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Estimates and Distribution of Body Mass Index in a Sample of Malaysian Adolescents

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Summary

The purpose of this study was to report on the estimates and distribution of body mass index in a sample of Malaysian adolescents. The study utilized a cross-sectional design and multi-stage random sampling of secondary schools to select 5 urban and 9 rural schools in Kedah and Penang. A total of 6555 male and female adolescents (11-15 years old) of Malay, Chinese and Indian ethnic groups were measured for weights and heights for body mass index calculation. Information on household demographic and socioeconomic were obtained from parents through self-administered questionnaires. Analyses of body mass index distribution by location, ethnicity, gender and age were conducted using Chi-square test of SPSS 11.5. More of the rural (12.1%) and urban (19.4%) adolescents were underweight and overweight, respectively. While in all ethnic, gender and age groups, rural adolescents were more likely to be underweight, more of the urban adolescents were overweight. The prevalence of underweight was highest among the Indians (19.2%) and lowest in Chinese (7.2%). The prevalence of overweight in the three ethnic groups was in the range of 18-19%. More male than female adolescents were underweight (15% vs 7.8%) and overweight (19.5% vs 16.7%). Consistent patterns were also observed across location, ethnic and age groups. As age increased, the prevalence of overweight decreased across the ethnic and gender groups. The reported findings can serve as current reference on body mass index distribution of Malaysian adolescents and a basis for future efforts in health and nutrition interventions for Malaysian children and adolescents.

Key Words: Adolescents, Body mass index, Overweight, Underweight

Introduction

Body mass index has been recommended for use in all age groups and is widely used as an indicator of body fatness in adolescence because it is easier to measure, inexpensive and relatively accurate[1]. Compared to other obesity indices that are commonly utilized in adolescents such as weight-for-age, weight-for-height and weight-height ratios, body mass index has been shown to be consistently better as an indicator of adiposity[2-4]. With overweight and obesity being fast growing health issues affecting children and adolescents today, the use of body mass index cutoff points in public health is a necessity to help describe populations for the purpose of identification and monitoring of those overweight and obese, and guidance for further assessments[5].

Childhood overweight and obesity is due to complex interactions of various factors such as socioeconomic, environment, genetic and policy that influence eating and physical activity behaviors. As childhood obesity has been shown to be a strong predictor of adult

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obesity[6-7] and the prevalence of adulthood obesity in the developed and developing nations is increasing[8], childhood obesity is now recognized as an important public health issue worldwide. The problem is further heightened with increasing and consistent evidences that supported the association between childhood obesity and both short-term and long-term consequences such as low self-esteem, behavioral problems, clinical conditions, cardiovascular risk factors and adult morbidity and premature mortality[9].

In recent years, Malaysia has experienced rapid industrial development and subsequent economic growth. Consequently, major transitions in the dietary habits and lifestyle of the population which are associated with an increased prevalence of obesity and diet-related chronic diseases have been observed among its population, including children and adolescents. As there is no longitudinal study of nutritional status of Malaysian children and adolescents to observe trends, the prevalence of overweight and obesity can only be compared among cross-sectional studies of similar age groups. Even so, published information on estimates of body weight and body fat among Malaysian adolescents are relatively few and not current [10-14]. Thus, the purpose of this paper is to provide estimates on prevalence and describe the distribution of body mass index in a sample of Malaysian adolescents in relation to ethnicity, gender, age and location.

Materials and Methods

This study was part of a project on 'The study of relationship between dietary habits, physical activity and nutritional status with body image among adolescents'. There were six research organizations involved in this multi-center project with the financial support from Intensification of Research in Priority Areas (IRPA) grant of the Malaysian Ministry of Science, Technology and Environment. The project was carried out in several states in Peninsular Malaysia, representing the southern (Johor Bahru), northern (Kedah and Penang), central (Wilayah Persekutuan) and eastern (Kelantan) regions and East Malaysia (Sarawak). For this study, however, we will only report the findings from the northern region of Malaysia.

