ORIGINAL ARTICLE

Awareness of ocular hazards among welders in Bindura, Zimbabwe

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ABSTRACT

Occupational health issues are the highest among workers in developing nations. This study aimed to assess the awareness of ocular hazards among welders in Bindura. An observational cross-sectional design with a validated structured self-administered questionnaire was used to assess the awareness of ocular hazards among 400 welders. Among the 400 welders, 397(99.3%) were males and their ages ranged from 19 – 56 with a mean age of 36 ± 8 years. Most (35%) of them, 140 had been involved in welding for 6-10 years. The most common type of welding among the participants was arc welding (87.8%). Majority (99.3%) of the welders were aware that welding without the use of protective equipment is a potential source of ocular hazards. Many welders had access to protective face shields and used them all the time (84.5%). The most common condition was ocular foreign bodies (17.7%), followed by Arc eye (4.8%). Awareness about welding as a source of ocular hazard depends on the type of welding used ($p < 0.05$). The awareness of ocular hazards among welders in Bindura is high. Although, protective devices are provided, regular utilization needs to be encouraged and enforced.

Key words:
awareness, ocular health, welders, Zimbabwe

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INTRODUCTION

Work-related injuries, including ocular hazard-related conditions, are of global public health concern. [1] Over 2.3 million individuals worldwide lose their lives yearly due to work-related injuries and workplace accidents, with an annual $1.25 trillion, or 4% of global GDP loss. [2,3] Similarly, more than 2.5 million individuals get eye injuries annually, and over 500,000 lose sight due to these accidents. [4] These occupational health issues are the highest among workers in developing nations. In underdeveloped countries, it is believed that up to 5% of all blindness is caused by accidents sustained in the workplace. [5]

The term "ocular hazards" refers to anything potentially compromising the eyes' ability to see clearly and comfortably. [6] Injury or conditions caused by these risks may cause temporary or permanent vision loss or even total blindness. Although welding may cause eye problems, most can be avoided if welders use protective gear such as goggles, face shields, and helmets. [7] Flying or sharp items, thermal burns from hot chemical liquids or gases, exposure to hazardous light, and infrared radiation are all potential causes of ocular and periocular damage or morbidity in welding. [4] Workplace eye injuries place a heavy burden on the public healthcare system and the national health budget, in addition to the economic and psychological implications of the injury itself to sufferers and their relations. [8] As a critical measure for gauging ocular hazards, awareness is defined as the knowledge of potential hazards to the eye associated with welding. [1]

Regarding welders' personal protective eye devices (PPEDs) and their effectiveness in preventing ocular hazard-related conditions is concerned, hurdles to their optimum usage remain largely unmet around the globe. [1] Ocular-hazard-related conditions include pterygium, cataracts, keratitis, and arc burns with associated symptoms like pain, irritation, cloudy vision, and photophobia that significantly affect the quality of life of welders. [6] The current National eye strategic plan for Zimbabwe has no information on the causes and prevalence of ocular hazards. [9] Welders in Zimbabwe have no mandatory occupational health training and policies. In this regard, there is a need to evaluate and appreciate ocular hazards and the conditions that are commonly related among welders. This study aims to determine the awareness of ocular hazards among welders in Bindura and to determine the association between awareness and socio-demographics and source of ocular hazards.

METHODS AND MATERIALS

An observational cross-sectional study was conducted among welders in Bindura, Mashonaland Central Province, Zimbabwe. Bindura is a peri urban town located in the Mazowe valley about 88 km North-East of Harare, the capital of Zimbabwe with a population of about 43,675 people [10]. The study was carried out between February and September 2022. Our study participants were purposely drawn from a target population of all welders aged 18 years old and above who had consented to participate in the study. A minimum sample size of 353 was calculated based on an estimated number of 3000 for welders in Bindura with a 0.05 margin of error using Slovin's sample size formula for a finite population, $n= N / (1 +NE^2)$. The estimated number of welders was obtained from the members of the Bindura welding community. Welders in Bindura irrespective of their experience or length of years engaged in welding, or the type of welding they are engaged in were recruited as well as all workshops within our catchment area- Bindura. We used

snow ball sampling where one welder introduced us to another one until we reached our sampling goal. We used this method because there is no register available to get our sampling frame. Welders in Bindura who agreed to take part in the study were included, while those who did not consent were excluded.

