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# Determinants of Safety and Health Behaviors of Wheat Farmers towards the Use of Chemical Pesticides in Qorveh County

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## Abstract

The poisoning of farm workers with pesticides is a common job hazard caused by the application of pesticides, especially in developing countries. Agriculture is directly related to the environment including water resources, and farming behaviors can entail a plethora of positive or negative effects on these vital resources. So, the present study aimed to explore the safety and health behaviors of wheat farmers towards the use of chemical pesticides in Qorveh County in Kurdistan province, Iran. The statistical population of this applied research consisted of all irrigated wheat farmers in the 2019-2020 crop year (N = 1700) in Qorveh County. The sample size was determined to be 170 people by Cochran's formula, and the random multistage technique was adopted for data collection. The main research instrument was a questionnaire whose content validity was checked by a panel of experts and the average variance extracted (AVE) index. Also, its reliability was estimated by Cronbach's alpha and the Cumulative Reliability (CR) coefficient. The results of the structural equation modeling (SEM) showed that the variables of the information source, attitude, and knowledge of chemical pesticide application accounted for 79 percent of the variance in the factors affecting the safety and health behaviors of wheat farmers as to the application of these pesticides. Considering the significant relationship that information source, attitude, and knowledge have with safety and health behaviors, it is recommended to hold training courses to familiarize wheat farmers with the hazards of conventional farming practices and the benefits of IPM practices by the organizations in charge, e.g. Agricultural Jihad Organization. This will foster a positive attitude among the farmers to adopt safety and healthy behaviors.

### Keywords:

Attitude; chemical pesticide; knowledge; safety and health behavior; wheat farmers

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## INTRODUCTION

The agricultural sector has a specific place in the economy of Iran as it is the main pillar of its development so that it accounts for almost 25 percent of the gross domestic product, 33 percent of non-oil exports, 33 percent of employment, and food supply for over 80 percent of the population (Bondori et al., 2018). It is projected that the population of Iran will reach 101 million by 2050 (Statistical Centre of Iran, 2021). So, optimal and sustainable management of vital water and soil resources in the agricultural sector will undoubtedly play a significant role in guaranteeing economic growth and avoiding dependence on other countries in crop production (Bigdeli & Sedighi, 2010). Given the vital role of agriculture in the economy, efficient and productive manpower is, on the other hand, the driving force of this sector (Jones et al., 2020). A major parameter that can contribute to improving the efficiency and productivity of the agricultural sector is to satisfy the occupational safety and health of farmers, which will prolong their careers. In other words, safe crops can be expected to be produced by safe farmers (Jamshidi & Rezaei, 2017). Farmer health is a key issue in the sector. The population has more than doubled since 1960. In this regard, and for increasing food production, pesticides are widely used for the protection of crops, foodstuffs, and other agricultural products against pests as well as for the control of disease vectors (Yazdanpanah et al., 2019). The coronavirus disease 2019 (COVID-19) and the related occupational safety and health risks highlight the importance of health and working conditions in the sector (Jones et al., 2020). Farming is the third most hazardous job after mining and building industries (Karami et al., 2015; Bondori, 2018). Over 60 percent of agricultural workers report having a limiting chronic disease and high levels of cardiovascular disease (Jones et al., 2020). According to an EU survey in 2012, workers from the agricultural sector were more likely to report that their work affected their health

than those in any other sector (Eurofound, 2017; Jones et al., 2020). There are several risks that farmers face in their production activities (Cecchini et al., 2018). A factor that jeopardizes farmers' health is chemical pesticides. Farmers are exposed to pesticides, fertilizers, and a wide range of other hazardous substances in farming (Sookhtanlou et al., 2022). According to the US Occupational Safety and Health Administration, workers may be exposed to pesticides in a variety of ways, including working in a field where pesticides have recently been applied, breathing in pesticide 'drift' from adjoining or nearby fields, working in a pesticide-treated field without appropriate personal protective equipment, eating with pesticide-contaminated hands, eating contaminated fruits and vegetables, and eating in a pesticide-contaminated field. Workers may also be exposed to pesticides if they drink from, wash their hands in, or bathe in irrigation canals or holding ponds, where pesticides can accumulate (Jones et al., 2020; Cechini et al., 2018). Given these risky potential conditions, farmers need to take specific safety behaviors to cope with their side effects and the diseases caused by them (Jones et al., 2020; Ghala-vandi et al., 2018). Inappropriate use of chemical pesticides reduces the sustainability of agriculture due to environmental issues on the one hand and brings about harmful effects on the health and safety of farmers and customers on the other (Sabzian Mollaei et al., 2015). The handling of chemical pesticides, e.g. their preparation, application, and storage, has many hazards for farmers, farm owners, and those who keep pesticides (Cecchini et al., 2018; Bondori et al., 2018). Most health and environmental issues arising from pesticide use are related to developing countries where they are brought about by the application of cheap, but dangerous, pesticides and non-standard equipment so that about 20,000 cases of death by pesticide poisoning are reported every year (Molaei, 2013). Undoubtedly, poisoning caused by the unsafe use of these chemicals is the most prevalent

