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Ethnicity and obesity: why are some people more vulnerable?

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Abstract

Obesity is a global problem that affects all ethnic groups and managing it is a major challenge. In developing countries obesity coexists with underweight. BMI is the most widely used measure of obesity. World Health Organization cut-off values of BMI ≥25 or ≥30 kg/m^2 for overweight and obesity, respectively, have been used worldwide for several years to assess the prevalence of obesity of varying degrees. The highest prevalence of overweight and obesity in the world is to be found in the Western Pacific Islands, especially among the populations of Nauru and Tonga, where it reaches 80–90%. Sub-Saharan Africa has the lowest prevalence of obesity. The greatest increase in obesity is occurring in countries with a diverse ethnic population, such as Mauritius and Brazil.

An increased percentage of body fat is normally coupled to an increase in body weight. However, there is evidence to show that the association between BMI, percentage and distribution of body fat differs across populations, with Asians having the highest percentage of body fat compared with other populations. Asians also have a higher amount of visceral adipose tissue. The variation in percentage of body fat and body fat distribution relative to BMI across ethnic groups is reflected in ethnic differences in the health risks associated with obesity. For example, populations from the Asia-Pacific region have been found to have substantial risks of cardiovascular disease (CVD) below a BMI of 25 kg/m^2.

In all populations, cardiovascular risk increases with increasing waist circumference, even though it is influenced by ethnicity. For example, compared with white populations, Inuit and Polynesians have been found to have lower blood pressure, lipids, stimulated glucose and insulin levels for the same levels of waist circumference. The metabolic impact of different levels of obesity differs considerably across populations, especially with regard to diabetes and CVD. Therefore the 'one-size-fits-all' approach adopted internationally must be reconsidered and carefully analysed. BMI, waist circumference and waist-hip ratio all have their limitations when it comes to comparing obesity and its risk factors across ethnic groups and populations.

The influence of genetics on the association between obesity and health risks remains unresolved. Data on obesity and metabolic risk factors including Inuit living in Greenland and Denmark showed that Inuit in Denmark followed the same patterns as an ethnic Danish reference population with regard to the association between obesity and cardiovascular risk factors. Lifestyle and environmental factors may therefore be more important than genetic factors regarding the influence of obesity on disease risk.

Key words:
Obesity, ethnicity, risk factors, type 2 diabetes

Introduction

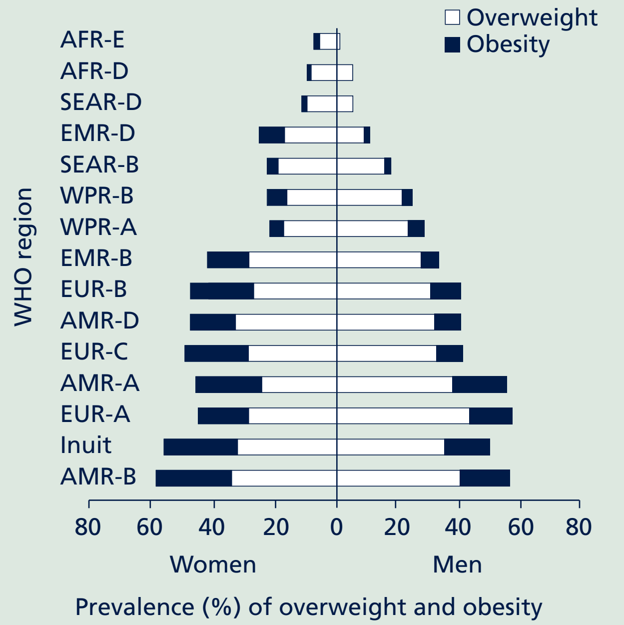
Chronic disease accounts for a large proportion of the global burden of disease and is the main cause of death in almost every country.

