Texila International Journal of Academic Research
ISSN: 2520-3088
DOI: 10.21522/TIJAR.2014.12.03.Art032

Assessment of Dyslipidemia and its Associated Risk Factors among Individuals with Diabetes Mellitus at Tamale Teaching Hospital, Ghana

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Abstract

Diabetes mellitus is a major global public health concern, frequently accompanied by dyslipidemia an abnormal lipid profile that significantly increases the risk of cardiovascular complications. This study aimed to determine the prevalence of dyslipidemia and its associated factors among diabetic patients at Tamale Teaching Hospital in Ghana. A hospital-based cross-sectional study was conducted among 43 diabetic patients receiving care at Tamale Teaching Hospital. Data on sociodemographic characteristics, anthropometric measurements, fasting blood glucose (FBG), and lipid profiles were collected. Statistical analysis included descriptive statistics, chi-square tests, and independent sample t-tests to assess associations. The mean age of participants was 57.33±10.77 years, with 83.70% being female. Dyslipidemia was present in 51.16% of participants. Significant differences were found in total cholesterol (TC), low-density lipoprotein (LDL), triglycerides (TG), and very low-density lipoprotein (VLDL) between dyslipidemic and non-dyslipidemic groups ($p < 0.01$). Higher FBG levels (≥7.1 mmol/L) were associated with significantly increased TG and VLDL and reduced high-density lipoprotein (HDL) levels. A shorter duration of diabetes correlated with higher TG and VLDL. Overweight individuals showed significantly elevated TG and VLDL levels. Dyslipidemia is highly prevalent among diabetic patients in Tamale. Abnormal lipid profiles, especially elevated TG and VLDL, are significantly associated with poor glycemic control, shorter duration of diabetes, and higher BMI. Regular lipid monitoring and targeted interventions are recommended to minimize cardiovascular risk in this population.

Keywords: *Cardiovascular Risk, Diabetes Mellitus, Dyslipidemia, Fasting Blood Glucose, Ghana, Lipid Profile, Tamale.*

Introduction

Dyslipidemia refers to abnormal levels of plasma lipids and lipoproteins, including elevated concentrations of low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglycerides, as well as reduced levels of high-density lipoprotein cholesterol (HDL-C) [1]. It is a recognized risk factor for atherosclerosis and cardiovascular diseases and is frequently observed in individuals with diabetes mellitus [2].

Type 2 diabetes mellitus (T2DM) is a metabolic disorder primarily characterized by chronic hyperglycemia resulting from insulin resistance and/or a relative deficiency in insulin secretion. While individuals with T2DM typically do not require exogenous insulin for management at diagnosis, the underlying pathophysiology varies, with the relative contributions of insulin resistance and beta-cell dysfunction differing between individuals and potentially changing over time [3]. Consequently, effective treatment strategies must adopt a multifaceted approach targeting both insulin resistance and pancreatic insufficiency.

Received: 18.05.2025 ***Accepted: 25.05.2025*** ***Published on: 31.07.2025***
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There is a well-established association between dyslipidemia and diabetes. Diabetic dyslipidemia is typically marked by elevated triglycerides and reduced HDL-C, rather than markedly increased LDL-C levels [4]. Although LDL-C is a well-known contributor to cardiovascular disease, its severe elevation is less common among diabetic patients. Nevertheless, the lipid abnormalities seen in T2DM often in the context of insulin resistance contribute significantly to the increased risk of atherosclerotic cardiovascular disease observed in this population [5].

Globally, the burden of diabetes continues to rise at an alarming rate. In 2019, an estimated 463 million individuals were living with diabetes, a figure projected to reach 642 million by 2040. Over 90% of these cases are classified as type 2 diabetes mellitus [6]. T2DM is frequently associated with metabolic syndrome (MetS), a cluster of interrelated metabolic abnormalities including dyslipidemia, hyperglycemia, and hypertension. MetS significantly increases the risk of cardiovascular events and is characterized by impaired cellular uptake of glucose, elevated blood pressure, and abnormal lipid profiles.