and serious occupational risk that farmers in developing countries are exposed to (Weng & Black, 2015) whose reason can be sought in farmers' incorrect perceptions and poor knowledge as well as the lack of regulations (Fan et al., 2015). Some farmers face a higher risk of poisoning as they ignore safety behaviors towards pesticides (Sookhtanlou et al., 2022). Despite the environmental, economic, health, and social costs of pesticides, researchers argue that farmers in developing countries will keep using pesticides (Yazdanpanah et al., 2019). In addition, poisoning with organophosphates has been reported to be the third important cause of poisoning and the leading cause of mortality by poisoning in Iran (Bakand et al., 2012). In brief, farmers are directly exposed to chemical pesticides in various ways, and their behaviors can produce many positive or negative impacts.

Some scholars suggest that the first step in planning for the alleviation of pesticide hazards is to conduct research on farmers' knowledge, attitudes, and behaviors toward the application of pesticides in farming practices (Coman et al., 2020; Bondori et al., 2018). Extensive research has been done on farmers' safety and healthy behaviors towards the application of chemical pesticides. In a study conducted in Turkey, Gün and Kan (2009) reported that only 57 percent used protective equipment, such as masks, gloves, and specific costumes, when applying pesticides and 1 percent did not do any health measures such as changing their clothes and bathing after the use of pesticides. Bondori et al. (2018) observed healthier behavior toward chemical pesticide use in farmers who were more satisfied with farming, who had a second job, and who had a higher educational background. Aghilinejad et al. (2006) and Neghab et al. (2013) reported that 68 and 85 percent of farmers did not use personal protective equipment during pesticide application, respectively. Ghalavandi et al. (2018) assessed the safety behavior of farmers during the chemical pesticide application to be in a poor state.

Some researchers have concluded that education can be effective in enhancing safety behaviors (Karami et al., 2015). Coman et al., (2020) stated that education aims to increase farmers' health and safety by encouraging them to adopt health-enhancing behaviors. Sankoh et al. (2016) reported that 71 percent of farmers lacked adequate knowledge, information, and training as to the correct way of pesticide application. A study in Greece indicated that farmers with poisoning background used protective equipment like hats, boots, gloves, and goggles to a greater extent than those with no poisoning background (Damalas & Abdollahzadeh, 2016). There are also reports on such symptoms as skin effects, burning eyes, diarrhea, itching, headache, vertigo, nausea, and stomachache among farmers using chemical pesticides (Sankoh et al., 2016; Bondori et al., 2018; Jones et al., 2020). In this regard, it must be mentioned that education tries to enhance not only knowledge but also skills, attitudes, and practices that serve to prevent accidents and maintain good health (Coman et al., 2020). Some researchers have hypothesized that knowledge and consciousness influence people's behaviors. In most works, lack of knowledge has been implicated as a major barrier against environmentally desirable behaviors (Hutter et al., 2018). Lack of knowledge and training courses is the main parameter involved in the expansion of unfavorable use of pesticides (Sookhtanlou et al., 2022). Some have also mentioned that inadequate knowledge of pesticides is a reason for the non-use of protective equipment by farmers (Gaber & Abdel-Latif, 2012; Karunamoorthi & Yirgalem, 2013; Jones et al., 2020). The effect of knowledge on safety and health behavior has also been studied extensively (Ghalavandi et al., 2018; Isin & Yildirim, 2007; Bondori et al., 2018; Hooshmandan Moghaddam Fard & Shams, 2016; Salameh et al., 2004). Some scholars have stated that the information source plays a remarkable role in farmers' safety behaviors. As such, extensive works have also dealt with

the impact of information sources on behavior (Sookhtanlou et al., 2022; Bondori et al., 2018; Hooshmandan Moghaddam Fard & Shams, 2016; Monfared et al., 2015).

