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Research Article
(Araştırma Makalesi)

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Health and safety sign knowledge levels of tractor operators in agricultural production

Tarımsal üretimde çalışan traktör operatörlerinin sağlık ve güvenlik işaretleri bilgi seviyeleri

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ABSTRACT

Objective: Health and safety signs are critical in communicating messages about potential hazards, safe practices, emergency procedures, and regulatory guidelines. The objective of this study was to investigate the understanding of safety sign comprehension among tractor operators in Türkiye's agricultural sector. It seeks to determine operators' knowledge of occupational safety and health signs, traffic signs, and tractor safety signs.

Materials and Methods: A total of 118 tractor operators from Izmir's two districts (Menemen and Foça) were surveyed using a questionnaire. The questionnaire included demographic information, occupational safety and health signs (ISO 7010), traffic signs (Turkish Standards for Road Traffic Signage) and tractor safety signs (ISO 11684). Descriptive and inferential statistics were used to analyze the data.

Results: The mean comprehension score was 37.2% for fourteen occupational safety and health signs, 34.9% for seven traffic signs, and 28.0% for ten tractor safety signs. The mean comprehension score for all signs was 33.7%

Conclusion: This study shows that tractor operators poorly understand these signs. Engineering and administrative control measures, including training, should be considered to improve sign comprehension. In addition, the poorly understood signs should be revised to effectively convey the intended messages.

ÖZ

Amaç: Sağlık ve güvenlik işaretleri, potansiyel tehlikeler, güvenli uygulamalar, acil durum prosedürleri ve yasal talimatlar konusunda iletişim kurmada kritik role sahiptirler. Bu çalışmanın amacı, Türkiye tarım sektöründeki traktör operatörlerinin işaretleri anlama seviyelerini araştırmaktır. Araştırma, operatörlerin iş sağlığı ve güvenliği işaretleri, trafik işaretleri ve traktör güvenlik işaretleri hakkındaki bilgi düzeyini belirlemeyi amaçlamaktadır.

Materyal ve Yöntem: İzmir'in iki ilçesinden (Menemen ve Foça) toplam 118 traktör operatörü anket ile incelenmiştir. Anket, demografik bilgiler, iş sağlığı ve güvenliği işaretleri (ISO 7010), trafik işaretleri (Karayolu Trafik İşaretleri Standartları) ve traktör güvenlik işaretlerini (ISO 11684) içermektedir. Verilerin analizi için tanımlayıcı ve çıkarımsal istatistikler kullanılmıştır.

Araştırma Bulguları: Ortalama doğru cevaplanma oranı on dört iş sağlığı ve güvenliği işareti için %37.2, yedi trafik işareti için %34.9 ve on traktör güvenlik işareti için %28.0 olarak bulunmuştur. Tüm işaretler için ortalama doğru cevaplanma oranı %33.7 olarak hesaplanmıştır.

Sonuç: Bu çalışma, traktör operatörlerinin sağlık ve güvenlik işaretlerini tanıma seviyesinin düşük olduğunu göstermektedir. İşaretleri tanıma seviyesini artırmak için eğitim verilmesini de içeren yönetimsel ve mühendislik kontrol önlemleri dikkate alınmalıdır. Ayrıca, anlaması zor olan işaretlerin amaçlanan mesajları etkili bir şekilde iletebilmesi için tasarımlarının tekrar gözden geçirilmesi gerekmektedir.