Despite the global significance of dyslipidemia in diabetes management, data on its prevalence and determinants in sub-Saharan African populations remain limited. In particular, there is a lack of comprehensive studies examining how socio-demographic, anthropometric, and behavioral factors influence lipid profiles in rural African settings. Therefore, the present study aims to assess the relationship between these factors and cholesterol levels in the population of Tamale, Ghana [7]. Improved understanding of these associations could support more effective prevention and management strategies tailored to the unique characteristics of African populations.

Materials and Methods

Study Design and Population

This descriptive cross-sectional study was conducted at the Tamale Teaching Hospital 60 adult participants with suspected or confirmed diabetes mellitus were consecutively recruited from the out-patient clinic after providing written informed consent.

Data Collection

A researcher-designed semi-structured questionnaire was administered to obtain socio-demographic characteristics (age, sex, marital status, education, occupation, monthly income) and lifestyle factors (smoking, alcohol intake, physical activity), as well as the duration of diabetes. Physical activity was defined as ≥30 min of moderate-intensity exercise that produced light perspiration or a noticeable increase in heart rate. Alcohol consumption was defined as ingestion of ≥1 standard bottle of alcoholic beverage per week. Participants who smoked ≥1 cigarette per day were classified as smokers.

Specimen Collection and Laboratory Analyses

Following an overnight fast of at least 10 h, 10 mL of venous blood was drawn aseptically from each participant into a fluoride-oxalate tube and a serum-separator tube (SST). SST samples were centrifuged at 3000 × *g* for 5 min, and sera were aliquoted and stored at 2–8 °C pending analysis. Fasting plasma glucose (FPG) was measured immediately in fluoride-oxalate specimens. Serum lipid profile and liver function parameters were quantified on a COBAS c311 automated chemistry analyser (Roche Diagnostics, Mannheim, Germany) according to the manufacturer's instructions.

Inclusion Criteria

Adults (≥18 years) with clinically diagnosed diabetes mellitus or abnormal fasting/random

blood glucose levels who provided informed consent.

Exclusion Criteria

Individuals receiving lipid-lowering therapy or with documented cardiovascular disease, chronic liver disease, or chronic kidney disease were excluded.

Results

Demographic and Clinical Characteristics of Study Participants

Table 1 summarizes the demographic and lifestyle characteristics of the study population, which included 43 participants. Of these, 7 (16.3%) were male and 36 (83.7%) were female. The mean age was 57.33 years (SD ±10.77). Regarding marital status, 35 participants (61.4%) were married, and 23 (53.5%) were employed; however, these distributions were not statistically significant.

A majority of the participants, 27 (62.8%), had no formal education. The median duration of diabetes among the participants was 5 years (interquartile range: 2–5–7 years), which was also not statistically significant.

Upon stratification by dyslipidemia status, 22 participants (51.16%) had dyslipidemia, while 21 (48.84%) did not. The average age of participants with dyslipidemia (58.64 years) was slightly higher than that of those without dyslipidemia (55.95 years), but this difference was not statistically significant ($p = 0.423$).

Marital status and employment were evenly distributed across the dyslipidemia and no dyslipidemia groups, with no significant differences observed. Additionally, a slightly higher proportion of participants with dyslipidemia did not engage in regular exercise compared to those without dyslipidemia, but this difference was also not statistically significant ($p = 0.663$).

Table 1. Demographic and Clinical Characteristics of Study Participants

Variable	**Total (n=43)**	**Dyslipidemia (n=22)**	**No Dyslipidemia (n=21)**	**P-Value**
Age (Years)	57.33±10.77	58.64±9.66	55.9±11.91	0.423
Sex				
Male	7(16.30)	4(18.20)	3(14.30)	0.729
Female	36(83.70)	18(81.80)	18(85.70)	
Marital Status				
Married	35(61.40)	19(86.40)	16(76.20)	0.637
Single	2(4.70)	1(4.50)	1(4.80)	
Widowed	6(14.00)	2(9.10)	4(19.00)	
Employment Status				
Unemployed	20(46.50)	10(45.50)	10(47.60)	0.887
Employed	23(53.50)	12(54.50)	11(52.40)	
Education				
None	27(62.80)	14(63.6)	13(61.90)	0.636
Primary	2(4.70)	0(0.00)	2(9.50)	
JHS	5(11.60)	3(13.60)	2(9.50)	
Secondary	3(7.00)	2(9.10)	1(4.80)	
Tertiary	6(14.00)	3(13.60)	3(14.30)	
Duration (Years)	5(2-5-7)	4(2-4-6)	5(3-5-8)	0.202
Smoking				
No	43(100.0)	22(100.0)	21(100.0)	-

