

Body mass index, waist hip ratio and it's correlation among urban women of Sambalpur city in Odisha

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■ **ABSTRACT** : The study included 200 urban women from Sambalpur district, Odisha. Normal women and women with risk of obesity were recruited for conducting the study. Data on general information, socio-economic status, and anthropometric measurements were collected using interview schedule. While calculating the WHR about 69 per cent women were normal and 31 per cent belongs to obese category. BMI has significant correlation with WHR, weight, MUAC and waist circumference, but has negative correlation with height. WHR has significant correlation with weight, MUAC and waist circumference but has negative correlation with height. The results revealed that about 21.5 per cent were normal women, 50 per cent were pre-obese, 24.5 per cent belonged to obese class-I type and only 4.0 per cent belonged to obese class-III category.

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The Body Mass Index (BMI) or Quetelet Index is a value derived from the mass and height of an individual. The BMI is defined as the body mass divided by the square of the body height and is universally expressed in units of kg/Mtr². Commonly accepted BMI ranges are underweight: under 18.5, normal weight: 18.5- 25, over weight: 25-30, obese: over 30. The index was devised by Adolphe Quetelet from 1830-1850 during which time he developed what he called "Social Physics". BMI was found to be the best proxy for body fat percentage among ratios of weight and height. The criterion for the clinical diagnosis of abdominal obesity has been the use of waist to hip ratio (WHR). A high WHR is the indicative of high abdominal obesity and has been directly related to

hyperinsulinemia, impaired glucose tolerance, atherosclerosis, diabetes and gout. It is also associated with an increased risk of cardiovascular disease (CVD) even when the body mass index is within the normal range.

According to the 2011 census, the state population was 41.9 million out of which 18.6 million were females. A review of literature reveals that no systematic study had been made on the Body mass index, Waist hip ratio and it's correlation among urban women. A humble attempt has been made in this paper to study the Body mass index, Waist hip ratio and it's correlation among urban women within Sambalpur municipality with the following objectives.

– To assess the prevalence of obesity and type of

Table A : Values of various indices for different grades of obesity

Indices	Value	Grade of obesity
Body Mass Index (BMI) Kg/m ² (Queitlet Index)	18.5-24.9	Normal
	25.0-29.9	Pre-Obese(Over weight)
	30.0-34.9	Obese Gr-I(Moderate)
	35.0-39.9	Obese Gr-II(Severe)
	40 or higher	Obese Gr-III(Very Severe)
Waist Hip Ratio(WHR)	Below 0.85	Normal
	0.85 and above	Abdominal adiposity (Obesity)

obesity among the urban women by using the criteria of body mass index (BMI) and waist hip ratio (WHR).

– To compare the mean height, weight and BMI with ICMR and NNMB data and with other related studies.

RESEARCH METHODS

According to the 2011 census the total population of Sambalpur district is 1,044, 410 out of which 529,424 are males and 514,986 are females. The urban women who were 25 years of age and above in different area of Sambalpur town *i.e.* Modipara, Cheruapara, Gopalmal, Housing Board Colony, Baraipali, Labour Colony, Station colony, constitute the universe of our study. The survey was carried out during 2007-2009. Total 200 urban respondents were selected by adopting purposive sampling method.

The parameters taken for the investigation were height, weight and waist and hip circumference using standard procedure suggested by Jelliff (1966). The anthropometric measurements were recorded once during the study. The abdominal obesity was judged by WHR (Lean *et al.*, 1995).

The mean height, weight and BMI of the urban women were compared with ICMR and NNMB data and also with other states of India. Multiple regression analysis tables were prepared by taking dependent variable BMI and WHR with other independent variable.

RESEARCH FINDINGS AND DISCUSSION

Table 1 presents the prevalence of obesity among the urban women on the basis of BMI level. It was observed that out of total 200 data, about 21.5 per cent were normal women having BMI level 18.5-24.9. About 50 per cent were pre-obese women having BMI level ranging from 25.0-29.9 and 24.5 per cent belonged to obese class I type where the BMI level is 30.0-34.9. None of them belong to obese class II category. Only 4 per cent of women belonged to obese class III category where BMI level is 40 or higher.