INTRODUCTION

The agricultural sector, which provides the fundamental element of life, nutrition, is one of the most important sectors in economic, social, and cultural terms. With the advent of the industrial revolution in agriculture, mechanization has become widespread to facilitate tasks that were previously carried out by hand. In recent years, the increased use of agricultural mechanization in Türkiye has brought about occupational safety and health risks in a sector where labor-intensive activities are predominant. Workers are adversely affected by occupational injuries and illnesses, which could potentially result in either a temporary or permanent reduction in their ability to work (Akkaya, 2007). According to the International Labour Organization (ILO), of the world's 1.3 billion agricultural workers, who make up half of the global labor force, 170,000 workers die each year, with a significant proportion suffering serious injuries or contracting occupational illnesses (ILO, 2023). It is estimated that about half of the fatal accidents in 1.95 million occupational accidents worldwide occur in the agricultural sector (Güven, 2012). According to the Turkish Statistical Institute (TÜİK) for the year 2022, the average number of people employed in agriculture is close to 4.9 million, and the share of agriculture in total employment is 15.8% on average (TÜİK, 2023). Based on the statistics of Work Accidents and Occupational Diseases, 3,059 occupational accidents and 19 fatalities were reported for 2021 (SGK, 2021). In the same year, the total number of days of temporary incapacity including outpatient and inpatient treatment was 32,767.

The literature reports that agricultural machinery used in agricultural activities is one of the main causes of accidents in the sector (Öz, 2005; Yurtlu et al., 2012; Vigoroso et al., 2019). One of the most important power vehicles used in agricultural production is tractors. Baesso et al. (2014) have reported that tractors a pose significant risk to agricultural workers, both physically and ergonomically. In regions where agricultural activities are widespread in Türkiye, accidents involving fatalities, injuries, or disabilities frequently occur due to tractors and the machinery attached to them (Kayhan et al., 2019). About half of tractor accidents are due to overturning and rollover (Öz, 2005; Güven, 2012). Reynolds et al. (2000) studied tractor overturn accidents resulting in fatalities and demonstrated the significant accident-preventing effect of Roll-Over Protective Structures (ROPS). A study conducted by Öz (2005) found that 54% of tractors removed the ROPS for specific reasons, including difficulty in getting under trees. In addition, an analysis of 880 tractor and 1,167 agricultural machinery accidents in Türkiye by Gölbaşı (2002) found that 80% of the operators involved in accidents had not read the machine's operation and maintenance manual and that 82% of tractors involved in accidents did not have a ROPS.

The reasons for agricultural workers' lack of awareness of occupational safety and health are similar to those in less developed and developing countries. The low level of education, the high proportion of female and child workers, and the large number of seasonal workers contribute to this problem (Eldeş, 2022). In a study conducted by Caffaro et al. (2017) in Italy, they investigated the familiarity of 248 tractor operators with twelve different ISO 11684 safety pictorials. In this study, operators were asked about the meanings of these signs before and after the training. According to the results, the training provided increased the knowledge level of participants, and it was reported that such training should be repeated regularly. In a study conducted by Kayhan et al. (2019) in Kırıkkale province (Türkiye), it was reported that 84.2% of tractor operators did not participate or receive any training in occupational safety and health.

Various control measures, including engineering and administrative controls, are used to prevent accidents in agriculture (Arphorn et al., 2003; Chan et al., 2009; Chan & Ng, 2010a; Ng et al., 2011; Davoudian Talab et al., 2013; Zamanian et al., 2013; Yazdani et al., 2017). Occupational safety and health signs are among the most important ones. Understanding the scope and meaning of these signs is critical to prevent occupational accidents. In addition, the proper understanding and comprehensibility of

such signs, as well as the accurate communication of the intended message, have become increasingly important over time. Numerous studies (Easterby & Hakiel, 1981; Brelsford et al., 1994; Wogalter et al., 1997; Blake Huer, 2000; Piamonte et al., 2001; Smith-Jackson & Essuman-Johnson, 2002; Arphorn et al., 2003; Lesch, 2003; Shinar et al., 2003; Hancock et al., 2004; Liu et al., 2005; Chan et al., 2009; Lesch et al., 2009, 2011; Chan & Ng, 2010b; Ng et al., 2011; Cavalcanti & Soares, 2012; Liu & Ho, 2012; Yazdani et al., 2017; Bagagiolo et al., 2018, 2019; Alara et al., 2019; Vigoroso et al., 2020; Güngör, 2023) have been conducted in this regard. They provide directional insights. For example, the studies conducted by Arphorn et al. (2003) and Güngör (2023) showed that workers do not fully understand occupational safety and health signs, which means that the intended message is not conveyed correctly.

