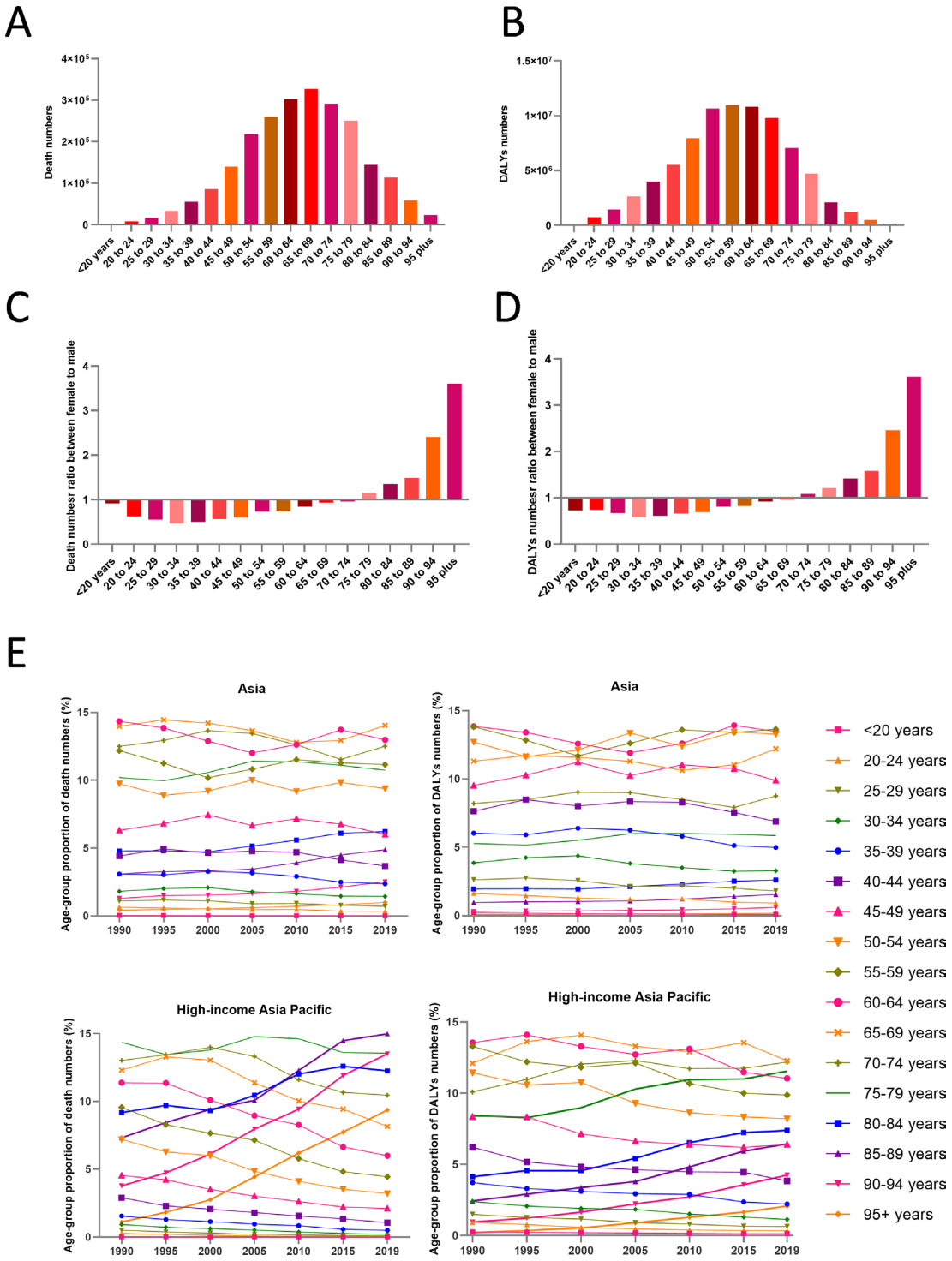

Figure 3 Disease burden attributed to high-BMI in different age groups in Asia. (A) Death numbers associated with high BMI in Asians by age groups. (B) DALY numbers associated with high BMI in Asians by age groups. (C) The death number ratio between females to males in Asia by age groups. (D) The DALYs number ratio between females to males in Asia by age groups. (E) Age-group proportions of death and DALYs number in Asia and high-income Asia Pacific by age groups from 1990 to 2019. ASDR, age-standardised deaths rate; ASR, age-standardised rate; BMI, body mass index; DALYs, disability-adjusted life years.