Various studies have revealed that people's attitudes have a significant effect on their safety behaviors toward chemical pesticides (Ghalavandi et al., 2018; Nazarian et al. 2009; Isin & Yildirim, 2007; Bondori et al., 2018; Yazdanpanah et al., 2019). The behaviors adopted by the people of a community are rooted in their attitudes and beliefs and as long as these beliefs are not changed or replaced with more appropriate behaviors, there will be no guarantee that personal risk factors can be mitigated in the community (Ghobadi et al., 2016). People do not always have a correct attitude towards chemical risk. A study was conducted in Brazil to analyze the perception of risk related to exposure to pesticides. It showed that protection strategies were used more frequently by men than by women. The perception of risk and working practices are influenced by cultural models and premises that need to be taken into account to develop effective intervention strategies, including communication strategies on risk prevention (Cecchini et al., 2018)

It has been argued that knowledge or information is a necessary prerequisite for all attitudes (Sookhtanlou et al., 2022). If people are not compelled that a factor is involved in the degradation of the environment, they will not have a negative attitude toward that factor. In fact, a human's knowledge of the environment dictates their attitude towards the environment (Cecchini et al., 2018). Various studies have addressed the impact of knowledge on attitudes (Sookhtanlou et al., 2022; Yazdanpanah et al., 2019; Cecchini et al., 2018; Ghalavandi et al., 2018; Bondori et al., 2018; Hooshmandan Moghaddam Fard & Shams, 2016; Yilmaz, 2015; Nazarian et al., 2009).

According to what was said, the agricultural sector including wheat farmers are in the frontline of working with chemicals and their behaviors can have significant positive or

negative impacts on their own health, the food security of society, and the environment. So, it is imperative to soundly manage the producers of the agricultural sector, including wheat farmers, when they are applying chemical pesticides. Accordingly, different studies have pointed out that the most important variables discriminating the health and safety behaviors of farmers were farmers' information sources, attitudes, and knowledge. So, this research aimed to explore the safety and health behaviors of wheat farmers in Qorveh County, Iran. As such, the following hypotheses were examined in the context of the theoretical framework of the study (Figure 1):

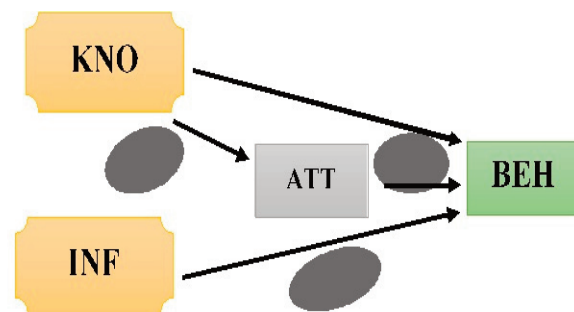


Figure 1. The Conceptual Model of the Research (BEH = behavior, ATT = attitude, KNO = knowledge, and INF = information source)

*Hypothesis 1:* There is a significant relationship between attitude toward chemical pesticides and wheat farmers' safety and health behavior in using chemical pesticides.

*Hypothesis 2:* There is a significant relationship between knowledge of chemical pesticides and wheat farmers' safety and health behavior in using chemical pesticides.

*Hypothesis 3:* There is a significant relationship between information sources and wheat farmers' safety and health behavior in using chemical pesticides.

*Hypothesis 4:* There is a significant relationship between knowledge of chemical pesticides and wheat farmers' knowledge of using chemical pesticides.

## METHODOLOGY

This research was an applied study and a

descriptive and non-experimental survey design in terms of data collection and data analysis. The study area was Qorveh County in Kurdistan province, Iran. Qorveh is a historical-cultural county with flat plains that is located on the route to Iraq and Turkey and is an agricultural hub in the province. The economy of the county, which has fertile soils and rich water resources, is based on the agricultural industry. The acreage of the irrigated wheat farms is about 14,000 ha in this region (Agricultural Jihad Organization, 2019). The statistical population of the research was composed of all irrigated wheat farmers (N= 1700) who had cultivated their farms in the 2019-2020 crop year. The sample size was determined to be 137 people using Cochran's formula (Cochran, 1942), which was increased to 170 people to enhance the reliability of the results. The sample was taken by the multistage sampling technique. First, four cities were selected from Qorveh County and one rural district was selected from each city. Then, the number of representative farmers was determined, and data were gathered from them as a sample.