In 2015, the member states of the United Nations (UN) jointly adopted a collection of seventeen Sustainable Development Goals (UN, 2022). Among these goals, the eighth focuses on promoting sustainable economic progress, improving employment prospects, and ensuring decent work for people around the world. Specifically, this goal is about upholding labor rights and ensuring the promotion of a safe and healthy work environment for all workers by 2030. The current study aims to assess personal comprehension of safety signs among tractor operators in Türkiye. The objective of the study was to determine the level of knowledge of tractor operators engaged in agricultural production regarding occupational safety and health signs, traffic signs, and tractor signs. In addition, this study aims to determine if these signs effectively convey the intended message to the target audience. A more comprehensive understanding of sign design factors has the potential to empower safety experts in devising safer workspaces, aligning with the goals outlined by the UN.

MATERIALS and METHODS

Sample

Participants in the present study were recruited from individuals engaged in agricultural production and holding a tractor driving license. A total of 118 tractor operators were randomly selected from the Menemen and Foça districts within the boundaries of Izmir province. They all voluntarily participated in the study. Before participating, all participants were provided with an informed consent document outlining the study's purpose, procedures, as well as the potential advantages and risks of their involvement. It was a prerequisite for participants to review and endorse the consent document before addressing any inquiries. Importantly, the researchers meticulously adhered to all ethical principles, standards, and directives outlined in the Belmont Report (1978), the Nuremberg Code (1949), and the Declaration of Helsinki (1964) to safeguard the autonomy, privacy, confidentiality, and well-being of the participants. This study received approval from the Social Sciences Ethics Committee of Izmir Katip Celebi University (ethical approval number: SAE 2023/07-05 on 28.03.2023).

Data collection

A questionnaire survey was conducted to assess tractor operators' understanding of safety signs and traffic signs in the agriculture sector. The questionnaire consisted of four sections. The first section gathered information about the subjects' demographics and background knowledge of occupational safety and health. The subsequent section presented multiple-choice questions related to the meanings of safety signs. Fourteen safety signs, as defined by the International Organization for Standardization (TS EN ISO 7010, Graphical Symbols - Safety Colors and Safety Signs - Registered Safety Signs) (ISO 7010, 2019), were included. Each multiple-choice question comprised one correct option and three incorrect yet plausible choices, adapted from Caffaro et al. (2017, 2018)

and Güngör (2023). Participants were required to select the correct answer that they believed to be correct, even if uncertain about the sign's meaning. They were informed that the study focused on their personal interpretation of the signs. The third section contained seven open-ended questions concerning traffic signs, as prescribed by the Turkish Road Traffic Signage Standards (KGM, 2020). Participants were tasked with explaining the meanings of these signs in writing. The final section included ten open-ended questions, each featuring a two-panel safety label outlined in the ISO 11684 standard (Tractors, Machinery for Agriculture and Forestry, Powered Lawn and Garden Equipment - Safety Signs and Hazard Pictorials) (ISO 11684, 2023). The two-panel safety label comprises a hazard description panel and a hazard avoidance panel in a vertical configuration. The hazard description panel contains either a hazard description pictorial enclosed by the safety alert triangle or an exclamation mark enclosed by the safety alert triangle. The hazard avoidance panel contains one hazard avoidance pictorial. All signs used in the survey were randomly selected from those commonly employed within the agriculture sector.

It should be noted that multiple-choice questions were chosen for assessing ISO 7010 workplace safety signs due to their prior use in studies with established validity analyses. This consistency allowed for comparisons across different sectors and cultures. In contrast, open-ended questions were chosen for traffic and ISO 11684 signs to gather more detailed and nuanced information in areas where multiple-choice questions had not been previously utilized, allowing for richer insights and the potential to inform the development of future multiple-choice questions based on the open-ended responses.