higher in men than in women. The burden attributed to high BMI-associated gallbladder and biliary tract cancer, and leukaemia was significantly higher in women (online supplemental figure S3). In addition, the disease burden of multiple myeloma, pancreatic cancer and thyroid cancer is greater in men than women at younger ages, however, as age increases, the burden of disease for women gradually exceeds that of men (figure 4E). The burden of breast cancer attributable to high BMI was most severe in 50–54 years of age, and gradually decreases with increasing age. In women aged 20–49 years, high BMI seems to be negatively related with the disease burden of breast cancer (figure 4E).

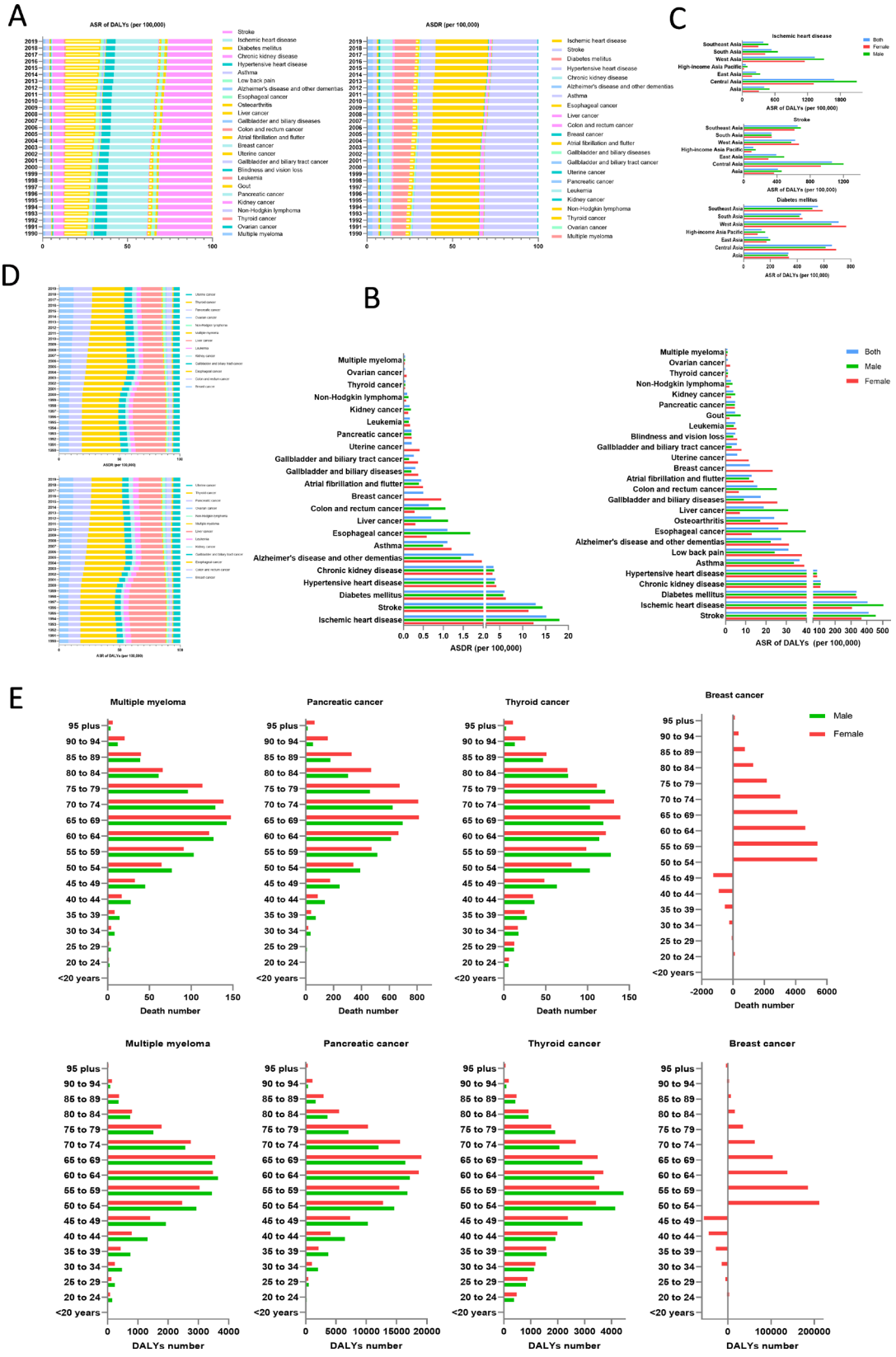

Figure 4 Specific disease burden of deaths or DALYs associated with high BMI in GBD grade 3 aetiologies. (A) Proportions of ASDRs and ASRs of DALYs with GBD grade aetiologies related to high BMI in Asia from 1990 to 2019. (B) ASDRs and ASRs of DALYs for GBD grade 3 aetiologies related to high BMI in men and women in Asia in 2019. (C) ASR of DALYs of ischaemic heart disease, stroke and diabetes associated with high BMI in men and women in Asia in 2019. (D) Trends in the proportions of ASDR and ASR of DALYs for cancers related to high BMI from 1990 to 2019. (E) Number of deaths and DALYs for neoplasms related to high BMI in men and women by age groups in Asia, 2019. ASDR, age-standardised deaths rate; ASR, age-standardised rate; BMI, body mass index; DALYs, disability-adjusted life years.

DISCUSSION

In the present study, we found that the diseases burden attributed to high BMI has been increasing in Asia during the past three decades. From 1990 to 2019, compared with other Asian regions, excess body mass-induced all causes disease burden in high-income Asia Pacific were much lower and showed a continuous downward trend. For other Asian regions, both ASDR and ASR of DALYs show different degrees of increase. The occurrence of obesity is influenced by socioeconomic and environmental factors. Obesity has been well publicised in high-income countries in recent years, while it is not fully recognised by the general public in low-income and middle-income countries.