Alcohol				
Yes	1(2.30)	0(0.00)	1(4.80)	0.300
No	42(97.70)	22(100.00)	20(95.20)	
Exercise				
Yes	17(39.50)	8(36.40)	9(42.90)	0.663
No	26(60.50)	14(63.60)	12(57.10)	

Anthropometric, Blood Glucose and Blood Pressure of Study Population

Table.2 shows the anthropometric, blood glucose and blood pressure of the studied population. The average weight of the population was 64.36(SD±10.72) with an average height of 1.62(SD±0.07) but were not statistically significant. The average fasting blood glucose of the studied population was 7.41(SD±2.59) of which was not statistically significant. When the data was stratified into dyslipidemia and no dyslipidemia, there were slight differences in weight, BMI, fasting blood sugar (FBS), and blood pressure, none of these differences were statistically significant. The majority of participants had a high FBS and normal BMI, with a slightly higher prevalence of overweight individuals in the dyslipidemia group.

Table 2. Anthropometric, Blood Glucose and Blood Pressure of Study Population

Variable	**Total (n=43)**	**Dyslipidemia (n=22)**	**No Dyslipidemia (n=21)**	**P-Value**
Weight (Kg)	64.36±10.72	66.27±10.79	62.36±10.54	0.236
Height (m)	1.62±0.07	1.61±0.06	1.63±0.08	0.519
BMI (kg/m²)	24.78±4.37	22.82±4.63	23.69±3.89	0.108
BMI Cat				
Normal	24(55.80)	10(45.50)	14(66.70)	0.161
Overweight	19(44.20)	12(54.50)	7(33.30)	
FBS (mmol/L)	7.41±2.59	7.47±2.18	7.34±3.01	0.873
FBS Cat				
Normal	15(34.90)	6(27.30)	9(42.90)	0.284
High	28(65.10)	16(72.70)	12(57.10)	
SBP (mmHg)	126.65±15.26	124.73±15.52	128.67±15.08	0.404
DBP (mmHg)	72.49±1.19	72.27±9.66	72.71±10.95	0.889
Elevated BP (mmHg)				
Yes	10(23.30)	4(18.20)	6(28.60)	0.420
No	33(76.70)	18(81.80)	15(71.40)	

N= Number of participant; BMI = Body mass index; Kg/m^2 = kilogram per meter square; mm/Hg=Millimeter of mercury; BP=Blood pressure; FBS=Fasting blood sugar; SBP=Systolic blood pressure; DBP=Diastolic blood pressure BMI is presented in mean ± standard deviation and compared using independent sample T- test. Categorical data were presented as frequencies with corresponding percentages and compared using Pearson Chi square P<0.05 was considered statically significant.

Lipid Parameters Comparison between Study Participants

Table .3 highlights the various lipid profile parameters compared between individuals with dyslipidemia (n=22) and those without dyslipidemia (n=21) for a total of 43 participants. Significant differences in TC ($p < 0.001$), LDL ($p < 0.001$), TG ($p = 0.006$) and VLDL ($p = 0.006$) exist between dyslipidemic and non-dyslipidemic individuals, with higher mean levels of TG, and high prevalence of high TC, LDL, and VLDL in the dyslipidemic group. HDL levels were generally higher in the dyslipidemic group.

Table 3. Lipid Parameters Comparison between Study Participants

Variable	Total (n=43)	Dyslipidemia (n=22)	No Dyslipidemia (n=21)	P-Value
TG (mmol/L)	1.095±0.68	1.370±0.81	0.8081±0.34	0.006
TC (mmol/L)	5.026±1.53	5.9636±1.55	4.0443±0.64	<0.001
HDL (mmol/L)	1.717±0.47	2.0073±0.48	1.4129±0.18	<0.001
LDL (mmol/L)	2.845±0.99	3.4005±1.06	2.2643±0.45	<0.001
VLDL (mmol/L)	0.498±0.31	0.6232±0.37	0.3681±0.16	0.006
TG Categories				
Normal	38(88.4)	17(77.3)	21(100.0)	0.020
High	5(11.6)	5(22.7)	0(0.0)	
TC Categories				
Normal	25(58.1)	4(18.2)	21(100.0)	<0.001
High	18(41.9)	18(81.8)	0(0.0)	
HDL Categories				
Low	1(2.3)	1(4.5)	0(0.0)	0.323
Normal	42(97.7)	21(95.5)	21(100.0)	
LDL Categories				
Normal	19(44.2)	4(18.2)	15(71.4)	<0.001
High	24(55.8)	18(81.8)	6(28.6)	
VLDL Categories				
Normal	38(88.4)	17(77.3)	21(100.0)	0.020
High	5(11.6)	5(22.7)	0(0.0)	