Sampling and Subject

This study was cross-sectional in design and utilized a multi-stage random sampling in the selection of secondary schools. Each state (Kedah and Penang) was divided into two locations (urban and rural) based on secondary school categorization by the Planning and Education policy Research Division of the Ministry of Education Malaysia. The inclusion criteria of co-educational, multiracial in composition, non-religious and non-residential were also applied to the urban and rural schools. Based on these criteria, a total of 46 urban and 107 rural schools were identified in Kedah (rural –86; urban –19) and Penang (rural –21; urban –27). To get a representative sample of students from both urban and rural schools and of both genders in each state (n=3000), 5 urban (Kedah –2; Penang –3) and 9 rural (Kedah –7; Penang –2) schools were randomly selected. All of these schools had approximately 6700 male and female students in Secondary 1 and 2, however only 6555 students participated in the study.

Measurements

The Secondary 1 and 2 male and female students (n=6555) who participated in the study were measured for their weights and heights using TANITA digital scale and SECA body meter to the nearest 0.5 kg and 0.1 cm, respectively. Two measurements were taken for both weight and height and the average of the two values were used in the analyses. For measurement accuracy, the respondents were asked to remove their shoes and empty their pockets and the instruments were calibrated daily. Quality control measures were included in the study such as the use of the same research assistants to measure weight and height (to reduce inter-variation error), frequent calibration of the instruments and duplicate weight and height measurements by the project investigator and research assistant (to check consistency in measurement readings). The weight and height measurements were then calculated into Body Mass Index (BMI) and the categorization of BMI levels were done according to the age and gender specific BMI for adolescents. Underweight is defined as BMI-age < 5th percentile while overweight is BMI-age > 85th percentile[15].

Information on household demographic and socioeconomic factors such as household income, household size, parental education and occupation were obtained from parents through self-administered questionnaires. The study protocol was approved by the Malaysian Ministry of Education. Permissions to conduct the study were also obtained from the state education departments and participating schools. The respondents were informed on the study and their voluntary participations were solicited. Those who

volunteered were required to sign consent forms prior to their participations in the study.

Data analysis
Sample characteristics were first analyzed descriptively for frequency, mean and standard deviation according to gender. Analyses of body mass index distribution by location, ethnicity, gender and age were conducted using Chi-square test. All statistical analyses were conducted with the use of Statistical Package for Social Sciences (version 11.5). Significance level was set at $p < 0.05$.

Results

Sample Characteristics
The characteristics of the adolescents are presented in Table I. About 60% and 40% of the respondents were from rural and urban schools, respectively. Ethnic distribution of the sample (Malay 59%, Chinese 29%, Indian 12%) is similar to the population ratios for the three major ethnic groups in Malaysia. The mean age for both gender groups is similar (13 years) with majority in the age range of 12-15 years (96%). In general, the male adolescents had higher mean weight (47.5 vs 45.9 kg) and height (1.6 vs 1.5 m) but lower mean body mass index (19.3 vs 19.6 kg/m^2) compared to female adolescents.

Body mass index distribution by location, ethnicity, gender and age
Table II shows that there were significant associations between BMI status of the adolescents and all of the tested variables. While more rural than urban adolescents (12.1% vs. 10.3%) were underweight, a higher percentage of the urban than rural adolescents (19.4% vs. 17.3%) were overweight. Among the three ethnic groups, the Indians had the highest percentage of underweight (19.2%) while the Chinese had the lowest (7.2%). The prevalence of overweight is in the range of 18-19% across the three groups. The percentage of underweight male adolescents (15%) is almost doubled that of the females (7.8%) and more male adolescents (19.5%) were overweight compared to female adolescents (16.7%). There is however, a decreasing trend in the prevalence of overweight as age of the adolescents increases.

Rural and urban distribution of body mass index by ethnicity, gender and age
In both urban and rural schools, the prevalence of underweight was highest among the Indian adolescents (19.0 –19.2%) (Table III). In the urban schools, the prevalence of overweight was higher among the Malay and Chinese subjects, however, in the rural schools, the prevalence was similar for all ethnic groups (17.2 – 17.5%). While urban male adolescents had higher percentages of underweight (13.2% vs 6.8%) and overweight (21.9% vs 16.3%) than female adolescents, only the percentage of underweight among the rural adolescents was twice (16.1%) than that of female adolescents (8.3%). A significant association was observed between body mass index status and age of urban but not rural adolescents. However, in both rural and urban schools, there was a decreasing trend in prevalence of overweight as age increased.

