Research Article

Risk Factors and Awareness about Non-communicable Diseases Among Adolescents: A School-based Analytical Study from West Bengal, India

Abstract

Background: This study aimed to evaluate and compare NCD awareness and associated risk factors among adolescents in rural and urban schools of West Bengal.

Subjects and Methods: A school-based, analytical study was conducted from March to August 2021 in selected schools across three districts of West Bengal using a multistage sampling technique. A total of 320 adolescents (160 urban, 160 rural) were selected using probability proportional to size and simple random sampling. Data were collected using a pre-tested, validated questionnaire and standardised physical measurements. Awareness was assessed using an 8-item Likert scale. Risk factors, including dietary habits, physical activity, body mass index, waist–hip ratio and blood pressure, were evaluated. Statistical analysis was done using SPSS v20.

Results: Urban students showed higher awareness of NCDs, including hypertension (100% vs. 88.6%), diabetes and coronary heart disease ($P < 0.001$). Median knowledge scores were lower (better awareness) in urban students (10, interquartile range [IQR]: 8) than rural students (11, IQR: 7, $P < 0.001$). Rural students had higher overweight/obesity prevalence (26.9% vs. 14.4%, $P = 0.008$) and extra salt intake (27.5% vs. 12.5%, $P < 0.001$). Physical activity and fruit/vegetable intake were suboptimal in both groups.

Conclusion: Urban students demonstrated better awareness, whereas rural adolescents showed a higher burden of modifiable risk factors. School-based programs, parental engagement and community surveillance are vital to prevent NCDs in adolescence.

Keywords: Adolescents, awareness, non-communicable diseases, risk factors, school health

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Introduction

Non-communicable diseases (NCDs), encompassing cardiovascular diseases, diabetes mellitus, cancers and chronic respiratory disorders, are a pressing global health challenge, accounting for 74% of all deaths annually.[1] In India, NCDs contribute to 63% of mortality, driven by modifiable risk factors such as unhealthy dietary patterns, physical inactivity and rising obesity rates.[2] Adolescence is a pivotal developmental stage when these detrimental behaviours often become entrenched, with 35% of Indian adolescents exhibiting at least one NCD risk factor, heightening their vulnerability to chronic conditions in adulthood.[3] Recent studies emphasise that prolonged sitting and excessive screen time significantly increase NCD risk, particularly in low- and middle-income countries where 78% of premature NCD deaths occur.[2,4] This global shift from communicable to NCDs underscores the critical importance of implementing early preventive measures to mitigate long-term health consequences.[1]

In India, rapid urbanisation and globalisation exacerbate NCD risk factors among adolescents, with obesity prevalence reaching 30% in urban settings due to poor dietary choices, sedentary

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lifestyles and increased digital device use.[5] These behaviours, particularly low physical activity and unhealthy eating habits, often cluster and persist, contributing to conditions such as hypertension and dyslipidaemia.[6] Despite the escalating NCD burden, comprehensive data on adolescent awareness and risk factor prevalence in India, especially in eastern states like West Bengal, remain insufficient.[7] Existing studies highlight regional variations influenced by diverse dietary practices, cultural norms and socio-economic disparities, yet comparative analyses of rural and urban adolescents are notably limited, hindering targeted prevention efforts.[5,7] This gap in localised evidence poses a significant challenge to designing effective health interventions.[6] Therefore, this study aims to evaluate and compare the awareness of NCDs and the magnitude of their risk factors among adolescents attending schools in rural and urban areas of West Bengal, providing valuable insights to guide public health policy and intervention planning.

Materials and Methods

This analytical study was conducted in selected high schools and higher secondary schools across rural and urban areas of West Bengal, India, under various educational boards, from March 2021 to August 2021. The study population included adolescent boys and girls (aged 14–17 years) enrolled in classes IX to XII in selected schools. Students residing in rural areas but attending urban schools or vice versa and not giving consent/assent were excluded to ensure distinct rural-urban comparisons.

The sample size of 320 students (160 each from rural and urban schools) was calculated using the formula for comparative studies, based on obesity prevalence (2.7% rural, 11.0% urban) from Mohan *et al.*,[8] with 95% confidence, 80% power and a 10% non-response adjustment. Although more recent national estimates indicate changing prevalence patterns, particularly in rural settings, the chosen estimate ensured adequate power to detect meaningful urban–rural differences.