[24] With the increasing economic development of Asian countries, traditional diets are gradually replaced by high-calorie and high-sugar fast foods coupled with a lack of exercise lifestyle.[25] On the other hand, obesity is also associated with low levels of education, and inequalities in socioeconomic levels exacerbate the health damage caused by obesity.[26] Although obesity is gaining attention and most countries have made efforts, many existing measures are insufficient to control the obesity epidemic in Asia. This shows that nutritional imbalance still exists, but the key problem now is not undernutrition, but overnutrition.[27]

In 1990, deaths and DALYs due to high BMI were higher in women in Asia, but these burdens in men surpassed that of women since 1995. These findings are consistent with the results of the global study by Dai *et al*.[8] This may be due to the faster pace of economic development in Asia in the recent two decades and increased work pressure, which leads to reduced exercise time and unhealthy eating habits among men. In addition, men generally have less concern for their body image, and women who are obese are more likely to seek treatment.[28] Other possible explanations include fewer vegetables and fruits consumption, and smoking and drinking alcohol are more common among men. These factors may contribute to higher disease burden associated with high BMI in men compared with women. Although the disease burden among men is higher than women in whole Asia, the situation is reversed in West Asia, which is consistent with previous research.[29] This is mainly due to specific social and cultural factors in this region, such as greater barriers for women to engage in physical exercise compared with men.[30] Additionally, we have found that the burden of obesity-related diseases in West Asia is much higher than in other Asian regions, which may be attributed to the subsidies provided by countries in this region that encourage increased consumption of high-energy foods.[31]