> ***Prevention and management of obesity are a major challenge, especially in developing countries, where obesity often coexists with malnutrition and underweight***

According to a report by the World Health Organization (WHO), each year at least 2.6 million people die as a result of being overweight or obese [1]. It is not only people from rich societies who develop obesity: recent decades have seen substantial lifestyle changes among many indigenous populations and their interaction with genetic susceptibility has led to an epidemic of obesity and obesity-associated disease. Prevention and management of obesity are a major challenge, especially in developing countries, where obesity often coexists with malnutrition and underweight.

Guidelines for defining obesity

Evidence for the emerging epidemic of obesity has been gathered from population surveys using measures of BMI and others such as waist circumference. International and national guidelines, such as those adopted by WHO [2] and the National Institutes of Health [3], define categories of overweight and obesity. Although guidelines are important tools to monitor populations, their applicability and generalizability across all ethnic groups, which likely differ in their health risks associated with specific BMI categories, remain an unresolved issue.



AFR, Africa region; SEAR, South-East Asia region; EMR, Eastern Mediterranean region; WPR, Western Pacific region; EUR, European region; AMR, American region.
A, B, C, D and E refer to subsets of countries in the WHO regions; for details see http://www.who.int/choice/demography/by_country/en/index.html.

Fig. 1: *Age-standardized prevalence of overweight and obesity according to WHO regions. Data from [4]. Figure adapted from [5].*

Estimates of the global prevalence of obesity

The WHO publication *Comparative quantification of health risks* [4] provides prevalence estimates for various WHO regions by age and gender. The estimates are based on the WHO criteria for overweight (BMI 25.0–29.9 kg/m^2) and obesity (BMI ≥30.0 kg/m^2), using the direct method of age standardization according to the hypothetical 'world population' of the International Agency for Research on Cancer as the standard (*Fig. 1*).

Another source of global comparison data is the International Obesity Task Force database, which provides estimates only of crude prevalence of obesity and overweight for all adults [6].

Few countries have reported data on waist circumference or waist-hip ratio. One source, however, is the multinational Monitoring of Trends and Determinants of Cardiovascular Disease study, whose final surveys were conducted in the mid-1990s [7]. Data on abdominal fat distribution are even scarcer, which is probably due to the fact that equipment for these measurements is expensive and — except for ultrasound scanning — impractical for field studies. Globally, obesity data have therefore mostly been reported based on simple measurements, the most commonly used of which is BMI.

One problem of comparing the development of obesity between different countries is the baseline level of obesity, which can vary considerably between countries. In the WHO publication *Obesity: preventing and managing the global epidemic* [2], the increase in obesity (BMI ≥30.0 kg/m^2) is given for different nations. In Brazil, for example, the prevalence of obesity in adults (aged 25–64 years) increased by 190% in males during the period 1975–1989, but the increase in obesity was only 62% in US males during the period 1976–1994. However, when comparing baseline reference values (beginning 1975 and 1976, respectively) for these two countries, the prevalence in Brazil was 3.1% but it was 12.3% in the United States. Nevertheless, the same WHO publication shows that:

- global obesity is on the increase in all continents;
- the prevalence of obesity is highest in the Pacific Islands followed by North America (United States and Canada) and the Middle East;
- sub-Saharan Africa has the lowest prevalence of obesity;
- developing countries with a diverse ethnic population, for example Mauritius and Brazil, seem to have the highest increase in obesity regardless of baseline obesity.

Certain ethnic or ethnically homogeneous populations either have a very high prevalence of obesity or have consistently been shown to have higher measures of fat variables compared with other ethnic groups within the same country. The populations of the Pacific islands of Tonga and Nauru have the highest prevalence of overweight and obesity (BMI ≥25.0 kg/m^2) in the world at 80–90% in both genders [8, 9]. It is of note that due to drastic economic changes over the past few years, overweight and obesity among the population of Nauru has dropped considerably (8–10%) [9]. In the United States the prevalence of overweight (BMI ≥27.0 kg/m^2) among Pima Indians ranges from 44% to 70% in males and from 48% to 88% in females across age groups ranging from 20–24 years to ≥75 years [10]. It was recently demonstrated that the Kenyan Maasai had higher fat accumulation with increasing age compared with the Luo and Kamba when looking at different measures including BMI, abdominal visceral and subcutaneous fat thickness, waist circumference and arm fat area. Among the males, the Maasai also had the highest prevalence of overweight (BMI ≥25.0 kg/m^2) at 14.0% [11].