The higher prevalence observed in the present study likely reflects the ongoing nutrition and lifestyle transition in India. A multi-stage random sampling method was adopted to select districts, community development blocks/municipal areas, schools and students. Out of 23 districts in West Bengal, three districts (Purba Medinipur, North 24 Parganas, Dakshin Dinajpur) were selected using simple random sampling via a two-digit random number table. Within these districts, 10% of community development blocks (rural) and municipal areas (urban) were randomly chosen using the same method. From these areas, 10% (government, government-aided and private) of high schools, higher secondary schools and senior madrassas were selected by simple random sampling from lists obtained from District Inspectors' offices. The number of schools varied by area (e.g. 17 in Amdanga, 12 in Balurghat). Students were selected using probability proportional to size based on class IX–XII enrollment from attendance registers, ensuring proportional representation.

A pre-designed, pretested questionnaire, adapted from the WHO STEPwise Approach to NCD Risk Factor Surveillance[9] and the Global School-based Student Health Survey (2013),[10] assessed socio-demographic characteristics, NCD awareness and risk factors. Awareness assessment consisted of two components: (1) Disease-specific awareness (hypertension, diabetes mellitus, coronary heart disease, cancer and stroke) using yes/no questions and (2) General NCD-related knowledge evaluated using a 8 item five-point Likert scale (score range 8–40, inversely proportional to awareness; 1 = high awareness, 5 = ignorance). Risk factor questions, based on a 1-week recall, covering family history and smoking. Physical activity and dietary habits were assessed using specific operational definitions. Physical activity was quantified by the number of days in the preceding week students engaged in activities for a cumulative 60 min per day, a criterion based on the minimum duration recommended by the WHO for adolescents.[11] In line with the WHO recommendation to consume at least five servings of fruits and vegetables daily, suboptimal intake was operationally defined as consumption on fewer than 5 days per week.[12] 'Extra salt intake' was defined as the self-reported practice of adding salt to food at the table or just before eating. Content validity was confirmed by nine experts, achieving a universal agreement score of 0.87. Anthropometric measurements (height, weight, waist/hip circumference) and blood pressure were recorded using a bathroom scale, non-stretchable measuring tape, Rossmax Sphygmomanometer GB101 and Dr. Morepen ST01 stethoscope. Blood pressure was measured thrice at 5 min intervals, averaged and classified per AHA guidelines for adolescents.[13] Body mass index (BMI) was categorised using WHO growth references.[14] Waist circumference cut-offs (boys: 70.75 cm; girls: 69.25 cm) followed Patnaik *et al.*[15]

After obtaining Institutional Ethics Committee clearance (RKC-58) and necessary permissions from the respective heads of the schools, data collection among the students was done during school recess and post-class periods, adhering to COVID-19 protocols. Informed assent ensured voluntary participation, confidentiality and withdrawal rights. Students completed the self-administered questionnaires in designated classrooms, followed by measurements after providing assent. The manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Statistical analysis was performed using Statistical analyses were conducted using SPSS (IBM, New York, USA) for Windows (version 20.0). Categorical variables were reported as frequencies and percentages, continuous variables as medians with interquartile ranges (IQRs) (non-normal per Kolmogorov–Smirnov test). Pearson's Chi-square test assessed categorical associations and Mann–Whitney U-tests compared non-normal variables. $P < 0.05$ was significant. Data were anonymised and stored securely. Post-study, NCD prevention education was provided, and morbidities were referred to local hospitals.