Ethnic distribution of body mass index by location, gender and age
The rural Malay adolescents had higher percentage of underweight (12.8% vs 9.4%) but lower percentage of overweight (17.2% vs 19.7%) than their urban counterparts (Table IV). More Malay male (16.3%) than female (7.8%) adolescents were underweight, however, the prevalence of overweight was similar in both groups. For the Malay group, no significant association was observed between body mass index status and age.

Among the Chinese adolescents, there was no significant association between body mass index status and location. By gender, more male Chinese adolescents were underweight (7.8% vs 6.5%) and overweight (23.0% vs 14.0%) than female adolescents. As age increased, the prevalence of overweight among the Chinese subjects decreased. Among the Indian adolescents, significant association was only observed between body mass index status and gender in that more male adolescents were underweight (24.3% vs 11.3%) and overweight (18.3% vs 17.2%).

Gender distribution of body mass index by location, ethnicity and age
While there was a significant association between body mass index status and location among male adolescents, no significant association was observed among the female adolescents (Table V). The prevalence of underweight was higher (16.1% vs 13.2%) but the prevalence of overweight was lower (21.9% vs 17.7%) among rural male than the urban male adolescents. For both male and female adolescents, the Indian subjects had the highest percentage of underweight. For overweight, the prevalence was highest in Chinese male (23.0%) but similar percentages

were seen in Malay (17.8%) and Indian (17.2%) female adolescents. A significant association between body mass index status and age was only observed among female adolescents with the highest age group (14-15 years old) having the lowest proportion of overweight (13.7%).

Age distribution of body mass index by location, ethnicity and gender

For all age groups, no significant association was observed between body mass index and urban and rural residences (Table VI). In all age groups, the Indian subjects had the highest percentage of underweight (18.0-20.1%) while the Chinese adolescents had the lowest underweight (6.6-7.8%) prevalence. Among 12-13 years olds, the prevalence of overweight was highest among the Chinese (22.8%) and lowest among the Indian (18.7%) subjects. The prevalence of overweight was 17.7%, 19.9% and 20.9% among Malay, Chinese and Indian adolescents in the 13 years age group. For the oldest age group (14-15 years), more of the Malay (17.0%) than Chinese (15.9%) or Indian (13.7%) subjects were overweight. In all age groups, male adolescents had higher percentages of underweight (13-16%) and overweight (18-21%) than female adolescents.

Table I: Sample characteristics (N=6555)

Variable Level n (%)	Male n (%)	Female n (%)	Total
Location			
Urban	1440 (55.3)	1163 (44.7)	2603 (39.7)
Rural	1913 (48.4)	2039 (51.6)	3952 (60.3)
Ethnicity			
Malay	1867 (48.3)	1998 (51.7)	3865 (59.0)
Chinese	1021 (53.1)	902 (46.9)	1923 (29.3)
Indian	465 (60.6)	302 (39.4)	767 (11.7)
Age (years) (M+SD)	(13.14+0.81)	(13.11+0.79)	(13.13+0.80)
11.0 – 11.9	3 (25.0)	6 (75.0)	9 (0.1)
12.0 – 12.9	755 (51.3)	718 (48.7)	1473 (22.5)
13.0 – 13.9	1509 (50.6)	1474 (49.4)	2983 (45.5)
14.0 – 14.9	943 (50.8)	913 (49.2)	1856 (28.3)
15.0 – 15.9	143 (61.1)	91 (38.9)	234 (3.6)
Weight (kg) (M+SD)	(47.47+15.07)	(45.97+10.93)	(46.74+13.23)
Height (m) (M+SD)	(1.56+0.10)	(1.52+0.06)	(1.54+0.09)
Body Mass Index (kg/m^2) (M+SD)	(19.33+4.98)	(19.75+4.19)	(19.53+4.62)

Male (n=3353); Female (n=3202)
M = mean; SD = standard deviation

Table II: Body mass index (BMI) distribution of adolescents by location, ethnicity, gender and age (N=6555)