Body mass index and age :

The average body mass index of the women in different age groups has been presented in Table 2. The BMI of the women increases with their increase in age. The mean BMI of the women varied from 27.33 kg/m² to 30.41 kg/m². The BMI was observed to be lowest (27.33 kg/m²) in < 40 years of age group. But BMI was highest (30.41 kg/m²) among 55 and above age group of urban women.

Grades of obesity based on BMI and age are given in Table 3. About 51 per cent of the women were pre-obese, 16 per cent were in obese-I and only 3 per cent were in obese III category out of total 90 in < 40 yrs. of age. Out of total 80 women in 40-49 age group, about 53 per cent were pre obese, 29 per cent were in obese - I and only 4 per cent were in obese-III category. A

Table 1 : Prevalence of obesity and BMI [wt/(ht)²]

Weight status	Number of subjects	Percentage	BMI range
Normal	43	21.5	18.5-24.9
Pre-obese	100	50	25.0-29.9
Obese-I	49	24.5	30.0-34.9
Obese-II	-	-	35.0-39.9
Obese-III	8	4	40 or higher

significant association was observed (Table 8) between age and BMI level among the urban women. ($\chi^2=31.12$, $p<0.05$).

Occupational level and BMI:

The average body mass Index of the women in different occupational level has been presented in Table 4. The BMI was found to be more *i.e.* 28.46 (kg/m²) for housewives or unemployed than the employed urban women, who had BMI range of 27.58 kg/m². Not much difference in BMI values was observed in this area. Variation was found to be maximum *i.e.* 54.28 for unemployed women and minimum *i.e.* 19.34 for employed women.

Various grades of obesity based on BMI and occupational level are given in Table 5. Out of total 162 unemployed women about 22 per cent were normal, 48 per cent were pre obese, 26 per cent were obese class I and 4 per cent were in obese class III. Similarly out of 38 employed women 21 per cent were normal, 38 per cent were pre obese, 18 per cent were obese class I, and only 3 per cent belonged to obese class III category. Obese percentage was higher among unemployed than

the employed urban women. The test of hypothesis on association of attribute (Table 8) revealed no association of employment status with BMI level of women.

Per capita income of family and BMI:

The average body mass index of the urban women in relation to their per capita income per month has been presented in Table 6. There was no distinct pattern observed in BMI value in relation to per capita income of the family. The BMI was found to be lowest *i.e.* 27.47 (kg/m²) in lower middle per capita income group. But the BMI was found to be highest *i.e.* 29 (kg/m²) in higher middle per capita income group. The variation in BMI was found to be maximum *i.e.* 54.28, where per capita income is at lower middle level, but it was minimum *i.e.* 16.72 where per capita income is at higher middle level.

Table 7 shows the various grades of obesity based on BMI value and per capita income of the family. Out of total 62 urban women 29 per cent were normal, 60 per cent were pre obese, 10 per cent were obese class I and 2 per cent belonged to obese Class III, in lower middle per capita income group. Similarly out of total

Table 2 : BMI in relation to age (Mean, \bar{E} S.D, Min, Max)

Age	No. of person	BMI(Mean, \pm S.D)	Minimum	Maximum
<40	90	27.33 \pm 3.87	20.83	40.42
40-49	80	28.58 \pm 3.72	21.66	41.74
\geq 50	30	30.41 \pm 9.30	21.88	75.64
Total	200	28.29 \pm 5.09	20.83	75.64

Table 3 : Grades of obesity based on BMI and age

Age	Grades of obesity				Total
	Normal	Pre-obese	Obese-I	Obese-III	
<40	27 (30)	46 (51)	14 (16)	3 (3)	90 (100)
40-49	12 (15)	42 (53)	23 (29)	3 (4)	80 (100)
\geq 50	4 (13)	12 (40)	12 (40)	2 (7)	30 (100)

Figures in parenthesis indicates percentage

Table 4 : BMI in relation to occupational level of women (Mean, \bar{E} S.D., Min, Max)

Occupation	No. of person	BMI	Minimum	Maximum
Unemployed	162	28.46 \pm 5.35	21.36	75.64
Employed	38	27.58 \pm 3.76	20.83	40.17
Total	200	28.29 \pm 5.09	20.83	75.64

Table 5 : Grades of obesity based on BMI and occupational level of women

Occupation	Grades of obesity				Total
	Normal	Pre-obese	Obese-I	Obese-III	
Unemployed	35 (22)	78 (48)	42 (26)	7 (4)	162 (100)
Employed	8 (21)	22 (58)	7 (18)	1 (3)	38 (100)

15 urban women in higher per capita income group, 40 per cent were pre obese, 27 per cent were obese Class I and 7 per cent belonged to obese Class III. Similarly among 46 urban women in middle income group, 17 per cent were normal, 43 per cent were pre obese, 35 per cent were obese Class I and 4 per cent belonged to obese Class III category.