Developing countries with a diverse ethnic population, for example Mauritius and Brazil, seem to have the highest increase in obesity regardless of baseline obesity

Association between anthropometric measurements, measures of fat and fat distribution

An increased percentage of body fat is normally coupled to an increase in body weight. A number of publications have described the relationship between BMI and percentage of body fat, all showing that the latter can be accurately predicted from the former as long as age and gender are taken into account [12–14]. However, there is increasing evidence that the association between BMI, percentage of body fat and distribution of body fat differs across populations and there is a general trend towards a higher percentage of body fat for a given BMI in Asians compared with Europeans, whereas the percentage of body fat is lower in African Americans and Polynesians. Fernandez et al. [15] demonstrated that not only does the percentage of body fat for a given BMI differ with ethnicity, so too does the slope of the BMI/percent body fat curve across populations.

Visceral fat distribution is recognized as a more important risk factor for ischemic heart disease and diabetes than is overall obesity. Compared with Europeans, Asians have greater amounts of visceral adipose tissue [16, 17], whereas African Americans have less [18–21]. The association between anthropometric measurements, percent body fat and fat distribution is also influenced by ethnicity. The available data suggest that Asians have larger amounts of visceral adipose tissue for the same age and level of body fatness and are less prone to subcutaneous fat distribution in comparison with Europeans. Correspondingly, African Americans have less truncal fat than do European Americans, Asian Americans and Hispanic Americans, and African Americans are more prone to subcutaneous fat accumulation for a given amount of body fat [22]. *Table I* summarizes the associations that have been found between anthropometric measurements and measures of fat and fat distribution in different populations.

Obesity and associated cardiovascular risk and comorbidity in different ethnic groups

Considering the variation between ethnic groups in percentage and distribution of body fat relative to BMI, it may not appear surprising that ethnicity influences the health risks associated with obesity.

For instance, a meta-analysis of 33 cohort studies from the Asia-Pacific region with more than 310,000 participants found that substantial risks of cardiovascular events were associated with a BMI below the currently defined lower limit of overweight (25.0 kg/m^2) [29].

The DECODE/A studies representing different ethnic groups (11 European, one Maltese, three Indian, two Chinese and three Japanese surveys comprising 14,240 men and 15,129 women) demonstrated that the effect of BMI on the age-adjusted prevalence of type 2 diabetes was modified by ethnicity and there were considerably lower thresholds in Indian and Maltese subjects than in those from the rest of Europe (*Fig. 2*) [30].

Studies from Hong Kong and Singapore have shown that the risk of having cardiovascular disease (CVD) or diabetes is high even at a lower BMI [31, 32]. Data from China indicate that the prevalence of hypertension, diabetes, dyslipidemia, and clustering of risk factors all increased with increasing BMI even at low BMI values [33].

Waist circumference and waist-hip ratio as direct markers of abdominal fat distribution have

Table I: Association between anthropometric measurements and measures of fat and fat distribution.

Authors	Population 1	Population 2	Population 3	Findings in Population 1 vs. other populations
Gallagher et al. [23]	Japanese	Caucasians from the UK and the United States	African Americans	Higher BF% relative to BMI
Deurenberg et al. [24]	Chinese, Ethiopians, Indonesians and Thais	Caucasians		Higher BF% relative to BMI
Deurenberg et al. [24]	African Americans and Polynesians	Caucasians		Lower BF% relative to BMI
Rush et al. [25]	Caucasians in New Zealand	Maori in New Zealand	Polynesians in New Zealand	Lower BF% relative to BMI
Rush et al. [25]	Caucasians in South Africa	Africans in South Africa		Lower BF% relative to BMI
Després et al. [26]	African Americans	Caucasians in North America		Lower visceral fat relative to BF%
Bacha et al. [27]	African Americans	Caucasians in North America		Lower visceral fat relative to total and BF%
Wu et al. [28]	Asian Americans	Caucasians and Hispanic Americans		Higher visceral fat relative to BF%
Wu et al. [28]	African Americans	Caucasians and Hispanic Americans		Lower visceral fat relative to BF%

BF%, Percentage body fat.

been suggested to be more strongly associated with health risks than BMI and thereby less sensitive to ethnic differences in body shape. However, the association between waist circumference and health effects has also been shown to interact with ethnicity, although in all populations cardiovascular risk increases with increasing waist circumference.