	BMI			
	underweight n (%)	normal n (%)	overweight n (%)	χ^2
Location				
Urban	268 (10.3)	1829 (70.3)	506 (19.4)	8.52 **
Rural	478 (12.1)	2791 (70.6)	683 (17.3)	
Ethnicity				
Malay	460 (11.9)	2714 (70.2)	691 (17.9)	81.05 ***
Chinese	139 (7.2)	1423 (74.0)	361 (18.8)	
Indian	147 (19.2)	483 (63.0)	137 (17.8)	
Gender				
Male	497 (14.9)	2201 (65.6)	655 (19.5)	101.62 ***
Female	249 (7.8)	2419 (75.5)	534 (16.7)	
Age				
11 – 12 years	169 (11.4)	1017 (68.7)	295 (19.9)	13.19 **
13 years	356 (11.9)	2071 (69.5)	556 (18.6)	
14 – 15 years	221 (10.6)	1532 (73.3)	337 (16.1)	

Table III: Rural and urban distribution of adolescents' body mass by ethnicity, gender and age (N=6555)

	BMI			
	underweight n (%)	normal n (%)	overweight n (%)	χ^2
Urban (n=2603)				
Ethnicity				
Malay	100 (9.4)	752 (70.9)	209 (19.7)	49.49 ***
Chinese	82 (7.5)	798 (72.8)	216 (19.7)	
Indian	86 (19.2)	279 (62.6)	81 (18.2)	
Gender				
Male	189 (13.2)	935 (64.9)	316 (21.9)	48.52 ***
Female	79 (6.8)	894 (76.9)	190 (16.3)	
Age				
11 – 12 years	55 (9.3)	412 (69.5)	127 (21.2)	11.49 *
13 years	135 (11.3)	811 (68.0)	247 (20.7)	
14 – 15 years	78 (9.6)	606 (74.3)	132 (16.1)	
Rural (n=3952)				
Ethnicity				
Malay	360 (12.8)	1962 (70.0)	482 (17.2)	37.82 ***
Chinese	57 (6.9)	625 (75.6)	145 (17.5)	
Indian	61 (19.0)	204 (63.6)	56 (17.4)	
Gender				
Male	308 (16.1)	1266 (66.2)	339 (17.7)	59.96 ***
Female	170 (8.3)	1525 (74.8)	344 (16.9)	
Age				
11 – 12 years	114 (12.8)	605 (68.1)	169 (19.1)	5.48
13 years	221 (12.3)	1260 (70.4)	309 (17.3)	
14 – 15 years	143 (11.2)	926 (72.7)	205 (16.1)	

Table IV: Ethnic distribution of adolescents' body mass by location, gender and age (N=6555)

	BMI			
	underweight n (%)	**normal** n (%)	**overweight** n (%)	χ^2
Malay				
Location				
Urban	100 (9.4)	752 (70.9)	209 (19.7)	10.34 **
Rural	360 (12.8)	1962 (70.0)	482 (17.2)	
Gender				
Male	304 (16.3)	1228 (65.8)	335 (17.9)	68.42 ***
Female	156 (7.8)	1486 (74.4)	356 (17.8)	
Age				
11 – 12 years	118 (11.9)	687 (69.0)	190 (19.1)	2.04
13 years	227 (12.2)	1310 (70.1)	330 (17.7)	
14 – 15 years	115 (11.5)	717 (71.5)	170 (17.0)	
Chinese (n=1923)				
Location				
Urban	82 (7.5)	798 (72.8)	216 (19.7)	1.90
Rural	57 (6.9)	625 (75.6)	145 (17.5)	
Gender				
Male	80 (7.8)	706 (69.1)	235 (23.0)	28.92 ***
Female	59 (6.5)	717 (79.5)	126 (14.0)	
Age				
11 – 12 years	26 (7.6)	242 (69.7)	79 (22.8)	10.28 *
13 years	60 (7.8)	558 (72.3)	154 (19.9)	
14 – 15 years	53 (6.6)	623 (77.5)	128 (15.9)	

Table V: Gender distribution of adolescents' body mass by location, ethnicity and age (N=6555)