A significant association was observed between per capita income and BMI level ($\chi^2=41.95$, $p<0.01$).

A waist hip ratio of 1.0 or greater in men and 0.85 or greater in women is an accepted clinical method for identifying the subjects with abdominal accumulation. Table 9 shows that about 69 per cent of women were normal and 31 per cent belonged to obese category.

Waist hip ratio and age:

The average waist hip ratio of the urban women in

different age groups has been presented in Table 10. The waist hip ratio increases with the increase in age of the women. The WHR was observed to be lowest (0.81) in age group < 40.

Grades of obesity based on WHR value and age are given in Table 11. Out of total 90 urban women in < 40 years age group, about 79 per cent had WHR below 0.85. So they are identified as normal but 21 per cent had WHR above 0.85 or equal to 0.85 which means they are with abdominal adiposity. Similarly out of 80 urban women in between 40-49 age group, 62 per cent are identified as normal and 38 per cent with abdominal adiposity. It was found that with increase in age of the urban women, the percentage of abdominal adiposity also increases. Test of hypothesis on association of attribute (Table 16) revealed no association of age with WHR level of women.

Table 6 : BMI in relation to per capita income of family (Mean, E S.D., Min, Max)

Per capita income(Rs.)	No. of person	BMI	Minimum	Maximum
>1000 ≤ 2000	59	28.47 ±3.82	22.00	41.74
>2000 ≤ 3000	62	27.47 ±6.87	21.36	75.64
>3000 ≤ 4000	46	28.73 ±3.78	20.83	40.30
>4000 ≤ 5000	18	29.00 ±4.83	24.35	41.07
Above 5000	15	28.77 ±4.85	21.36	40.17
Total	200	28.29 ±5.09	20.83	75.64

Table 7 : Grades of obesity based on BMI and per capita income of family

Per capita income(Rs.)	Grades of obesity				Total
	Normal	Pre-obese	Obese-I	Obese-III	
>1000 ≤ 2000	11 (19)	26(44)	20 (34)	2 (3)	59 (100)
>2000 ≤ 3000	18 (29)	37 (60)	6 (10)	1 (2)	62 (100)
>3000 ≤ 4000	8 (17)	20 (43)	16 (35)	2 (4)	46 (100)
>4000 ≤ 5000	2 (11)	11 (61)	3 (17)	2 (11)	18 (100)
Above 5000	4 (27)	6 (40)	4 (27)	1 (7)	15 (100)

Table 8 : Association of socio- economic variables with obesity (on the basis of chi-square value)

Socio-economic variables	Chi-Square value	Degree of freedom	Critical limit	
			0.01	0.05
Age	31.12*	18	34.80	28.86
Education	12.67	9	21.66	16.91
Occupation	1.51	3	11.34	7.81
Caste	6.94	6	16.81	12.59
Type of family	1.52	3	11.34	7.81
Size of family	9.80	6	16.81	12.59
Total income	11.69	12	26.21	21.02
Per capita income	41.95**	12	26.21	21.02
Education of husband	9.18	6	16.81	12.59
Occupation of husband	9.23	9	21.66	16.91

* and ** indicate significance of values at P>0.05 and 0.01, respectively

Occupational level and WHR:

The average waist hip ratio of the women in different occupational levels has been presented in Table 12. The WHR was found to be more *i.e.* 0.82 for unemployed or housewives than the employed urban women. The variation was found to be maximum (0.22) for unemployed women and was minimum (0.15) for employed women.