Data were collected from the wheat farmers by face-to-face interviews. The research instrument was a self-designed questionnaire composed of five sections for demographic information, safety and health behavior (14 items), information sources (5 items) measured on the five-point Likert scale (from 1=very low to 5 = very high), knowledge (9 items) measured on the five-point Likert scale (from 1=very low to 5 = very high; negative items are scored in reverse), and attitude (9 items) measured on the five-point Likert scale (from 1 = completely disagree to 5 = completely agree). To investigate the content validity and face validity, the research instrument was approved by a panel of experts. The convergent validity index was estimated by the average variance extracted (AVE) to be higher than 0.5 for all variables, indicating that the correlation of each dimension with the relevant components was acceptable.

Cronbach's alpha coefficient and composite reliability (CR) to measure the reliability and internal consistency of the questionnaire were greater than 0.7 for all dimensions, indicating the internal consistency of the questionnaire (Table 2). After the data were derived from the questionnaires, they were encoded and subjected to statistical analyses in SPSS<sub>v23</sub> and LISREL<sub>8.80</sub> software packages using descriptive and inferential statistics. Structural equation modeling (SEM) in the form of confirmatory factor analysis (CFA) and path analysis to test the hypotheses were applied to measure the impact of the independent variables on the dependent variable.

The knowledge, attitude, and safety behavior of the wheat farmers regarding the application of chemical pesticides were also explored using the interval of standard deviation from the mean (ISDM) (Bondori et al., 2018). In this method, data are divided into the following four levels (Eq. 1) and finally, the variable is assessed as per the frequency and percentage derived from each level (Bondori et al., 2018).

$$\text{Very weak or very negative: } \text{Min} \leq A < \text{Mean} - \text{SD} \quad (1)$$

$$\text{Relatively weak or relatively negative: } \text{Mean} - \text{SD} \leq B < \text{Mean} \quad (2)$$

$$\text{Relatively good or relatively positive: } \text{Mean} \leq C < \text{Mean} + \text{SD} \quad (3)$$

$$\text{Good or positive: } \text{Mean} + \text{SD} \leq D < \text{Max} \quad (4)$$

Eq. 1

## RESULTS

The mean age of the respondents was 46 years with a maximum and minimum of 69 and 23 years, respectively. All respondents were male and 170 individuals lived in rural areas. Of all the participants, 20.8 percent were single and 79.2 percent were married. In terms of educational level, 24.7 percent were illiterate or had elementary literature,

35.9 percent were graduates of intermediate schools, 27.6 percent had a diploma, and 11.8 percent had an academic degree.

*Wheat farmers' safety and health behaviors towards chemical pesticides*

The behavior of the farmers as to personal protective equipment (PPE) when handling and spraying their farms was analyzed by eight items. Based on the means shown in Table (2), the item "Washing hands and contaminated equipment after pesticide application" was ranked first and the item "Wearing special costumes during pesticide preparation and application on farms" was ranked last.

*Farmers' knowledge of chemical pesticides*

The farmers' knowledge of chemical pesticides was measured by eight items. According to the results in Table 2, the item "Does pesticide application increase production and income?" was ranked first and the item "Does extensive application of chemical pesticides in consecutive years make the pests resistant to pesticides?" was ranked last. The average score of the farmers' knowledge regarding the hazards of chemical pesticides was 2.95, showing their poor knowledge.

*Farmers' attitude towards chemical pesticide application*

Nine items were included in the question-

naire to measure the farmers' attitudes toward the use of chemical pesticides. The participants were asked to express their agreement/disagreement with each item. Based on Table 2, the first and second ranks were assigned to the items "The use of chemical pesticides in farming jeopardizes human health" and "The use of chemical pesticides in farming contaminates surface and ground-water source", respectively.

*Extent of the use of information sources*

Five items were designed to assess the use of information sources, including access to farmers and neighbors, personal experience, Agricultural Jihad Service Centers, pesticide retailers, and radio and TV broadcasts to gain information. According to the findings in Table 2, the item "Retailers of pesticides and farm inputs" was ranked first and the item "Radio and TV broadcasts" was ranked last.