	BMI			
	underweight n (%)	normal n (%)	overweight n (%)	χ^2
Male (n=3353)				
Location				
Urban	189 (13.2)	935 (64.9)	316 (21.9)	12.60 **
Rural	308 (16.1)	1266 (66.2)	339 (17.7)	
Ethnicity				
Malay	304 (16.3)	1228 (65.8)	335 (17.9)	80.34 ***
Chinese	80 (7.8)	706 (69.2)	235 (23.0)	
Indian	113 (24.3)	267 (57.4)	85 (18.3)	
Age				
11 – 12 years	109 (14.4)	488 (64.4)	160 (21.2)	5.96
13 years	241 (16.0)	973 (64.5)	295 (19.5)	
14 – 15 years	147 (13.5)	740 (68.2)	199 (18.3)	
Female (n=1923)				
Location				
Urban	79 (6.8)	894 (76.9)	190 (16.3)	2.82
Rural	170 (8.3)	1525 (74.8)	344 (16.9)	
Ethnicity				
Malay	156 (7.8)	1486 (74.4)	356 (17.8)	14.93 **
Chinese	59 (6.5)	717 (79.5)	126 (14.0)	
Indian	34 (11.3)	216 (71.5)	52 (17.2)	
Age				
11 – 12 years	60 (8.3)	529 (73.1)	135 (18.6)	10.54 *
13 years	115 (7.8)	1098 (74.5)	261 (17.7)	
14 – 15 years	74 (7.4)	792 (78.9)	138 (13.7)	

Table VI: Age distribution of adolescents' body mass by location, ethnicity and gender (N=6555)

	BMI			
	underweight n (%)	normal n (%)	overweight n (%)	χ^2
11 – 12 years (n=1482)				
Location				
Urban	55 (9.3)	412 (69.4)	127 (21.3)	5.06
Rural	114 (12.8)	605 (68.2)	169 (19.0)	
Ethnicity				
Malay	118 (11.8)	687 (69.0)	191 (19.2)	12.54 *
Chinese	26 (7.5)	242 (69.7)	79 (22.8)	
Indian	25 (18.0)	88 (63.3)	26 (18.7)	
Gender				
Male	109 (14.4)	488 (64.4)	161 (21.2)	17.37 ***
Female	60 (8.3)	529 (73.1)	135 (18.6)	
13 years (n=2983)				
Location				
Urban	135 (11.3)	811 (68.0)	247 (20.7)	5.76
Rural	221 (12.3)	1260 (70.4)	309 (17.3)	
Ethnicity				
Malay	227 (12.1)	1310 (70.2)	330 (17.7)	39.34 ***
Chinese	60 (7.8)	558 (72.3)	154 (19.9)	
Indian	69 (20.1)	203 (59.0)	72 (20.9)	
Gender				
Male	241 (16.0)	973 (64.5)	295 (19.5)	53.82 ***
Female	115 (7.8)	1098 (74.5)	261 (17.7)	
14 – 15 years (n=2090)				
Location				
Urban	78 (9.6)	606 (74.2)	132 (16.2)	1.48
Rural	143 (11.2)	926 (72.7)	205 (16.1)	
Ethnicity				
Malay	115 (11.5)	717 (71.5)	170 (17.0)	35.46 ***
Chinese	53 (6.6)	623 (77.5)	128 (15.9)	
Indian	53 (18.7)	192 (67.6)	39 (13.7)	
Gender				
Male	147 (13.5)	740 (68.2)	199 (18.3)	33.75 ***
Female	74 (7.4)	792 (78.9)	138 (13.7)	

Discussion

Our study indicates that the prevalence of underweight was higher in the rural (12.1%) than urban schools (10.3%) but the prevalence of overweight was higher in the urban (19.4%) than rural schools (17.3%). When comparing urban and rural locations in relation to ethnic, gender and age groups, the prevalence of underweight is generally higher among rural Malay, Chinese and Indian subjects, rural male and female subjects and all age groups in the rural schools. However, the prevalence of overweight was higher in all ethnic, gender and age groups of the urban schools. Khor and Tee[14] reported high prevalence of underweight for both male (29.9%) and female (17.7%) adolescents aged 12 to 18 from rural villages and estates in Peninsular Malaysia. However, no comparison on the prevalence of underweight was made with urban samples. In another study in urban and rural districts of Selangor, Bong and Safurah[13] reported that the prevalence of obesity among primary six children (12 years old) was significantly higher in the urban (9.8%) than rural (6.1%) schools. The difference in the prevalence of overweight and obesity in urban and rural areas may simply reflect the different rates of cultural transition that occur in both areas stimulated by the rapid advancements in socioeconomic status of the population and subsequent significant lifestyle changes such as physical inactivity and consumption of high-fat, high-sugar and low fiber diet[16]. Although in many developing countries, overweight is higher in urban than rural areas and the reverse is true for underweight, there is also increasing evidence that the existence of both underweight and overweight in rural areas may pose a greater public health challenge[17].