Data collection procedure

Data was collected using a modified structured and validated questionnaire by Hassan et al consisting of 3 sections, with a total of 17 questions. [11] The first part was a self-administered section that collected the participants' demographic information, and the second section was on occupational data, followed by the third, knowledge and awareness of ocular hazards containing closed and open-ended questions. Yes or no questions were asked to probe the awareness of participants about ocular hazards associated with welding. This was then followed by open ended questions that allowed participants to list some of the common ocular hazards they encountered in their work. Participants then responded to questions on how frequently they encounter these ocular hazards. Questionnaires were translated into the local language for participants who could not read and understand English and participants were further assisted with explanations and clarifications by a native speaker of their language to complete the questionnaire, when they needed help. Participants were made to complete questionnaires in the privacy of their workshops. Data from the questionnaire was extracted and translated into an Excel spreadsheet with participants' information de-identified using codes and numbers to represent them.

Analysis

Data analysis was conducted in JASP using the frequentist statistical framework. To test our hypotheses, we relied on Binomial and contingency tests to calculate frequencies and proportions and tests statistics for the various factors we collected data on. We used Chi-squared tests of independence to determine if the observed frequency distributions were significantly different from the expected and to ascertain if participants' awareness of ocular hazards depended on key demographic characteristics. In determining the association between participants' awareness of ocular hazards and their demographic characteristics, we noticed that the expected counts of responses were less than 5 in some of the comparisons. For these scenarios, we regrouped the data into a 2x2 contingency table and performed the Fisher's exact test of independence which is robust against such small sample sizes. We report the results of these analysis next.

RESULTS

Socio-demographic characteristics of participants

Responses from 397(99.3%) males and 3 females (0.7%), between the ages of 19 – 56 (mean age: 36 ± 8 years), who completed the study questionnaire were included in the analysis. Overall, there was a significant difference in the distribution of all socio-demographic characteristics among the participants ($p < .001$). Specifically, the majority (n=200, 50%) of the participants were adults between the ages of 31-40 years, followed by 21 - 30 age group (n=95, 23.7%). Only 158(39.5%) of the welders have been educated to the tertiary level and 52(13%) attained O-level education, while 34 (8.5%) had no formal education. Welders in this study had a wide range of experience, with most (n=140, 35%) of them involved in welding for periods between 6-10 years. Broadly, the range of experience among welders spanned 1 to 29 years with a mean number of years of service around 10 ± 5 years. As expected, the monthly income of welders surveyed was low. More than half (n=318,

79.5%) earned less than 500 USD and we recorded an average monthly income of 327.31 ± 154.9 USD was recorded. The most common type of welding among the participants was arc welding (n=359, 89.7%), Table 1.

Table 1. Sociodemographic characteristics of welders in Bindura

Characteristic		Frequency (N=400)	(%) Frequency
Age group	10 -20	12	3.0
	21-30	95	23.7
	31-40	200	50.0
	41-50	82	20.5
	>50	11	2.8
Sex	Male	397	99.3
	Female	3	0.7
Highest level of education	A level	87	21.7
	O level	158	39.5
	Tertiary	52	13.0
	Primary	69	17.2
	None	34	8.5
Marital status	Divorced	32	8.0
	Married	288	72.0
	Single	54	13.5
	Widowed	26	6.5
Number of years engaged in welding	1 - 5	98	24.5
	6 - 10	140	35.0
	11 - 15	97	24.2
	16 - 20	54	13.5
	>20	11	2.8
Monthly income from welding	0 - 200	128	32.0
	250 - 450	190	47.5
	500 - 700	80	20.0
	>700	2	0.5
Number of hours spent on welding	1 - 5	4	1.0
	6 - 10	396	99.0
Type of welding activity engaged in	Arc welding	359	89.7
	Gas welding	9	2.2
	Both arc and gas welding	32	8.0

Awareness of ocular hazards and utilization of PPED

Overall, majority (n=397, 99.3%) of the welders involved in the study were aware that welding is a potential source of ocular hazards and all welders were aware of ocular hazards associated with welding. Additionally, most of them (n=368, 92%) knew that exposure to these hazards could result in irreversible blindness. Almost half (n=190, 47.8%) of the participants named conditions such as excessive brightness, flying sharp metals, heat, welding fumes,

sparks, and chemicals as some of the hazards that could expose them to ocular injuries while welding. The results show that 390 (97.5%) of the welders' initial knowledge of ocular hazards related to welding was obtained on the job while 10 (2.5%) of them acquired this knowledge through formal education.