Populations such as South Asians, Chinese and indigenous Canadians have higher fasting glucose, HbA_{1c} and total cholesterol in relation to waist circumference than have European Canadians [34]. Japanese people have been found to have higher fasting plasma glucose, systolic blood pressure, total and LDL cholesterol and triglycerides compared with Mongolians for a given level of waist circumference [35]. By contrast, lower blood pressure, lipids, stimulated glucose and insulin for the same levels of waist circumference have been found in populations such as the Inuit in the Arctic region and Polynesians compared with white populations [5, 36, 37].

Why are some people more vulnerable?

The rapid increase in overweight and obesity in developing countries is possibly due to an interaction between lifestyle factors and genetic or intrauterine predisposition in these populations. Under traditional living conditions characterized by ‘feast or famine’ and a high level of physical activity, insulin resistance and fat accumulation were advantageous, but with easy access to high-calorie, high-fat food and physical inactivity, this predisposition leads to obesity, known as the ‘thrifty genotype’ hypothesis [38]. Malnutrition during pregnancy and low birth weight are known to increase the risk of future obesity, insulin resistance and CVD; the ‘thrifty phenotype’ hypothesis is another likely explanation of the rapid growth of obesity in some populations [39].

The metabolic impact of different levels of obesity appears to differ considerably between populations, especially with regard to diabetes and CVD

What are the reasons for ethnic differences in obesity?

The metabolic impact of different levels of obesity appears to differ considerably between populations, especially with regard to diabetes and CVD, and such data do raise concern about the ‘one-size-fits-all’ approach of the international obesity guidelines. These ethnic differences may be due to differences in body