Results

The study included 320 adolescents (160 urban, 160 rural) with a mean age of 15.62 ± 1.15 years (range 14–17), comprising 168 (52.5%) males and 152 (47.5%) females [Table 1]. Socio-demographic characteristics showed 60% of urban students in classes XI–XII versus 45% of rural students ($P = 0.012$). Urban students had higher median per capita monthly income (₹2000 [IQR: 1500–3000]) compared to rural students (₹1800 [IQR: 1200–2800]), though the difference was not statistically significant ($P = 0.266$), but the socio-economic status (Modified BG Prasad Scale 2020) differed significantly ($P < 0.001$) [Table 1]. Most participants (85%) were Hindu, with no significant urban–rural difference ($P = 0.723$). Awareness of NCDs varied significantly [Table 2]. Urban students had higher awareness of hypertension (100% vs. 88.6%, $P < 0.001$), diabetes

Table 1: Baseline characteristics of study participants in urban and rural schools of West Bengal (*n*=320)

Socio-demographic factors	Urban (*n*=160), *n* (%)	Rural (*n*=160), *n* (%)	*P*
Gender			
Male	104 (65)	94 (58.8)	0.250
Female	56 (35)	66 (41.3)	
Age (years)			
14	16 (10)	16 (10)	0.604
15	18 (11.3)	24 (15)	
16	36 (22.5)	34 (21.3)	
17	90 (56.2)	86 (53.8)	
Religion			
Hindu	148 (92.5)	153 (95.6)	0.237
Muslim	12 (7.5)	7 (4.4)	
Socio-economic status (Modified BG Prasad Scale, 2020)			
Class I (≥7533 INR)	10 (6.3)	5 (3.1)	<0.001
Class II (3766–7532 INR)	20 (12.5)	15 (9.4)	
Class III (2260–3765 INR)	35 (21.9)	30 (18.8)	
Class IV (1130–2259 INR)	67 (41.9)	71 (44.4)	
Class V (≤2258 INR)	28 (17.5)	39 (24.4)	
Per capita income (INR), median (IQR)	2000 (1500–3000)	1800 (1200–2800)	0.266*
Class of study			
Class IX	20 (12.5)	25 (15.6)	0.217
Class X	30 (18.8)	35 (21.9)	
Class XI	101 (63.1)	84 (52.5)	
Class XII	9 (5.6)	16 (10)	

*Mann–Whitney *U*-test for non-normal continuous variables (e.g., income). $P<0.05$ statistical significance. Chi-square test used for categorical variables. IQR: Interquartile range

Table 2: Awareness of non-communicable diseases among study participants in urban and rural schools of West Bengal (*n*=320)

NCD awareness	Urban (*n*=160), *n* (%)	Rural (*n*=160), *n* (%)	*P*
Diabetes			
Yes	151 (94.3)	128 (80)	<0.001
No	9 (5.7)	32 (32)	
Hypertension			
Yes	160 (100)	142 (88.6)	<0.001
No	0	18 (11.4)	
CHD			
Yes	156 (97.5)	136 (85)	<0.001
No	4 (2.5)	24 (15)	
Cancer			
Yes	160 (100)	142 (88.6)	<0.001
No	0	18 (11.4)	
Stroke			
Yes	159 (99.4)	139 (86.9)	<0.001
No	1 (0.6)	21 (13.1)	

$P<0.05$ statistical significance. Chi-square test used for test of significance. CHD: Coronary heart disease, NCD: Non-communicable disease

mellitus (94.3% vs. 80%, $P < 0.001$), coronary heart disease (97.5% vs. 85%, $P < 0.001$), cancer (100% vs. 88.6%, $P < 0.001$) and stroke (99.4% vs. 86.9%, $P < 0.001$) [Table 2]. Median NCD knowledge scores (inversely proportional to awareness) were lower in urban students [10 (IQR: 8)] than rural students [11 (IQR: 7)], indicating better urban awareness ($P < 0.001$) [Table 3]. Sources of NCD knowledge differed, with urban students more likely to cite print/electronic media (53.1% vs. 37.5%) and school (25% vs. 12.5%), while rural students relied more on books (81.3% vs. 68.7%). Risk factor prevalence differed significantly [Table 4]. No significant urban-rural difference was observed in median fruit/vegetable intake days (5, IQR: 2 urban vs. 5, IQR: 4 rural, $P = 0.391$) or physical activity days (5, IQR: 3 urban vs. 5, IQR: 1 rural, $P = 0.217$). Smoking prevalence was low (5% urban, 3% rural, $P = 0.414$). Family history of NCDs was reported by 36.2% of urban and 20% of rural students ($P = 0.027$). Obesity prevalence was higher among rural students (5% vs. 0%, $P = 0.008$). Elevated blood pressure was more prevalent among rural students (18.2% vs. 6.2%), though the difference was not statistically significant ($P = 0.498$). Bivariate logistic regression analysis revealed unadjusted associations between urban/rural residence and selected NCD risk factors [Table 4]. Urban residence was associated with higher odds of family history of NCDs (odds ratio [OR] = 2.25, 95% CI: 1.37–3.70, $P < 0.001$), while rural residence was associated with higher odds of extra salt intake (OR = 0.38, 95% CI: 0.21–0.67, $P < 0.001$) and overweight/obesity (OR = 2.19, 95% CI: 1.25–3.84, $P = 0.008$). These associations reflect urban-rural differences rather than the multivariate prediction of NCD risk.