With respect to the use of PPEDs, the results further indicate that most welders had face shields to work with (n=390;97.5%). Indeed, a large number of welders in this study acknowledged that they had access to protective face shields and they used them at all times whenever needed (n=338, 84.5%), however, only 62 (15.5%) of the welders reported not using protective equipment regularly. Among these welders, they cited *reduced vision* 37(59.7%) and *discomfort* (32, 51.6%) as some of the contributing factors to the irregular use of the protective face shields, although there was no statistically significant difference ($p > .05$) between reduced vision and discomfort as the main reason for non-use. Thus, both reasons contribute equally to the non-use of PPEDs among welders surveyed, Table 2.

Table 2. Awareness of ocular hazards and utilization of PPEDs

Questions	**Response**	**Frequency**	**(%) Frequency**
Do you know that welding is a source of ocular hazard?	Yes	397	99.3
	No	3	0.7
How did you get to know about ocular hazards associated with welding?	At work	390	97.5
	Through formal education	10	2.5
Do you have an eye shield to protect your eyes during welding?	Yes	390	97.5
	No	10	2.5%
Do you use your eye shield all the time when you are welding?	Yes	338	84.5
	No	62	15.5
Any reason(s) for not using eye shield all the time?			
Reduced vision	Yes	37	59.7
	No	25	40.3
	Total	**62**	**100**
Discomfort	Yes	32	51.6
	No	30	48.38
	Total	**62**	**100**
Do you know that ocular hazards from welding can cause irreversible blindness?	Yes	368	92.0
	No	32	8.0
Total		**400**	**100**

Awareness of specific ocular conditions associated with welding

Having shown that welders were aware of ocular hazards, we determined the awareness of welders about some of the specific ocular conditions that could result from exposure to these ocular hazards. The results show that welders' awareness was sound in this regard. The lowest proportion recorded for this aspect of welder's awareness was 43% for retinal burns, perhaps because it is an intraocular condition that may not be readily visible to welders.

Surprisingly, majority of the participants were not aware that pterygium (n=213, 53.2%) and pinguecula (n=213; 53.2%) are important eye conditions associated with welding. This may be because these conditions have multiple risk factors (eg. dust, UV, allergic reactions etc); thus, welders may not easily associate them with welding or that they are rarely frequent among this group of welders. The awareness of all other conditions was greater than 60% and their distributions were statistically significant among welders ($p < .001$), Table 3.

Table 3. Awareness of specific ocular conditions associated with welding

Conditions	Responses	Frequency(N=400)	(%) Frequency
Arc eye	Aware	395	98.8
	Not aware	5	1.3
Keratitis	Aware	355	88.7
	Not aware	45	11.3
Blunt trauma	Aware	372	93.0
	Not aware	28	28
Cataracts	Aware	265	66.2
	Not aware	135	33.8
Foreign body in the eye	Aware	385	96.3
	Not aware	15	3.7
Retinal burns	Aware	175	43.8
	Not aware	225	56.3
Pterygium	Aware	187	46.8
	Not aware	213	53.2
Pinguecula	Aware	187	46.8
	Not aware	213	53.2

Frequency of ocular conditions associated with welding

Table 4 describes an assessment of how frequently ocular conditions related to welding- associated hazards occur among participants. The results reveal that the most common condition experienced by welders on a regular basis is foreign bodies falling in the eyes (n = 71, 17.7%) while welding, followed by Arc eye (n = 19, 4.8%). Majority of the welders either rarely or never experience the ocular conditions surveyed although they are aware of them. However, in the event of these conditions occurring, most welders (45.3%) prefer to

visit a doctor although a great majority also prefer to resort to *home-made remedies* (n = 181, 43.0%) for treatment rather than visiting a doctor, and 47 welders (11.7%) just ignore the symptoms until they self-resolve, Table 4.