Various grades of obesity based on WHR and occupational level are given in Table 13. Out of total 162 unemployed urban women about 69 per cent had WHR below 0.85, so they are identified as normal and 31 per cent had $WHR \geq 0.85$, so they are with abdominal adiposity. Similarly out of 38 employed urban women 71 per cent were identified as normal and 29 per cent with abdominal adiposity. So it was clear that the percentage of abdominal obesity was higher among

housewives than employed women. A significant association was observed (Table 16) between employment status of women and WHR. ($\chi^2=9.24$, $p<0.01$)

Per capita income of the family and WHR:

The average waist hip ratio of the urban women in relation to their per capita income has been presented in Table 14. Income is a deciding factor of purchasing power and may have positive influence on waist hip ratio. The WHR value was found to be lowest *i.e.* 0.80, where the per capita income of the family was at lower middle level. The variation in WHR was found to be maximum *i.e.* 0.21, where per capita income was lower, but the variation was minimum *i.e.* 0.13, where per capita income was at higher middle level.

Table 15 shows the various grades of obesity based

Table 9 : Prevalence of obesity and WHR

Weight status	Number of subjects	Percentage	WHR range
Normal	138	69.0	<0.85
Obese	62	31.0	>0.85

Table 10 : Waist hip ratio in relation to age (Mean, ±S.D, Min, Max)

AGE	No. of person in each group	WHR	Minimum	Maximum
<40	90	0.81 ± 0.04	0.73	0.91
40-49	80	0.82 ± 0.04	0.69	0.90
≥50	30	0.82 ± 0.04	0.73	0.88
Total	200	0.82 ± 0.04	0.69	0.91

Table 11 : Grades of obesity based on WHR and age

Age	Grades of obesity		Total
	Normal(<0.85)	Obese(≥0.85)	
<40	71 (79)	19 (21)	90 (100)
40-49	50 (62)	30 (38)	80 (100)
≥50	17 (57)	13 (43)	30 (100)

(Figures in parenthesis indicates percentage)

Table 12 : Waist hip ratio in relation to occupational status (Mean, ±S.D, Min, Max)

Occupation	No. of person in each group	WHR	Minimum	Maximum
Unemployed	162	0.82 ± 0.04	0.69	0.91
Employed	38	0.81 ± 0.04	0.73	0.88
Total	200	0.82 ± 0.04	0.69	0.91

(Figures in parenthesis indicates percentage)

Table 13 : Grades of obesity based on WHR and occupational status

Occupation	Grades of obesity		Total
	Normal (<0.85)	Obese (≥0.85)	
Unemployed	111 (69)	51 (31)	162 (100)
Employed	27 (71)	11 (29)	38 (100)

on WHR value and per capita income of the family. Out of 59 urban women whose per capita income was lower, 66 per cent were normal and 34 per cent were with abdominal adiposity. Similarly out of 62 urban women where the per capita income was at lower middle level, 82 per cent were identified as normal and 18 per cent were with abdominal adiposity. Among 18 urban women, 72 per cent were normal and 28 per cent were with abdominal adiposity, where the per capita income was at higher middle level. Out of 15 urban women whose per capita income was higher, 60 per cent were normal and 40 per cent were identified with abdominal adiposity. The test of hypothesis on association of attribute (Table 16) revealed no association of per capita income of family with WHR level of women.

Comparison of anthropometric measurements with other related data:

Comparison of mean height, weight and body mass index of the urban women with the ICMR and NNMB data of urban areas (Table 17) indicate that the mean height, weight and BMI of women of present study were higher than the mean of urban women of India (NNMB, 1980 and ICMR, 1980).

The comparison of mean height, weight and BMI of the present study with that of mean height and weight of women in India (age group of 25-44 yrs of 10 states) including Orissa shows that all the three mean were higher in the present study, when compared with other states (Table 18).

It was seen from Table 19 that age has significant correlation with BMI and weight of the urban women

Table 14 : Waist hip ratio in relation to per capita income of the family (Mean, ±S.D, Min, Max)

Per capita income (Rs.)	N	Mean	Minimum	Maximum
>1000 ≤ 2000	59	0.82±0.04	0.69	0.90
>2000 ≤ 3000	62	0.80±0.03	0.73	0.88
>3000 ≤ 4000	46	0.82±0.03	0.74	0.91
>4000 ≤ 5000	18	0.81±0.04	0.76	0.89
Above 5000	15	0.82±0.04	0.76	0.90
Total	200	0.82±0.04	0.69	0.91