Discussion

This study revealed urban–rural disparities in NCD awareness and risk factors, providing insights into adolescent health education needs. The mean age was 15.62 ± 1.15 years, with urban students showing higher awareness of hypertension (100% vs. 88.6%,

Table 3: Knowledge scores different items in relation with risk factors of non-communicable diseases among study participants in urban and rural schools of West Bengal (*n*=320)

Items in relation with risk factors of NCDs	Urban, median (IQR)	Rural, median (IQR)	Mann–Whitney *U*	*P*
Tobacco smoking increases	1 (2)	1 (1)	12,524.5	0.690
Alcohol consumption increases	1 (0)	1 (1)	11,600.0	0.052
Fruits and vegetables decrease	1 (1)	2 (2)	9506.0	<0.001
Passive smoking increases	1 (1)	2 (1)	10,077.0	<0.001
Obesity increases	1 (1)	2 (2)	10,018.5	<0.001
Stress increases	1 (1)	1 (2)	10,992.5	0.011
Lack of physical activity increases	1 (0)	2 (2)	7884.4	<0.001
Excess salt intake increases	1 (1)	2 (1)	10,123.5	<0.001
Average knowledge score	10 (8)	11 (7)	8787.0	<0.001

P<0.05 statistical significance. Mann–Whitney *U*-test used for test of significance. Knowledge scores are inversely proportional to awareness (i.e. a lower score indicates better awareness). NCDs: Non-communicable diseases, IQR: Interquartile range

Table 4: Non-communicable disease risk factors and their association among study participants in urban and rural schools of West Bengal (*n*=320)

Socio-demographic factors	Urban (*n*=160), *n* (%)	Rural (*n*=160), *n* (%)	*P*	OR (95% CI)
Family history of NCD's				
Present	58 (36.2)	32 (20)	<0.001	2.25 (1.37–3.70)
Absent	102 (63.8)	128 (80)		
Extra salt intake				
Present	20 (12.5)	44 (27.5)	<0.001	0.38 (0.21–0.67)
Absent	140 (87.5)	116 (72.5)		
BMI (as per WHO growth reference for 5–19 years)				
Normal	137 (85.6)	117 (73.1)	0.008	2.19 (1.25–3.84)
Overweight	23 (14.4)	35 (21.9)		
Obese	0	8 (5)		
Blood pressure (as per AHA classification of hypertension for adolescents				
Normal	147 (91.9)	146 (91.2)	0.498	1.36 (0.82–2.64)
Elevated	10 (6.2)	13 (18.2)		
Stage 1	3 (1.9)	1 (0.6)		
Number of days of taking fruits and vegetables in the last week (days), median (IQR)	5 (2)	5 (4)	0.391*	-
Number of days doing physical activities in the last week (days), median (IQR)	5 (3)	5 (1)	0.217*	-
Number of days doing walking/cycling in the last week (days), median (IQR)	3 (2)	2 (2)	<0.001*	-
Number of days of smoking in the last week (days), median (IQR)	0 (2)	0 (0)	<0.001*	-
BMI, median (IQR)	21.4 (3.2)	22.3 (5.5)	0.008*	-
WHR, median (IQR)	0.70 (0.12)	0.75 (0.11)	0.007*	-

*Mann–Whitney *U*-test for non-normal continuous variables (e.g., income). *P*<0.05 statistical significance. Chi-square test used for categorical variables. OR are unadjusted, with rural residence as the reference category for urban comparisons. WHR: Waist–hip ratio, IQR: Interquartile range, BMI: Body mass index, NCDs: Non-communicable diseases, OR: Odds ratio, CI: Confidence interval, AHA: American Heart Association, WHO: World Health Organization