Table 4. Frequency of ocular conditions associated with welding

Condition	Responses	Frequency (N=400)	(%) Frequency	P-value
Arc eye	Frequently	19	4.8	< 0.001
	Occasionally	92	23.0	
	Rarely	259	64.7	
	Never	30	7.5	
Blunt trauma	Frequently	4	1.0	< 0.001
	Occasionally	23	5.8	
	Rarely	133	33.3	
	Never	240	60.0	
Cataract	Frequently	2	0.5	< 0.001
	Occasionally	2	0.5	
	Rarely	23	5.8	
	Never	373	93.2	
Foreign bodies in eye	Frequently	71	17.7	0.003
	Occasionally	104	26.0	
	Rarely	125	31.3	
	Never	100	25.0	
Retinal burns	Rarely	18	4.5	< 0.001
	Never	382	95.5	
Pterygium	Frequently	1	0.3	< 0.001
	Rarely	101	25.3	
	Never	298	74.5	
Pinguecula	Frequently	1	0.3	< 0.001
	Rarely	98	24.5	
	Never	301	75.2	
Keratitis	Frequently	8	2.0	< 0.001
	Occasionally	47	11.7	
	Rarely	211	52.7	
	Never	134	33.5	
Preferred mode of treatment	Home remedies	172	43.0	< 0.001
	Visit a doctor	181	45.3	
	Ignore	47	11.7	

Association between awareness of welding as a source of ocular hazards and demographic characteristics of welders.

There was a statistically significant difference in the distribution of welders' awareness of welding as a potential source of ocular hazards across demographic factors Table 5.

In addition, we computed Chi-square statistics to determine which socio-demographic factors are associated with participants' awareness of *welding as a potential ocular hazards*. Our results show that participants awareness was not dependent on their age (X^2 (1, N = 400) = .22, p = 0.53, V = .02), gender (X^2 (1, N = 400) = .02, p = 1, V = 0.008), level of education (X^2 (1, N = 400) = 1.15, p = 0.34, V = .05), marital status (X^2 (1, N = 400) = 2.33, p = 0.19, V = .08), years of welding experience (X^2 (1, N = 400) = .13, p = 0.57, V = .02), monthly income (X^2 (1, N = 400) = .76, p = 1, V = .04) or number of hours spent on welding (X^2 (1, N = 400) = .02, p = 1, V = .008). However, we found that participants' awareness depended significantly on the type of welding they were engaged in (X^2 (1, N = 400) = 16.47, p < 0.001, V = .20), with about 90% of participants reporting their awareness of arc welding as a significant source of ocular hazards.

Further, we computed Chi-square statistics to examine the relationship between key socio-demographic factors and specifically participants'

a) awareness of the use of protective equipment against ocular hazards
b) awareness of the preferred mode of treatment for these ocular hazards.

We report that welders' use of face shields does not depend on their age (X^2 (1, N = 400) = .56, p = 0.60, V = .038), gender (X^2 (1, N = 400) = .48, p = 1, V = .035), level of education (X^2 (1, N = 400) = 0.69, p = .51, V = .042), marital status (X^2 (1, N = 400) = .059, p = 0.87, V = .012), years of welding experience (X^2 (1, N = 400) = .098, p = 0.74, V = .016), monthly income (X^2 (1, N = 400) = 1.02, p = 0.36, V = .051) or number of hours spent on welding (X^2 (1, N = 400) = .32, p = 1, V = .02). We found that participants' awareness of the use of face shields does not depend on the type of welding they were engaged in although the results trended towards statistical significance (X^2 (1, N = 400) = 5.14, p = 0.077, V = .11).

With respect to the preferred mode of treatment for ocular hazards, our results show that age

age (X^2 (2, N = 400) = .56, p = 0.052, V = .12), gender (X^2 (1, N = 400) = .86, p = 0.065, V = .047), level of education (X^2 (2, N = 400) = .23, p = 0.89, V = .020), marital status (X^2 (2, N = 400) = 3.40, p = 0.18, V = .092), years of welding experience (X^2 (1, N = 400) = 2.28, p = 0.32, V = .076), monthly income (X^2 (2, N = 400) = 1.83, p = 0.40, V = .068), number of hours spent on welding (X^2 (1, N = 400) = 2.96, p = 0.23, V = .086) or the type of welding engage in (X^2 (2, N = 400) = 2.97, p = 0.56, V = .061) were not associated with welders' awareness of the preferred mode of treatment for the ocular hazards from welding, Table 5:

Table 5. Association between awareness of welding as a source of ocular hazards and demographic characteristics of welders

Variables	Sub-groups	Do you know welding is a source of ocular hazard?		Total	P-value
Age group(years)		Yes	No		
	10 -20	12(3.0%)	0(0%)	12(3%)	0.53
	21-30	95(23.75%)	0(0%)	95(23.75%)	
	31-40	198(49.50%)	2(0.50%)	200(50.0%	
	41-50	81(20.25%)	1(0.25%)	82(20.50%)	
	>50	11(2.75%)	0(0%)	11(2.75%)	
Level of education	A-Level	87(21.75%)	0(0%)	87(21.75%)	0.36
	O-Level	157(39.25%)	1(0.25%)	158(39.50%)	
	Tertiary	51(12.75%)	1(0.25%)	52(13.0%)	
	Primary	69(17.25%)	0(0.0%)	69(17.25%)	
	None	33(8.25%)	1(0.25%)	34(8.5%)	
Welding experience (years)	1-5	97(24.25%)	1(0.25%)	98(24.5%)	0.42
	6-10	140(35%)	0(0.0%)	140(35%)	
	11-15	95(23.75%)	2(0.50%)	97(24.25%)	
	16-20	54(13.50%)	0(0%)	54(13.50%)	
	>20	11(2.75%)	0(0.0%)	11(2.75%)	
Type of welding	Arc welding	358(89.5%)	1(0.25%)	359(89.75%)	**< 0.001**
	Gas welding	8(2.0%)	1(0.25%)	9(2.25%)	
	Both Arc and gas welding	31(7.75%)	1(0.25%)	32(8.0%)	
Total		**397(99.25%)**	**3(0.75%)**	**400(100%)**	

DISCUSSION

The study assessed the awareness and knowledge of ocular hazards among welders in Bindura, Zimbabwe. Awareness of ocular hazards associated with welding was almost absolute. Majority of them were arc welders and reported using protective devices all the time. The predilection of males recorded in our study was similar to reports from other studies conducted in Africa, France and Pakistan.[12–18] The male dominance in welding could be as a result of the demand for physical strength involved in the welding profession which might be difficult for females to withstand. However, a contrary finding was recorded in a study in Hong Kong and this could be attributed to variations in settings or culture. [19]

The mean age of the study participants showed that they are in their productive years and have the physical strength necessary for welding profession. Similar findings were recorded by Sabitu et al and Budhathoki et al.[16,20] Contrary to our study findings, Isah and Okojie, recorded a younger mean age group of 20-29 years in their study in Benin, Nigeria. [14] The high rate of high school dropout reported in Nigeria could be the reason for the younger age recorded in this earlier study.

Consistent with the findings of previous studies was the high number of participants who had formal education. [11,14,16,20] This is good as formal education would help in appreciating the need for using safety devices. On the contrary, a good proportion of welders in studies conducted in Nigeria and Ghana had no formal education. [4,21,22] Discrepancy in the findings could be because welders in Africa are often trained through apprenticeship and formal education is not really required.

No school dropout was recorded in our study which was contrary to the 14 to 22% recorded in studies from Nigeria. [14] Nigeria has a high record of male school dropouts and that could be the reason for the high school dropout rate recorded among welders.[14] This suggests that the welders in Bindura are readily trainable compared to their counterparts in West Africa. This could explain the high level of awareness of ocular hazards and their association with welding recorded among the population studied.

Previous studies in developing countries showed that small skilled workers including welders receive low monthly incomes. [4,11,21,23] The informal method of recruitment and training without any proper certification coupled with no salary regulation could explain the reason for the low income. There is a need to standardize recruitment, and training methods for welders in developing countries in order to get proper certification and improve monthly income.