Ethnicity is an important variable for understanding the distribution of overweight and obesity, however, its interaction with culture as an etiology of obesity requires further elucidation[18]. In the United States, African American males were consistently less obese than the Caucasian males, whereas African American women showed a consistently higher prevalence of obesity at all ages than Caucasian women[19]. Similar ethnic disparity in obesity has been observed among children and adolescents[20-21]. In our study, the Indian subjects consistently had higher percentage of underweight by location, gender and age compared to the Chinese and Malay subjects. In a study among 7-12 year old children of the three ethnic groups, the Indian children had the highest percentages of underweight, stunting and wasting[22]. While there is no consistent pattern in the percentage of overweight among the three ethnic groups in this study, Kasmini and colleagues[12] reported that among 7-16 years old urban school children, the Indian children had the highest percentage of overweight and obesity combined (12%) compared to the other ethnic groups (Malay -8.9%; Chinese -9.9%). Similar findings were obtained by Judson and Jeyalingam[10] in that Indian children had the highest mean percentage of body fat compared to the other ethnic groups.

Our findings showed that more male than female adolescents were underweight and overweight regardless of location, ethnicity and age. While it is known that there is gender difference in body fat distribution in humans, there have been inconsistent findings on gender differences in overweight and obesity. Among children and adolescents, several studies have found that males had lower percentage of body fat and body mass index[20,23]. A local prevalence study on obesity among 2986 Malay primary school children (7-12 years) indicated that using weight-for-height and BMI-age specific, the prevalence of overweight and obesity was consistently higher in male than female children[11]. Similar findings on the higher prevalence of obesity among male adolescents were reported by other researchers[24-26]. These inconsistent findings may be due to different measures and cutoffs used to define overweight and obesity, biased sampling or gender comparison of the data i.e. mean or prevalence.

In our study, while the percentages of underweight for all age groups were similar across ethnic, location and gender categories, the percentage of overweight showed a decreasing trend as age increased. The latter finding is similar to the finding by Kasmini et al[12] in that among 7-16 years old urban children, the prevalence of overweight and obesity combined was lowest in the 16 year old group (3.3%) and highest in the 12 year old group (12.2%). However, Aminah et al[11] found that in both male and female children (7-12 years), the prevalence of overweight and obesity increased as age of the student increased. The timing of puberty may also influence the prevalence of childhood obesity in that from the age of 7 years, maturation is associated with higher BMI (physiological changes in body fat and weight as preparation for puberty) but after puberty, the association is greatly reduced, unless other contributory factors (e.g. physical inactivity, intake of high fat and sugar food) to obesity appear during adolescence.

One of the limitations of this study is its cross-sectional design in that the study provides information only on the current state of nutritional status of the adolescents and not the development of the condition. Therefore, cause and effect relationship between body mass index status and the studied variables (location, gender, ethnicity and age) cannot be established. Another limitation is the use of body mass index as a sole measure of adiposity in the adolescents. A more sensitive measure of body fatness such as skinfold thickness should complement the use of BMI in determining and monitoring the prevalence of obesity[27]. Despite these limitations, this study which utilized a large sample size (n=6555) is able to provide current information on estimates of body mass index status of adolescents and its association with ethnicity, urban and rural residences, gender and age. The data can further be used as reference for cross-sectional comparison for future studies and as underlying rationale for the need of health and nutrition interventions and policies for Malaysian children and adolescents.

Conclusion

This present study has shown that underweight still prevail among the Malaysian adolescents and that overweight may be on the rise as evidenced by the higher prevalence reported in this study compared to those reported by other researchers. For children and adolescents to achieve and maintain healthy weight, may require changes towards healthy eating behaviors and regular physical activity. Individual efforts and societal changes which require the involvement of multiple sectors and stakeholders (e.g. government, food industries, media, health care professionals, schools and parents) are imperative in promoting healthy eating and active lifestyle in these age groups.

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