P = 0.001), diabetes (94.3% vs. 80%, P < 0.001), coronary heart disease (97.5% vs. 85%, P = 0.001), cancer (100% vs. 88.6, P = 0.001) and stroke (99.4% vs. 86.9%, P = 0.001) [Table 2]. This finding is consistent with a 2021 study in Saudi Arabia which reported urban adolescents had 22% higher NCD knowledge (P < 0.01), linked to urban school curricula emphasising health education.[16] The urban-rural awareness gap in our study underscores the need for enhanced rural health education programs. The potential efficacy of such an approach is supported by a cluster-randomised intervention study in Shimla by Mahajan *et al*., which demonstrated that a school-based health behavioural intervention significantly improved awareness of healthy lifestyles and cardiometabolic risk factors among students.[17]

In this study, sources of NCD knowledge differed significantly. Urban students were more likely to rely on digital sources, including print and electronic media (53.1% vs. 37.5%), as well as school-based initiatives (25% vs. 12.5%). In contrast, rural students showed a greater reliance on traditional sources, such as books (81.3% vs. 68.7%). A 2021 study in India by Bhaskaran *et al*. noted urban adolescents accessed digital health resources

30% more than rural peers ($P = 0.003$), reflecting infrastructure disparities.[18] A 2024 scoping review by WHO highlighted school-based interventions as critical for NCD awareness, with urban schools benefiting from better resources.[1] Rural reliance on books suggests limited access to dynamic platforms, necessitating digital interventions, as supported by a 2021 study in sub-Saharan Africa and Europe advocating mobile health education ($P = 0.01$).[19]

Median NCD knowledge scores were lower (indicating better awareness) in urban students (10 [8]) than rural (11 [7]), $P < 0.001$. A 2020 study in Ghana found urban adolescents scored 18% higher on NCD knowledge ($P < 0.001$), linked to socio-economic advantages.[20] Similarly, a 2022 study in Jodhpur reported urban students had 20% higher NCD awareness due to media campaigns ($P < 0.01$).[21] Our findings suggest urban students benefit from diverse information sources, highlighting the need for rural-focused educational strategies, such as community-based programs, as recommended by a study in Delhi.[22]

The risk behaviours showed notable differences. Urban students had higher extra salt intake (27.5% vs. 12.5%, $P < 0.001$), a known hypertension risk factor. A 2020 study in Puducherry[23] found 30% of rural adolescent girls added extra salt to meals compared to 16% of urban adolescents ($P < 0.001$). This implies the need for salt reduction campaigns tailored to rural dietary practices. Furthermore, no significant urban-rural differences were found in fruit/vegetable intake frequency ($P = 0.391$) or physical activity levels ($P = 0.217$), suggesting uniform exposure to these suboptimal behaviours, possibly influenced by cultural dietary norms in West Bengal.

Overweight (21.9% vs. 14.4%) and obesity (5% vs. 0%) prevalence was higher in rural students ($P = 0.008$), surpassing national average of 8.3% (5.9% overweight, 2.4% obese) reported among adolescents aged 15–17 years in the National Noncommunicable Disease Monitoring Survey, India 2017–2018 (ICMR–NCDIR, 2020),[24] challenging urban obesity stereotypes. A pilot study in rural Kerala by Ravi and Vineetha also documented a high prevalence of overweight and hypertension among adolescents, supporting the observation that these NCD risk factors are a significant concern within rural populations.[25] Similarly, a systematic review by Khan *et al*. highlighted increasing overweight and obesity rates among school-age children in developing countries, attributing this trend to evolving dietary habits and declining physical activity.[26] While earlier Indian studies largely described prevalence, few explored the underlying drivers, such as the ongoing nutrition transition – the shift from traditional diets to energy-dense foods and sedentary lifestyles. Our findings suggest that such transitions may now be extending to rural regions, warranting localised preventive interventions.

The median BMI (22.3 vs. 21.4) and waist–hip ratio (0.75 vs. 0.70) were higher in rural students ($P < 0.01$), indicating greater central adiposity. Family history of NCDs was more prevalent among urban students (36.2% vs. 20%, $P < 0.001$), consistent with a study conducted by Bhaskaran *et al*., reporting 22% higher familial NCD burden in urban adolescents ($P < 0.001$).[18] This implies urban interventions should leverage family history to enhance risk perception.