The predilection of electric arc welding recorded in this study is in line with findings from previous studies in Nigeria and Ghana. [1,4,12,13,16] Accessibility and affordability of arc welding could be the reason why it is the most practiced type of welding in Africa. Gas welding is always associated with explosions and that could be the reason why the majority of the welders do not prefer it. [1]

It is worthy to note that the majority of our study participants were aware of ocular hazards associated with welding. Our study findings were comparable to the awareness levels of 100%, 91% and 86.8% recorded in studies in Nigeria (2 studies) and Kenya, respectively but significantly higher than 77% and 55% reported in other studies in Nigeria (Kaduna) and Pakistan.[11,14–16,18,24] Variations in the socioeconomic profiles of participants could be the reason for the differences in the findings. For example, a good number of the participants in the current study have tertiary education and only a few had no formal education while majority of the participants in the study in Kaduna Nigeria were school drop-outs and a good number had no formal education. This further emphasizes the importance of formal education. In addition, variations in methods, study populations, definitions of hazard awareness, methods of data collection, and workplace conditions could be another reason for variations in the findings.

Awareness of ocular hazards was found to be associated with only the type of welding in our study. However, studies in Ethiopia and Kenya reported that awareness of ocular hazards was associated with the experience of more than six years.[25,26] In a study conducted in India, work safety regulation in the work place was reported to be associated with awareness of ocular hazards.[27] Job satisfaction, marital status and level of education were among factors reported to be associated with awareness of ocular hazards. [16] Strategies to increase the awareness of ocular hazards among welders are highly advised to reduce the prevalence of ocular injuries among welders.

The utilization rate of ocular protective devices among welders in this study was similar to that recorded in a study in Kenya but considerably higher than that reported in studies conducted in Nigeria, Nepal and Pakistan.[1,11,16,20,25] Availability of ocular protective devices in the work place could be the reason for the high utilization rate recorded in our study as the availability of protective devices could encourage utilization. Provision of ocular protective devices for welders in work places cannot be over emphasized. On the contrary, studies in Kenya reported low ocular protective device utilization because of the unavailability of the devices.[25] In addition,

type of welding, awareness of ocular hazards, experience, and level of education were reported to be significantly associated with the use of protective devices in a previous study contrary to the findings in this study.[25]

Discomfort has continuously been reported as the major reason for not using protective devices in the work place in various studies.[1,11] Improvement in the design of ocular protective devices to make them more comfortable for use by welders will encourage utilization and should not be ignored. Also, workplace policies to enforce the use of protective devices especially for welders will be helpful in reducing the prevalence of ocular injuries at workplaces.

Frequency of foreign body injuries recorded in our study is in line with findings from studies in Kenya and Nigeria.[15,25,28] The beating of metal cheats associated with welding exposes individuals to ocular foreign body related injuries if protective devices are not worn. This shows that regular utilization of ocular protective devices for welders cannot be over-emphasized. A good proportion of our study participants still resorting to homemade remedies in the event of ocular injuries is not surprising as it is a reported practice in developing countries.[11,21] Public education on the consequences of home remedies and the need to seek prompt eye care services in the events of any ocular injuries is highly advised. Also, workplace clinics for occupational healthcare should be established and regular medical check-ups should be encouraged for small skilled workers including welders.

ETHICAL CONSIDERATION

Ethical approval was obtained from "removed to ensure anonymity" with approval number 0017/2022. To avoid any sort of injury to the study subjects and curb the spread of COVID-19, ethical consideration procedures were followed and thorough sanitization of the workspace was done. The participants were given an informed consent form with a thorough description of the investigation. Participation in the study was entirely optional, and participants were free to leave at any moment.

STRENGTH AND LIMITATION

Our study had some limitations that should be acknowledged. Recall bias is associated with questionnaire-based studies. Our findings cannot be generalized since industrial welders were not included in our study. Further studies should include industrial welders and should be conducted as a qualitative study. Also, we could not determine confounding factors associated with this study. Despite our study limitations, to the best of our knowledge, this is the first study to provide insight into the awareness and knowledge of ocular hazards among welders in Zimbabwe. Our study sample size is large enough to represent welders in this community and our findings are valid as it gives insight into the awareness and knowledge of ocular hazards in Zimbabwe.

CONCLUSION AND RECOMMENDATIONS

The awareness and knowledge of ocular hazards among welders in Bindura are high. Although, protective devices are provided, regular utilization needs to be encouraged and enforced. Improving the design of the protective device will encourage their utilization in order to reduce the burden of ocular injuries among welders.

DISCLOSURE OF FUNDING

None

CONFLICTS OF INTEREST

All authors declare that they do not have any conflicts of interest.

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