Table 15 : Grades of obesity based on WHR and per capita income of the family

Per capita income (Rs.)	Grades of obesity		Total
	Normal (<0.85)	Obese(≥0.85)	
>1000 ≤ 2000	39 (66)	20 (34)	59 (100)
>2000 ≤ 3000	51 (82)	11 (18)	62 (100)
>3000 ≤ 4000	26 (57)	20 (43)	46 (100)
>4000 ≤ 5000	13 (72)	5 (28)	18 (100)
Above 5000	9 (60)	6 (40)	15 (100)

Figures in parenthesis indicates percentage

Table 16 : Association of socio- economic variables with obesity (on the basis of chi-square value)

Socio-economic variables	Chi-square value	Degree of freedom	Critical limit	
			0.01	0.05
Age	10.28	6	16.81	12.59
Education	1.39	3	11.34	7.81
Occupation	9.24**	1	6.63	3.84
Caste	3.38	2	9.21	5.99
Type of family	1.75	1	6.63	3.84
Size of family	2.10	2	9.21	5.99
Total income	6.39	4	13.27	9.48
Per capita income	9.33	4	13.27	9.48
Education of husband	6.32*	2	9.21	5.99
Occupation of husband	4.62	3	11.34	7.81

* and ** indicate significance of value at P>0.05 and 0.01, respectively

(correlation was significant of <0.01 level). Age has also significant correlation with WHR and MUAC (correlation was significant at <0.05 level). BMI has significant correlation with WHR, weight, MUAC, and

waist circumference, but has negative correlation with height (correlation was significant at <0.01 level). WHR has significant correlation with weight, MUAC and waist circumference, but has negative correlation with height

Table 17 : Comparison of mean body mass index of the urban women with ICMR and NNMB data on adult women and with other related studies

	Obese women of Coimbatore 1(2002)	Obese women of Tamil Nadu 2(2009)	Present study 3 (2011)	NNMB 4(1980)	ICMR 5(1980)
Height (cm)	154.8	158	155.63	154.9	154.1
Weight (kg)	77.0	67.7	67.58	52.2	46.2
BMI (kg/m ²)	32.5	27.2	28.29	21.76	19.45

1=Thilakavathi and Purushothaman (2002) 2=Parimalavalli *et al.* (2009) 3=present study(2011) 4=NNMB(1980) 5=ICMR(1980)

Table 18 : Comparison of mean height and weight of women in India (age 25-44 years of 10 states) with mean height and weight of urban women of present study (25-55 years and above)

State	N/age	Height(cm)	Weight (kg)	BMI (kg/m ²)	References
Kerala	1290 (25-44)	149.3	42.3	18.98	National
Tamil Nadu	1385(-do-)	150.7	43.5	28.90	Nutrition
Karnataka	1972(-do-)	151.5	42.6	18.56	Monitoring
Andhra Pradesh	1645(-do-)	150.8	42.7	18.80	Bureaus.
Maharashtra	1560(-do-)	150.1	41.5	18.42	Annual Report (1974-79)
Gujarat	1791(-do-)	152.9	43.6	18.66	NNMB and (199) and ICMR
Madhya Pradesh	873(-do-)	150.7	44.4	19.55	(1980)
West Bengal	1344(-do-)	148.5	39.9	18.10	*NNMB- 1996
Uttar Pradesh	1288(-do-)	150.0	41.9	18.62	
Orissa	478(-do-)	148.6	42.0	19.02	
*Orissa	-	150.9	42.5	-	
Present study	(25-55 and above)	155.63	67.58	28.29	

Table 19 : Correlation among various parameters of urban women (n=200)

	Age	BMI	WHR	Total score	Total income	Height	Weight	MUAC	Waist	Hip
Age	1.000	.227**	.143*	-.055	-.084	-.057	.183**	.168*	.117	.028
		.001	.044	.440	.236	.421	.009	.018	.099	.695
BMI		1.000	.555**	.084	.046	-.399**	.594**	.478**	.492**	.122
			.000	.236	.520	.000	.000	.000	.000	.085
WHR			1.000	.074	.025	-.338**	.701**	.710**	.857**	.137
				.296	.722	.000	.000	.000	.000	.053
Total score				1.000	-.009	-.083	.041	.049	.081	.061
					.899	.244	.567	.493	.256	.394
Total income					1.000	-.113	.005	.086	.051	.060
						.112	.943	.225	.470	.398
Height						1.000	.012	-.257**	-.303**	-.066
							.863	.000	.000	.000
Weight							1.000	.684**	.614**	.128
								.000	.000	.072
MUAC								1.000	.714**	.303**
									.000	.000
Waist									1.000	.624**
										.000
Hip										1.000