Statistical analyses

Descriptive statistics were calculated on subjects' demographics and their self-reported knowledge of occupational safety and health. Pearson's chi-square statistical tests were applied to determine the relationship between subjects' demographic characteristics and correct response to a sign. The significance level for this study was set at a probability level of 95% ($p \leq 0.05$). All statistical analyzes were performed using IBM SPSS Statistics for Windows, Version 22.0.

RESULTS and DISCUSSION

Demographic data and background of study subjects

Participants were asked to provide their demographic information and indicate their familiarity with occupational safety and health. Almost all participants (99.2%) were male. The average age of all subjects was 46.4 (SD = 12.2) years, and the majority of participants (73.7%) fell within the age range of 30 to 59 years. Slightly over half of the participants had completed elementary school. A significant proportion of operators (86.4%) had held a driver's license for over 10 years. Within this group, 56.0% had accumulated 20 years or more of driving experience. The majority (72%) had undergone safety training, though only 9.3% of them rated their level of safety knowledge as high or very high. The demographic details of the participants are presented in Table 1.

Tractor operators' comprehension levels on occupational safety and health signs

To gauge the levels of familiarity with occupational safety and health signs according to the relevant standard (ISO 7010) and to indirectly evaluate the accuracy of the intended messages conveyed by these signs, 118 tractor operators, who participanted in the study, were surveyed. The outcomes related to their responses to these inquiries are tabulated in Table 2.

Table 1. Demographic data of the study participants.

Çizelge 1. *Çalışmaya katılanların demografik özellikleri.*

Variable	Category	n	%
Gender	Male	117	99.2
	Female	1	0.8
Age (years)	20-29	12	10.2
	30-39	27	22.9
	40-49	28	23.7
	50-59	32	27.1
	≥ 60	19	16.1
City district	Menemen	77	65.3
	Foça	41	34.7
Educational level	Elementary school	61	51.7
	High school	30	25.4
	Higher education	27	22.9
Driver license possession (years)	0-10	16	13.6
	11-20	36	30.5
	≥ 21	66	55.9
Driving experience (years)	0-10	36	30.4
	10-20	16	13.6
	≥ 20	66	56.0
Safety training	Yes	85	72.0
	No	33	28.0
Self-assessment of safety knowledge	Very little	30	25.4
	Little	31	26.3
	Average	46	39.0
	High	9	7.6
	Very high	2	1.7

Table 2. The distribution of knowledge levels of tractor operators regarding ISO 7010 occupational health and safety signs.

Çizelge 2. *Traktör operatörlerinin ISO 7010 iş sağlığı ve güvenliği işaretleri hakkındaki bilgi düzeylerinin dağılımları.*

ISO Number	Sign	Choices for the meaning of the sign*	n	%	C/I** (%)
F001		**Location of fire extinguisher**	48	40.7	40.7
		It can catch fire	9	7.6	59.3
		Do not expose the fire extinguisher to heat	31	26.3	
		Place the fire extinguisher upright	30	25.4	
-		**First aid**	92	78.0	78.0
		Mosque area	3	2.5	22.0
		Night work continues	12	10.2	
		Emergency assembly area	11	9.3	
W017		**Hot surface**	60	50.8	50.8
		Food service area	3	2.5	49.2
		The engine is heating up	14	11.9	
		There is vaporization	41	34.7	

Table 2. *(Contiuned)*

Çizelge 2. (Devamı)