N= Number of participant; BMI = Body mass index; Kg/m^2 = kilogram per meter square; TG= Triglyceride; TC=Total cholesterol; HDL=High density lipoprotein; LDL=Low density lipoprotein; VLDL=Very low-density lipoprotein. Lipid parameters were presented in mean ± standard deviation and compared using independent sample T- test. Categorical data (all the categories) were presented as frequencies with corresponding percentages and compared using Pearson Chi square P<0.05 was considered statically significant.

Lipid Parameters Comparison with Duration among Diabetics

Table.4 shows variables Compared by Dyslipidemia Duration (<5 years vs. ≥5 years). Participants with dyslipidemia for ≥5 years tend to have a lower BMI and greater height compared to those with a shorter duration. Those with a longer duration of dyslipidemia had significantly lower TG and VLDL levels.

Table 4. Lipid Parameters Comparison with Duration among Diabetics

Variables	<5 (n=21)	≥5 (n=22)	P-Value
Age (Years)	56.90±11.34	57.73±10.45	0.806
Weight (Kg)	67.41±13.14	61.46±6.88	0.075
Height (m)	1.59±0.07	1.65±0.06	0.007
BMI (kg/m²)	26.51±5.27	23.13±2.42	0.012
FBS (mmol/L)	7.99±3.19	6.86±1.73	0.160
SBP (mmHg)	131.14±14.71	122.36±14.83	0.058
DBP (mmHg)	73.86±12.34	7.18±7.68	0.402
TG (mmol/L)	1.39±0.84	0.81±0.28	0.006
TC (mmol/L)	5.48±1.64	4.59±1.31	0.059
HDL (mmol/L)	1.88±0.51	1.56±0.37	0.027
LDL (mmol/L)	3.03±1.03	2.67±0.94	0.231
VLDL (mmol/L)	0.63±0.38	0.37±0.13	0.006
TC/HDL	2.91±0.31	2.92±0.22	0.978
TG/HDL	0.72±0.33	0.55±0.24	0.059

N= Number of participant; BMI = Body mass index; Kg/m^2 = kilogram per meter square; mm/Hg=Millimeter of mercury; BP=Blood pressure; FBS=Fasting blood sugar; SBP=Systolic blood pressure; DBP=Diastolic blood pressure; TG= Triglyceride; TC=Total cholesterol; HDL=High density lipoprotein; LDL=Low density lipoprotein; VLDL=Very low-density lipoprotein. BMI and Lipid parameters were presented in mean ± standard deviation and compared using independent sample T- test. P<0.05 was considered statically significant.

Lipid Parameters Comparison with Fasting Blood Sugar among Diabetics

Table 4.5 shows variables Compared by Fasting Blood Sugar (<7.1 vs. ≥7.1 mmol/L). Participants with higher FBS (≥7.1 mmol/L) had significantly higher TG and VLDL levels and lower HDL levels, which are associated with increased cardiovascular risk. There was a slightly increased in the BMI and blood pressure of participants with greater fasting blood sugar levels but were not statistically significant.