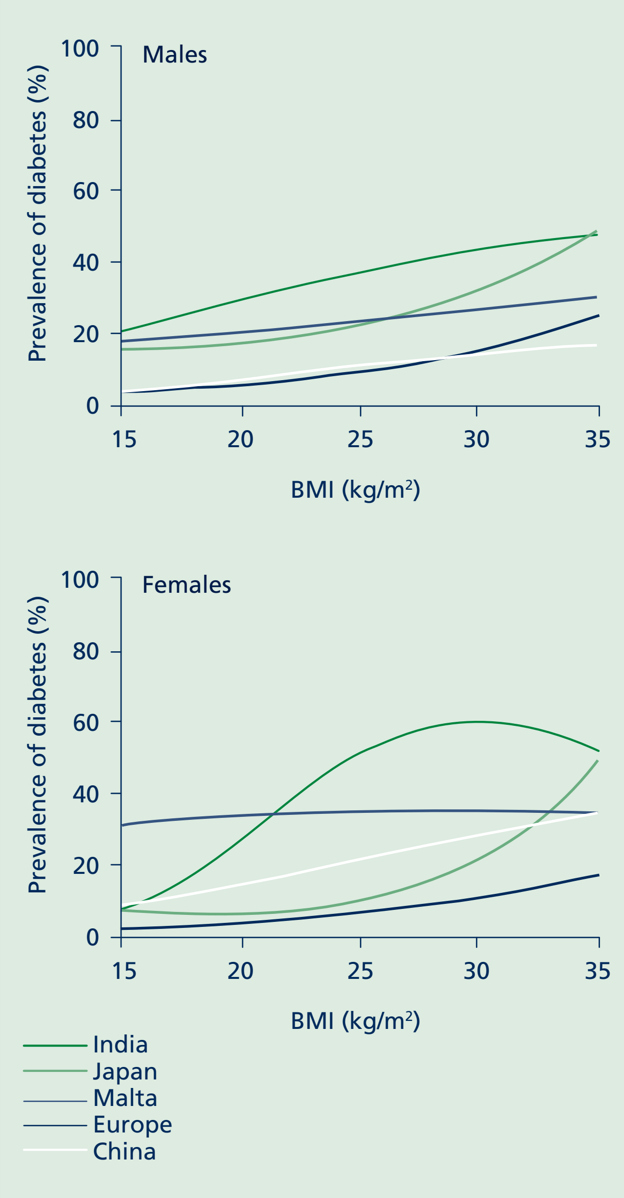


Fig. 2: *Population-specific differences in obesity and the prevalence of diabetes among 60 year olds. Adapted from [30].*

composition, as well as differences in energy intake and physical activity.

The limitations of using BMI as an indicator of excess body fat in different populations are well known [40]. Although BMI 'adjusts' for height in its computation, it does not completely adjust for body dimensions. Studies have found that it correlates with relative sitting height (ratio of sitting height to stature) across populations [41, 42].

Also, the fact that waist circumference and waist-hip ratio are not associated with the same degree of metabolic disturbances in different populations indicates that these anthropometric measurements do not reflect the same amount of visceral fat. The amount of subcutaneous fat, which is metabolically less active, is known to vary between populations. Thus measures such as waist circumference and waist-hip ratio may be less useful for comparisons between countries. An alternative hypothesis is that visceral adipose tissue, rather than being a causal factor, is a marker of ectopic fat distribution in tissues such as skeletal muscle, liver and heart, believed to play a major role in insulin resistance and CVD risk associated with obesity [22]. Visceral adipose tissue and ectopic fat distribution, however, are difficult to measure for clinical and epidemiological purposes.

The potential influence of genetic factors on the association between obesity and health effects is unknown. A study of genetically homogenous groups of Inuit living in Greenland and Denmark indicated that lifestyle factors rather than genetic factors modified the obesity-associated risk [43]. At any given level of waist circumference and BMI, Inuit residents in Greenland had lower blood pressure, triglycerides, glucose and insulin than did Inuit migrants in Denmark. More importantly, the Inuit migrants seemed to follow the same pattern as that of a general Danish reference population in regard to their level of obesity and associated cardiovascular risk (*Fig. 3*).

Should guidelines for overweight and obesity be population-specific?

With obesity driving the twin global epidemics of type 2 diabetes and CVD there is a medical and economic requirement to identify individuals at risk due to obesity. The main purpose of defining cut-off points for overweight and obesity is to allow comparisons within and between populations. Cut-off points enable identification of high-risk individuals who would benefit from intervention.

When population-specific cut-off points are defined, it should be noted that they may reflect differences in lifestyle and environmental factors rather than genetic factors that influence disease risk associated with obesity

Recently, the International Diabetes Federation proposed a definition of the metabolic syndrome that recognized ethnic differences by including separate cut-off points for waist circumference for Europeans, South Asians and East Asians [44]. WHO does not fully support this recommendation but has suggested so-called