Our research found that the burden of diseases related to high BMI is primarily concentrated in the middle-aged and elderly population, which aligns with the demographic distribution in society. There are gender differences in the burden of diseases related to high BMI across different age groups. In younger populations, men have a higher burden than women. However, as age increases, the disease burden gradually surpasses men and becomes higher in women, primarily due to the longer life expectancy of women. Other studies have shown that it is since adulthood rather than only in the elderly that women have higher prevalence of obesity than men.[1 32] The cause of this phenomenon has not been fully understood. Obesity causes a higher loss of life expectancy in women than in men in middle age and beyond; at the same time, obesity accelerates redox imbalance, chronic inflammation and mitochondrial dysfunction and accelerates ageing.[33]

Over the past 30 years, the proportion of disease burden across different age groups in Asia has not shown significant changes. However, in high-income Asia Pacific regions with high socioeconomic development and better healthcare, there has been a rapid increase in the burden of diseases among the elderly. This can be attributed to the higher socioeconomic development, better healthcare and longer life expectancy, leading to a prominent ageing population in this region.

According to research reports, obesity is associated with over 230 comorbidities or complications, with the most common ones being ischaemic heart disease, diabetes, hypertension and stroke.[34] Over the three decades, causes profile attributable to high BMI has changed. The major cause of death burden attributable to high BMI, has changed from stroke in 1990 to ischaemic heart disease in 2019. But the main cause of DALYs burden attributable to high BMI has been stroke throughout this period. Although diabetes burden related to high BMI were not the highest, but it was the aetiology of those most affected by high BMI.

It is widely believed that excessive obesity is associated with low cancer survival rates.[35] In this study, we found that the burden of breast cancer attributable to high BMI was highest among women aged 50–54 years and gradually decreased with increasing age. However, in women below 50 years, there appears to be a negative relationship between high BMI and the disease burden of breast cancer. This was consistent with the results of previous studies, which revealed that high BMI is related to an increased risk of postmenopausal breast cancer and a decreased risk of premenopausal women.[36 37] It may also be the result of a multifactorial mix of patient history of obesity, behavioural factors, ethnicity, cancer heterogeneity and statistical bias. Moreover, breast cancer occurrence is not solely attributed to a single factor. These multiple factors need to be taken into account, rather than simply defining obesity as a 'protective' or 'detrimental' factor. Therefore, the association of high BMI with breast cancer in premenopausal women needs to be interpreted with caution and more big-sample studies are needed to explore.

It is worth noting that in GBD 2019, the term 'high BMI' in adults refers to a BMI over 25 kg/m^2, which may differ from the specific cut-off point for Asians. Evidence suggests that Asians have a higher body fat content relative to Caucasians or Europeans at the same BMI.[11] Additionally, Asians appear to be more prone to abdominal

obesity, which is associated with an increased risk of metabolic diseases.[12 13] Therefore, using a universal BMI cut-off point instead of specific cut-off points for Asians may underestimate the burden of diseases attributable to high BMI. This is also one of the limitations of this study, and future research is expected to evaluate the disease burden in Asians based on specific cut-off points for this population.

Common limitations of studies based on the GBD database have been reported in previous studies,[38] and other specific limitations of the present study are listed as follows. First, the indicator BMI does not apply to weight gain between muscularity and excess fat, visceral fat and subcutaneous fat. There is a large discrepancy between obesity and disease burden due to these factors. Second, the prevalence of obesity in children and adolescents continues to rise globally. Many countries have focused on innovative approaches and strategies to reverse this trend. Due to the paucity of information for the childhood and adolescent obesity population in GBD 2019, our data only categorise <20 years as a group. Obesity in children and adolescents is often maintained into adulthood and is related to a higher risk of disease. This information is important for studying the burden of disease in obesity. Therefore, studies should be conducted to obtain more relevant information on these data on obesity in the future.

CONCLUSION

In conclusion, during the past three decades, disease burden attributed to high BMI in Asia has experienced great changes. These disease burden, especially in men, should be paid much more attention. Moreover, this issue in low-income areas should be given priority. The prevention and control of obesity should be carried out throughout the life cycle, and the whole society will be mobilised to participate in the completion.

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