Table 5. Lipid Parameters Comparison with Fasting Blood Sugar among Diabetics

Variables	<7.1 (n=21)	≥7.1 (n=22)	P-Value
Age (Years)	57.14±11.46	57.50±10.33	0.915
Weight (Kg)	63.07±13.00	65.59±8.09	0.454
Height (m)	1.61±0.02	1.63±0.08	0.328
BMI (kg/m²)	24.53±5.19	25.01±3.52	0.726
SBP (mmHg)	123.57±14.72	129.59±15.51	0.199
DBP (mmHg)	70.43±10.48	74.45±9.74	0.200
TG (mmol/L)	0.81±0.32	1.37±0.82	0.005
TC (mmol/L)	4.58±1.08	5.45±1.79	0.060
HDL (mmol/L)	1.57±0.31	1.86±0.55	0.046
LDL (mmol/L)	2.64±0.77	3.04±1.16	0.187

VLDL (mmol/L)	0.37±0.15	0.62±0.37	0.005
TC/HDL	2.90±0.21	2.92±0.31	0.720
TG/HDL	0.53±0.24	0.73±0.32	0.027

N= Number of participant; BMI = Body mass index; Kg/m^2 = kilogram per meter square; mm/Hg=Millimeter of mercury; BP=Blood pressure; FBS=Fasting blood sugar; SBP=Systolic blood pressure; DBP=Diastolic blood pressure; TG= Triglyceride; TC=Total cholesterol; HDL=High density lipoprotein; LDL=Low density lipoprotein; VLDL=Very low-density lipoprotein. BMI and Lipid parameters were presented in mean ± standard deviation and compared using independent sample T- test. P<0.05 was considered statically significant.

Lipid Parameters Comparison with BMI Classes among Diabetics

Table.6 shows variables Compared by BMI (Normal vs. Overweight). Overweight participants had significantly higher TG and VLDL levels compared to those with a normal BMI. Most of the other variables were not statistically significant.

Table 6. Lipid Parameters Comparison with bmi Classes among Diabetics

Variables	**Normal (n=24)**	**Overweight (n=19)**	**P-Value**
Age (Years)	55.50±11.31	59.63±9.86	0.832
FBS (kg/m²)	6.79±1.76	8.19±3.24	0.116
SBP (mmHg)	124.83±15.84	128.95±14.58	0.711
DBP (mmHg)	72.00±10.08	73.11±10.57	0.660
TG (mmol/)	0.92±0.41	1.31±0.88	0.005
TC (mmol/L)	4.90±1.54	5.18±1.54	0.992
HDL (mmol/L)	1.64±0.42	1.82±0.52	0.319
LDL (mmol/L)	2.85±1.06	2.84±0.94	0.846
VLDL (mmol/L)	0.42±0.19	0.59±0.40	0.005
TC/HDL	2.96±0.23	2.86±0.31	0.283
TG/HDL	0.58±0.24	0.69±0.36	0.204

N= Number of participant; BMI = Body mass index; Kg/m^2 = kilogram per meter square; mm/Hg=Millimeter of mercury; BP=Blood pressure; FBS=Fasting blood sugar; SBP=Systolic blood pressure; DBP=Diastolic blood pressure; TG= Triglyceride; TC=Total cholesterol; HDL=High density lipoprotein; LDL=Low density lipoprotein; VLDL=Very low-density lipoprotein. BMI and Lipid parameters were presented in mean ± standard deviation and compared using independent sample T- test. P<0.05 was considered statically significant

Discussion

Dyslipidemia, characterized by abnormal lipid profiles such as elevated triglycerides, reduced high-density lipoprotein (HDL) cholesterol, and/or increased low-density lipoprotein (LDL) cholesterol, is a major risk factor for cardiovascular disease [8]. Understanding the key contributing factors to dyslipidemia is crucial for effective prevention and management strategies. This study aimed to examine the relationship between lipid parameters (triglycerides, very low-density lipoprotein [VLDL], HDL, and LDL cholesterol) and various demographic, clinical, and lifestyle factors among a sample of diabetic individuals.

In this study, there was no statistically significant association between sex and the presence of dyslipidemia. This may be due to the limited sample size. These findings are consistent with those of [9], who also reported no significant sex-related differences in

dyslipidemia prevalence in a cross-sectional study in India. However, contrary evidence exists. A meta-analysis by [10] found that women had significantly higher odds of developing dyslipidemia, potentially due to hormonal fluctuations, particularly during menopause, that negatively affect lipid metabolism.

Alcohol consumption was reported by only one participant without dyslipidemia, and no statistically significant difference in alcohol intake was found between groups. Moderate alcohol consumption has been linked to improved lipid profiles, including lower triglycerides and higher HDL cholesterol [11]. Conversely, heavy alcohol intake can impair lipid metabolism and increase the risk of dyslipidemia [12], highlighted that while light-to-moderate drinkers typically exhibit favorable lipid levels, abstainers and heavy drinkers often present with less desirable lipid profiles.