ISO Number	Sign	Choices for the meaning of the sign*	n	%	C/I** (%)
E016		**Emergency window with escape ladder**	69	58.5	58.5
		Do not lean out of the window	15	12.7	41.5
		In case of an earthquake, exit through the window	13	11.0	
		Emergency exit door	21	17.8	
M021		**Disconnecting the machine or equipment before carrying out maintenance or repair**	61	51.7	51.7
		The train changes track	31	26.3	48.3
		Pull the handle to stop	10	8.5	
		Change the line	16	13.6	
W025		**Counterrotating rollers**	34	28.8	28.8
		Risk of hand entrapment	32	27.1	71.2
		Change the belt	36	30.5	
		Crushing is being done	16	13.6	
P069		**Not to be serviced by users**	15	12.7	12.7
		Do not place hand tools	50	42.4	87.3
		There is no service available	48	40.7	
		Toolkit is not present	5	4.2	
P011		**Do not extinguish with water**	63	53.4	53.4
		No open fire	19	16.1	46.6
		No fire	21	17.8	
		Do not extinguish the fire	15	12.7	
W016		**Toxic material**	25	21.2	21.2
		Electrical hazard	18	15.3	78.8
		Danger of death	53	44.9	
		High voltage	22	18.6	
M038		**Start engine in launch sequence**	26	22.0	22.0
		The gear is turning to the right	37	31.4	78.0
		Watch out for the saw	23	19.5	
		Piston is moving	32	27.1	
E003		**First aid**	33	28.0	28.0
		Pharmacy area	12	10.2	72.0
		Emergency assembly point	45	38.1	
		Red Cross organization gathering area	28	23.7	
P012		**No heavy load**	24	20.3	20.3
		Do not weigh the load	59	50.0	79.7
		An object can fall	25	21.2	
		The scale can malfunction	10	8.5	
M029		**Sound horn**	43	36.4	36.4
		Do not sound horn	25	21.2	63.6
		Caution, very high horn sound	38	32.2	
		Horn can be played at certain times	12	10.2	
W018		**Machinery may start automatically**	21	17.8	17.8
		Low temperature/freezing conditions	9	7.6	82.2
		Heavy wind	52	44.1	
		Biological hazard	36	30.5	

*Correct answers are given in bold. The sequence of signs in the table corresponds to the order they appeared in the questionnaire.

** C/I: Correct/Incorrect.

The overall mean comprehension score for the fourteen safety signs was 37.2%, with a standard deviation of 19.0%, indicating a poor level of comprehension in accordance with the ISO standard. The comprehension scores for each individual sign ranged from the lowest score of 12.7% to the highest score of 78.0%. Only one sign (Red Crescent symbol for First Aid) achieved a comprehension score of 67% or higher, as established by the acceptance criterion for safety-related symbols in ISO 3864 (ISO 3864-1, 2011; ISO 3864-3, 2012). None of the fourteen signs achieved a comprehension score greater than 85%, a threshold specified as an acceptance criterion in ANSI Z535.3-2022 (ANSI Z535.3, 2022).

For five signs, the mean comprehension score ranged from 40.7% to 58.5%, while for nine signs, it was even lower than 40%. The average comprehension score for emergency signs (54.8% for three emergency signs) was higher than that for other signs (28.8% for three prohibition signs, 29.7% for four warning signs, 36.7% for three mandatory signs, and 40.7% for one fire safety sign).

The overall mean (37.2%) of comprehension score in the present study was similar to Arphorn et al. (2003)'s scores in safety sign perception (39.2%), but smaller than most studies 63.8% (Chan et al., 2009), 66.2% (Chan & Ng, 2010a), 67.5% (Ng et al., 2011), 69.2% (Davoudian Talab et al., 2013), 70.9% (Zamanian et al., 2013) 78.4% (Davoudian Talab & Azari, 2017), 63.4% (Yazdani et al., 2017), and 66.6% (Güngör, 2023). The differences can be attributed to different backgrounds (e.g., ethnic, cultural) or different experimental designs (e.g., sign selection). Some previous studies (Blake Huer, 2000; Piamonte et al., 2001; Smith-Jackson & Essuman-Johnson, 2002; Shinar et al., 2003; Chan et al., 2009; Lesch et al., 2009) indicated that different cultural backgrounds might lead to differences in sign perception. For example, the first aid sign with the red crescent was answered correctly by 78.0% while its equivalent and internationally accepted version sign (green squared sign with white cross pictorial on it) was only answered by 28.0%. In the present study, statistical analyzes could not suggest any significant and meaningful relationship between demographic properties and answering the sign correctly.