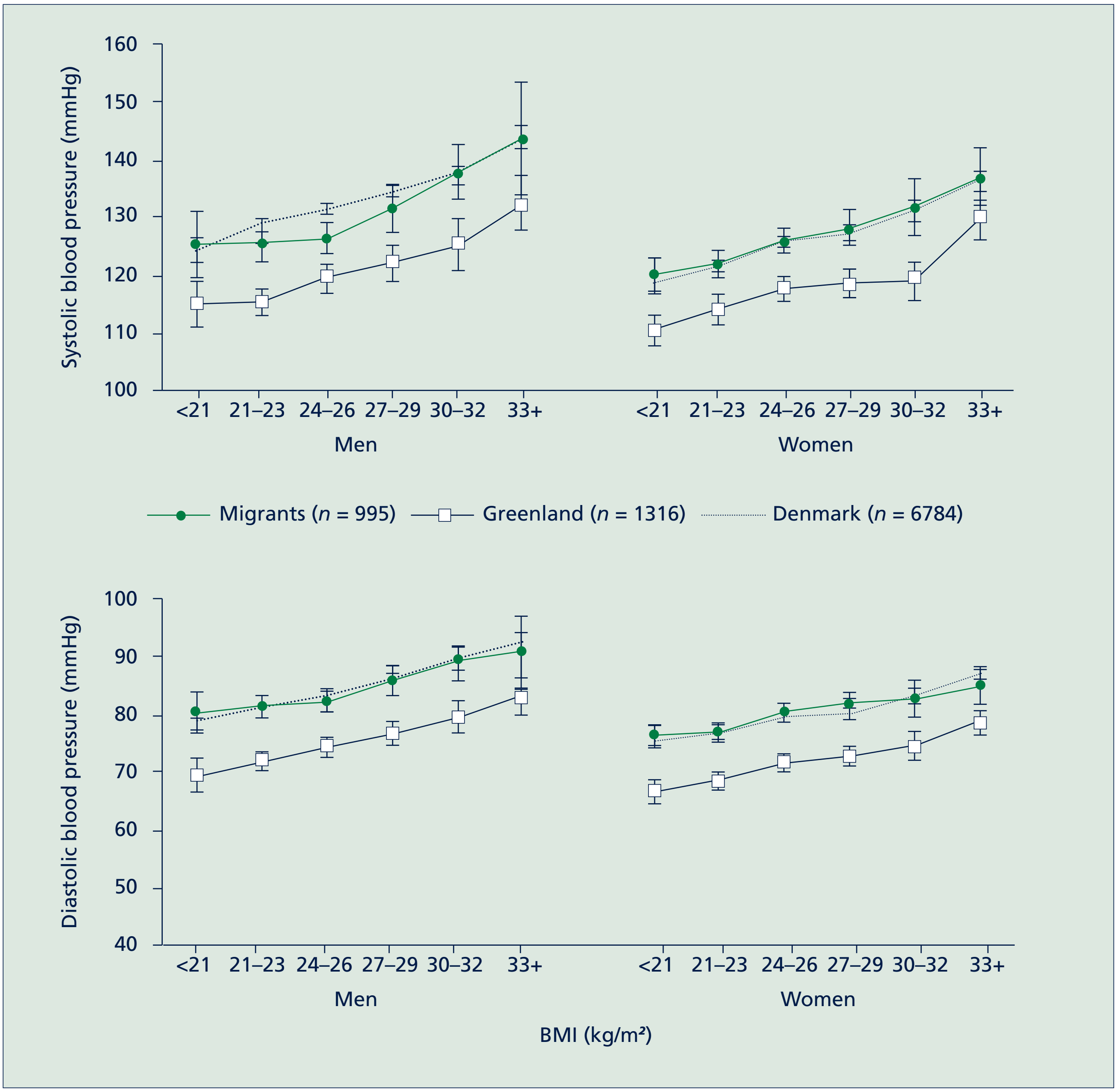


Fig. 3: *Age-adjusted mean levels and 95% confidence intervals of systolic and diastolic blood pressure by category of BMI and ethnicity. Adapted from [43].*

health action points for BMI for Asians at BMI 23.0, 27.5, 32.5 and 37.5 kg/m^2 [45].

It would appear that for other populations such as the Polynesians and Inuit, higher cut-off points may be needed. However, given the increasing threat of diabetes and other obesity-related diseases, the full public health impact of increasing cut-off points needs to be carefully determined.

When population-specific cut-off points are defined, it should be noted that they are only applicable to the population of origin and may reflect differences in lifestyle and environmental factors rather than genetic factors that influence disease risk associated with obesity. Hence, cut-off points should not be interpreted alone but in combination with other risk factors for morbidity and mortality.

To answer these questions, longitudinal studies are needed for international comparisons of obesity-related morbidity including standardized techniques for the measurement of body fat and fat distribution.

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