Regarding physical activity, exercise was reported by 9 participants without dyslipidemia and 8 with dyslipidemia, with no statistically significant difference between groups. Although regular physical activity is widely recognized as beneficial for lipid profiles, the relationship may be influenced by exercise type, intensity, and duration [13]. found that moderate-intensity exercise had a more favorable effect on lipid levels compared to high-intensity workouts. Similarly, a meta-analysis by [14] indicated that aerobic exercise significantly reduced LDL cholesterol and triglycerides while increasing HDL cholesterol.

Participants classified as overweight showed elevated triglyceride and VLDL levels. This aligns with findings by [15], who demonstrated that overweight or obese individuals had significantly higher levels of triglycerides and VLDL compared to those with normal BMI [16]. further corroborated this relationship across different populations, showing a consistent positive association between increased BMI and adverse lipid profiles.

However, some studies provide contrasting evidence. For instance, [17] and [18], found no significant association between BMI and triglyceride or VLDL levels in specific populations, such as African Americans and individuals with type 2 diabetes in Pakistan. These discrepancies may be due to ethnic or genetic differences, underlying health conditions, or other confounding factors influencing lipid metabolism.

Elevated fasting blood sugar levels were associated with increased triglyceride and VLDL levels, consistent with previous research [19], reported that patients with higher fasting glucose exhibited significantly elevated triglycerides. Similarly, [20] and [21] found that the triglyceride-to-HDL ratio was positively correlated with FBS levels and was a common feature in individuals with type 2 diabetes.

Interestingly, participants with higher FBS in this study also exhibited slightly higher HDL levels, which contrasts with some literature. [22] noted that insulin resistance and hyperglycemia are typically associated with reduced HDL cholesterol. These differences may reflect individual variability in glycemic control, metabolic adaptation, or other modifying factors such as medication use.

This study found that individuals with shorter durations of diabetes exhibited higher triglyceride and VLDL levels and higher HDL levels. This may reflect the limited time for these individuals to adopt effective lifestyle changes or receive adequate treatment.[23] observed that individuals with a longer history of diabetes often had improved lipid profiles, likely due to accumulated health education, lifestyle interventions, or pharmacological management.

However, other studies report conflicting results. For instance, [24] observed that longer duration of dyslipidemia was associated with increased triglyceride levels, possibly due to cumulative metabolic damage and impaired lipid clearance. Meanwhile,[25] found no

significant reduction in HDL levels over time, and [26] reported no definitive association between VLDL and disease duration. These inconsistencies suggest that lipid parameters may be more influenced by ongoing management strategies than by the duration of diabetes alone.

Conclusion

Overall, this study highlights the complex interplay between demographic, lifestyle, and clinical factors in influencing lipid abnormalities among diabetic individuals. While some trends align with existing literature, others diverge, potentially due to the sample size or population-specific characteristics. These findings underscore the need for individualized assessment and management of dyslipidemia in diabetic populations and suggest areas for further research in larger and more diverse cohorts.

Limitation

1. The total number of participants (n = 43) was relatively small, which may limit the generalizability of the findings. A small sample reduces statistical power, making it more difficult to detect significant associations between variables.
2. The cross-sectional nature of the study limits the ability to infer causality. While associations between variables were observed, the directionality and long-term effects of these relationships cannot be determined.
3. Certain variables, such as alcohol consumption and physical activity, were self-reported, which may be subject to recall bias or social desirability bias. Participants may underreport unhealthy behaviors or overreport healthy ones.
4. Diet plays a critical role in lipid metabolism; however, dietary habits were not assessed in this study. The absence of this data limits the understanding of how nutrition may have influenced lipid profiles in the participants.
5. The study was conducted at a single location, potentially introducing regional bias. The findings may not be representative of other populations or settings, especially those with different socioeconomic, genetic, or lifestyle backgrounds.

Conflict of Interest

There is no conflict of interest.

Acknowledgement

I will like to thank Mohammed Ziblim, Abdulai Abubakr Sadik for their immerse contribution toward this work.

Reference

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