Bivariate logistic regression analysis demonstrated unadjusted associations between place of residence and selected NCD risk factors. Urban residence was associated with higher odds of reporting a family history of NCDs (OR = 2.25, 95% CI: 1.37–3.70, $P < 0.001$), whereas rural residence was associated with higher prevalence of extra salt intake (OR = 0.38, 95% CI: 0.21–0.67, $P < 0.001$) and overweight/obesity (OR = 2.19, 95% CI: 1.25–3.84, $P = 0.008$). These findings reflect urban–rural differentials in risk factor distribution rather than independent predictors of NCD risk, as the analysis was unadjusted and exploratory in nature. In contrast, studies employing multivariable models have identified family history and obesity as independent predictors of cardiometabolic risk. Oza *et al*. reported family history of cardiovascular disease as a significant predictor of metabolic risk among Indian adolescents with type 1 diabetes, while Teixeira *et al*. demonstrated a 2.2-fold increased risk of elevated blood pressure among overweight adolescents.[27,28] Together, these findings underscore the importance of incorporating screening for family history and obesity into school-based NCD prevention programs.

Aligning with the WHO 2013–2020 Global Action Plan,[29] integrating NCD education into school curricula and leveraging digital tools could reduce disparities, promoting healthier adolescent lifestyles.

This study has some limitations. Data collection was carried out from March to August 2021, during the COVID-19 pandemic, when most schools in West Bengal functioned online. This may have differentially influenced NCD awareness and access to health-related information, potentially widening the urban–rural gap because of unequal digital connectivity and exposure to online educational resources. The cross-sectional design and reliance on self-administered questionnaires introduce the risk of recall bias and social desirability bias. However, the use of standardised, validated tools and anonymised data collection helped minimise these limitations. The absence of longitudinal follow-up restricts the ability to assess long-term trends in NCD risk factors among this adolescent cohort. The use of older prevalence estimates for sample size calculation may not fully reflect current epidemiological patterns; however, this does not affect the internal validity of the observed associations.

Conclusion

The study revealed significant urban-rural disparities in NCD awareness and risk factors, highlighting critical gaps in adolescent health education. Urban students demonstrated higher NCD awareness and access to diverse knowledge sources, while rural students showed higher obesity, extra salt intake and central adiposity, underscoring the need for tailored interventions. To bridge the gap and promote adolescent health, embedding NCD awareness in school curricula, expanding digital health access, especially in rural areas and conducting regular health screenings, including family history assessments and physical measurements, can help identify risk factors early and foster healthier lifestyles.

Relevance to preventive medicine:
This study highlights urban-rural disparities in NCD awareness and risk factors among West Bengal adolescents, emphasising the need for targeted preventive education. Addressing rural obesity and salt intake through public health policies can reduce future NCD burden. Further research can refine these strategies for vulnerable populations.

Implications for clinical practice:
Findings can guide clinicians to screen rural adolescents for obesity and hypertension, improving early intervention. Enhanced awareness training for urban patients with family NCD history can optimise care plans. These insights support tailored preventive counselling in clinical settings.

Author contribution

SKP conceptualised the study, designed the research framework and contributed to the literature review and data acquisition. IRA and SSR were involved in the study design, data analysis and statistical interpretation, while SB participated in data acquisition and manuscript drafting. All authors, including TGR, contributed to manuscript editing, reviewed the final version for intellectual content and approved the submitted manuscript. SKP will act as the guarantor of this paper.

Data availability statement

The data supporting this study's findings are not publicly available due to restrictions related to protecting the privacy of research participants. The limited data used in the analysis can be obtained from the corresponding author, upon reasonable request.

Adherence to reporting guidelines

This study was reported in adherence to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines, as recommended by the EQUATOR Network, to ensure transparency, completeness, and methodological rigor in reporting.

Use of AI in drafting of manuscript statement

The authors declare that they have not used any generative AI or AI - assisted technologies in the writing process.

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Conflicts of interest

There are no conflicts of interest.

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