* and ** indicate significance of values at P <0.05 and 0.01, respectively

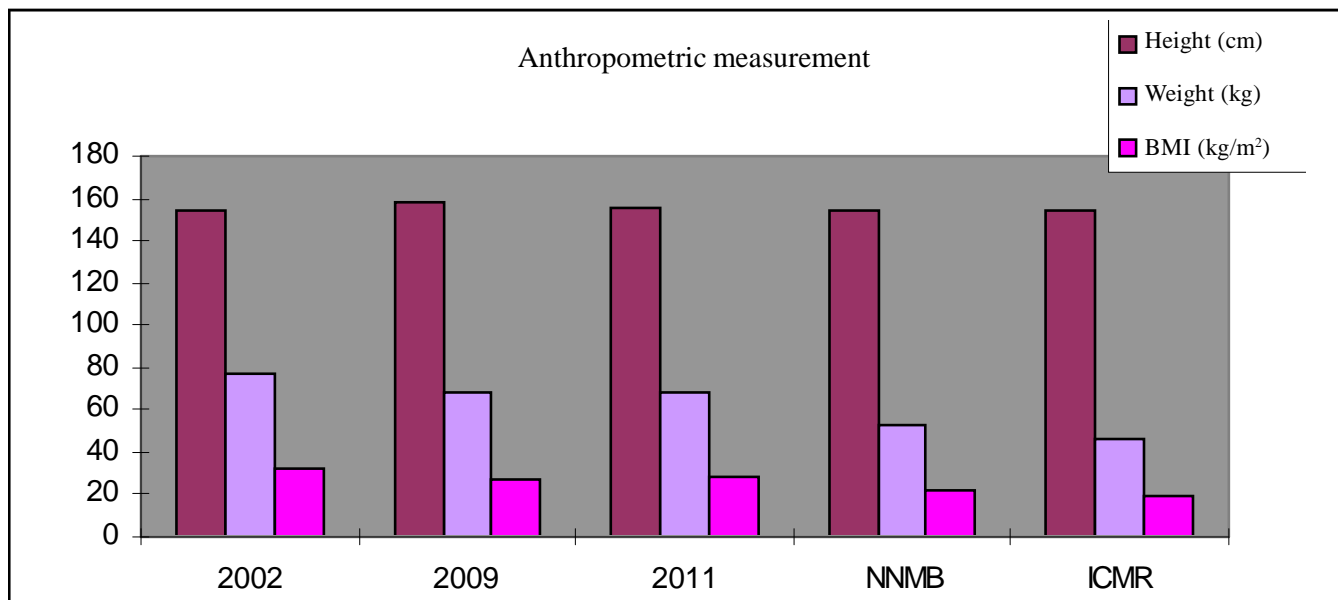


Fig. 1 : Comparison of mean body mass index of the urban women with ICMR and NNMB data on adult women and with other related studies

(correlation was significant at <0.01 level). Height has negative correlation with MUAC and waist circumference (correlation was significant at <0.01 level). Weight has significant correlation with MUAC and waist circumference (correlation was significant at <0.01 level). MUAC has significant correlation with waist and hip circumference (correlation was significant at <0.01 level). Waist has significant correlation with hip circumference and correlation was significant at <0.01 level.

Conclusion :

In this study, about 21.5 per cent women belong to normal category, 50 per cent were pre-obese, 24.5 per cent were obese-I and only 4 per cent of them belong to obese-III category. While calculating WHR, about 69 per cent women were normal and 31 per cent belong to obese category. BMI has significant correlation with WHR, weight, MUAC and waist circumference, but has negative correlation with height. WHR has significant correlation with weight, MUAC and waist circumference but has negative correlation with height. Comparison of mean height, weight and body mass index of the urban women with the ICMR and NNMB data of urban areas indicate that the mean height, weight and BMI of the present study were higher than the mean value of other urban women.

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