Tractor operators' comprehension levels on traffic signs

Participants were asked to interpret the meaning of each traffic sign as prescribed by the Turkish Road Traffic Signage Standard (Karayolu Trafik İşaretleri Standartları 1, KGM, 2020). The distribution of the participants' answers can be found in Table 3. The average number of correct answers was 34.9% (SD = 19.6%) for the seven traffic signs. The lowest comprehension score (14.4%) was obtained for the 'Controlled railway crossing' sign, while the highest score (72.0%) was obtained for the 'Maximum speed limit' sign. Only one sign ('Maximum speed limit') had a comprehension score higher than 50%.

The low knowledge level of tractor operators indicates that they may cause accidents because they do not sufficiently understand the traffic instructions. For example, only 31.4% of operators correctly interpreted the meaning of the 'No entry for tractors' sign. In other words, 68.6% of operators do not understand the meaning of the sign, which may cause them to drive on roads where they are not allowed to drive. This lack of understanding could pose an accident risk to themselves and others. The number of accidents might be reduced by training of operators (Görücü Keskin et al., 2012). Therefore, improving operator knowledge through targeted training and education is imperative for ensuring safety, reducing accidents, and enhancing overall agricultural efficiency. It should be noted that farm vehicles are not primarily designed for road transportation and often share roads with other motorists, potentially resulting in hazardous situations and severe crashes due to their large size and slow-moving nature (Karimi & Faghri, 2021). The vehicle's large dimensions not only complicate maneuverability but also enlarge driver blind spots, obstructs the view of other drivers, and heightens the risk of collisions with oncoming and passing vehicles. In addition to physical cumbersomeness, unsafe behaviors by tractor operators, such as a lack of sign interpretation and failure to adhere to rules, pose risks to both their own safety and that of other road users.

Table 3. The distribution of knowledge levels of tractor operators regarding the Turkish Road Traffic Signage Standard signs.

Çizelge 3. *Traktör operatörlerinin karayolu trafik işaretleri standartları işaretleri hakkındaki bilgi düzeylerinin dağılımları.*

			Correct Answer	
Code	**Sign**	**Meaning of the sign**	**n**	**%**
TT-15		No entry for tractors	37	31.4
T-21		Uncontrolled intersection	26	22.0
T-33a		Dangerous left curve	58	49.2
T-25		Controlled railway crossing	17	14.4
TT-41a		Minimum mandatory speed	30	25.4
TT-29a		Maximum speed limit	85	72.0
TT-1		Yield	35	29.7

Tractor operators' comprehension levels on tractor safety signs

Tractor operators were also asked about the meaning of the signs prescribed by the ISO 11684 standard (Tractors, machinery for agriculture and forestry, powered lawn and garden equipment - Safety labels). These signs are affixed to the tractor or machine to warn operators of potential hazards. The distribution of the subjects' responses to these signs are given Table 4.

The responses to the ten open-ended questions sourced from the ISO 11684 standard were assessed by a safety expert. The accuracy of answers for the two-panel safety labels was determined based on whether they were fully or partially correct; otherwise, they were considered incorrect. The mean comprehension score for the ten pairs of signs was 28.0%, with a standard deviation of 16.2%. The lowest score (6.8%) was recorded for the 'Shut off engine and remove key before performing maintenance or repair work' sign, while the highest score (39.8%) was achieved for the 'Do not ride on machine except for in supplied seat' sign.

Table 4. The distribution of knowledge levels of tractor operators regarding ISO 11684 tractor safety signs.

Çizelge 4. *Traktör operatörlerinin ISO 11684 tractor güvenlik işaretleri hakkındaki bilgi düzeylerinin dağılımları.*

Sign	Meaning of the sign	Correct Answer		Sign	Meaning of the sign	Correct Answer	
		n	%			n	%
	Read operator manual	31	26.3		Keep a safe distance from rotating parts	45	38.1
	Do not open or remove safety shields while engine is running	34	28.8		Stay a safe distance from the machine to avoid crushing torso (force applied from side)	32	27.1
	Do not ride on machine except for in supplied seat	47	39.8		Stay clear of hot surface	26	22.0
	Always lock ROPS in upright position unless it has to be folded down to allow operation underneath trees or brushes.	41	34.7		Stay clear of articulation area while engine is running	23	19.5
	Do not drive on slopes where machine could slip or tip	43	36.4		Shut off engine and remove key before performing maintenance or repair work.	8	6.8

According to a study by Öz (2005), it was revealed that 90% of operators transport individuals on tractors. It is worth noting that transporting people on tractors is also prohibited by traffic laws. Some preventive measures for the unsafe behavior of transporting individuals on tractors should be taken by promoting safe practices, implementing training programs and raise awareness among tractor operators about the potential hazards associated with carrying passengers. Operators should be educated about the structural limitations and potential instability caused by added weight.

Tipping-over incidents are alarmingly frequent (Reynolds & Groves, 2000; Öz, 2005; Görücü Keskin et al., 2012; Güven, 2012; Keskin et al., 2016; Pessina & Facchinetti, 2017). To mitigate the risk of tipping over, the protective bar (ROPS) should always remain locked in an upright position, except when it needs to be folded down for operations around trees or bushes. It's also advisable to avoid driving on sloping terrain to prevent tipping-over accidents. Studies suggest that accidents can be reduced through effective training, particularly when it includes hands-on instruction regarding the proper utilization of

ROPS and seat belts, as well as the inspection and correct installation of safety equipment on tractors (Pate et al., 2019; Karimi & Faghri, 2021).

Other most common tractor incidents are due to entanglement of body parts in moving machinery, and involved crashing into other vehicles or obstacles (Görücü Keskin et al., 2012). In the present study, tractor operators correctly answered signs 'Keep a safe distance from rotating parts,' 'Do not open or remove safety shields while engine is running,' 'Stay a safe distance from the machine to avoid crushing torso,' and 'Stay clear of articulation area while engine is running' signs at rates of 38.1%, 28.8%, 27.1%, and 19.5%, respectively. The low levels of sign comprehension may indicate that tractor operators are not aware of these hazards, which may explain why these incidents are common.

CONCLUSIONS

Safety signs placed in workplaces, on roads, or on agricultural machinery have significant potential as effective communication tool. Their role is to communicate important messages about accident prevention, fire safety, health hazards, emergency evacuation protocols, traffic regulations, and safe work practices. However, the results of this study reveal a concerning trend wherein these signs were generally poorly understood by tractor operators. The average comprehension score for the thirty-one signs stood at 33.7%, with a standard deviation of 16.7%. These scores further break down to 37.2% for fourteen occupational safety and health signs, 34.9% for seven traffic signs, and 28% for ten tractor safety signs. It is noteworthy that only six (19.4%) of the thirty-one signs attained a comprehension score exceeding 50%. Overall, the results underscore the urgent need for more attention to effective risk communication. One possible avenue for improvement is through the provision of safety sign training programs tailored specifically for tractor operators.

Previous studies showed that safety sign training has a positive effect on improving comprehension (Anger et al., 2006; Xu & Zheng, 2021). Future research could explore different approaches to determine which methods are most appropriate for tractor operators. For example, adopting a user-centered design approach to training materials could enhance learning efficacy (Vigoroso et al., 2020). Frequent training sessions could also serve as reminders and reinforcements (Caffaro et al., 2017). Consequently, future studies could investigate the frequency of follow-up training sessions to develop optimal training programs.

The results of the study also highlighted the possibility that certain safety signs are inadequately designed, as evidenced from the limited comprehension by the majority of tractor operators. This indicates the potential necessity for reevaluating the design of such signs. Overall, this study aims to contribute valuable insights to the existing knowledge base concerning safety signs within the agriculture sector.

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