As is evident in Figure 2, with respect to PPE behaviors, 20.0 percent of the wheat farmers had very poor behavior, 37.7 percent had poor behavior, 24.7 percent had moderate behavior, and 20.6 percent had good behavior. It was also revealed that 15.9, 33.5, 32.4, and 18.2 percent of the farmers had poor, relatively poor, relatively good, and good knowledge of chemical pesticides, respectively. Furthermore, Figure 2 displays that the attitude of 17.6 percent of the wheat farmers was poor toward chemical pesti-

Table 1  
*Demographic Features of the Wheat Farmers (n = 170)*

Variable	Level	Frequency	%
Age (year)	<30 (young)	15	8.8
	30-45 (adult)	67	39.4
	45-60 (old)	69	40.6
	>60 (very old)	19	11.2
Marital status	Single	17	10.0
	Married	153	90.0
Educational level	Illiterate-elementary literacy	40	24.7
	Graduate of intermediate school	56	35.9
	Diploma	52	27.6
	Academic education	22	11.8

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Table 2

*Frequency Distribution of Safety and Health Behaviors among Wheat Farmers as to the Use of Chemical Pesticides*

Variable	Symbol	Mean	SD
<b>Behavior (<math>\alpha = 0.93</math>)</b>		<b>2.91</b>	<b>1.39</b>
Wearing goggles or eye cover during pesticide preparation and application on farms	B1	2.87	1.26
Wearing a mask during pesticide preparation and application on farms	B2	2.96	1.21
Wearing gloves during pesticide preparation and application on farms	B3	2.91	1.47
Wearing a hat during pesticide preparation and application on farms	B4	2.86	1.26
Wearing special long pants during pesticide preparation and application on farms	B5	2.79	1.31
Wearing boots during pesticide preparation and application on farms	B6	2.88	1.62
Wearing long-sleeved shirts during pesticide preparation and application on farms	B7	3.06	1.26
Wearing special costume during pesticide preparation and application on farms	B8	2.70	1.65
Washing hands and contaminated equipment after pesticide application	B9	3.25	1.22
Drinking and eating during pesticide preparation and application on farms	B10	2.78	1.29
Smoking during pesticide preparation and application on farms	B11	2.63	1.47
Keeping foodstuff near pesticides on farms	B12	2.88	1.41
Bathing immediately after pesticide application	B13	3.21	1.63
Changing clothes immediately after pesticide preparation and application on farms	B14	3.07	1.50
<b>Knowledge (<math>\alpha = 0.91</math>)</b>		<b>2.95</b>	<b>1.18</b>
Does pesticide application increase production and income?	K1	3.04	1.16
Does extensive application of chemical pesticides in consecutive years make the pests resistant to pesticides?	K2	2.79	1.30
Does pesticide application pollute surface and table water sources?	K3	2.98	1.21
Does exposure to pesticides jeopardize human health?	K4	3.13	1.11
Does exposure to pesticides jeopardize the health of domesticated and wild animals?	K5	2.89	1.37
Does the use of chemical pesticides jeopardize the health of beneficial insects and other organisms of soils?	K6	2.96	1.20
How much can the timely application of pesticides reduce pesticide use?	K7	2.86	1.16
Is it necessary to wear a special costume, hat, gloves, etc. during pesticide application?	K8	2.93	1.05
Is it necessary to avoid eating or drinking during pesticide application?	K9	3.02	1.10
<b>Attitude (<math>\alpha = 0.87</math>)</b>		<b>2.70</b>	<b>1.31</b>
The use of chemical pesticides in farming jeopardizes human health.	A1	3.08	1.44
The use of chemical pesticides in farming destructs the environment.	A2	2.79	1.70
The use of chemical pesticides in farming contaminates surface and groundwater sources.	A3	2.28	1.39
The excessive use of chemical pesticides in farming jeopardizes domesticated and wild animals.	A4	2.58	1.13
The use of chemical pesticides in farming is necessary to increase crop production.	A5	2.99	1.18
A successful farmer is a farmer who produces safe crops without pesticide use.	A6	2.68	1.33
The cause of many incurable diseases, e.g. cancers, should be sought in excessive use of chemical pesticides on farms.	A7	2.88	1.19
The use of chemical pesticides in farming destroys beneficial insects of the farms.	A8	2.63	1.21
Pesticides are the last weapon in the battle with pests.	A9	2.43	1.24
<b>Information sources (<math>\alpha = 0.89</math>)</b>		<b>2.81</b>	<b>1.17</b>
Neighboring farmers and other villagers	I1	2.88	1.16
Personal experience	I2	2.78	1.13
Agriculture experts of Agricultural Jihad Service Centers	I3	2.75	1.19
Retailers of pesticides and farm inputs	I4	2.93	1.25
Radio and TV broadcasts	I5	2.73	1.15



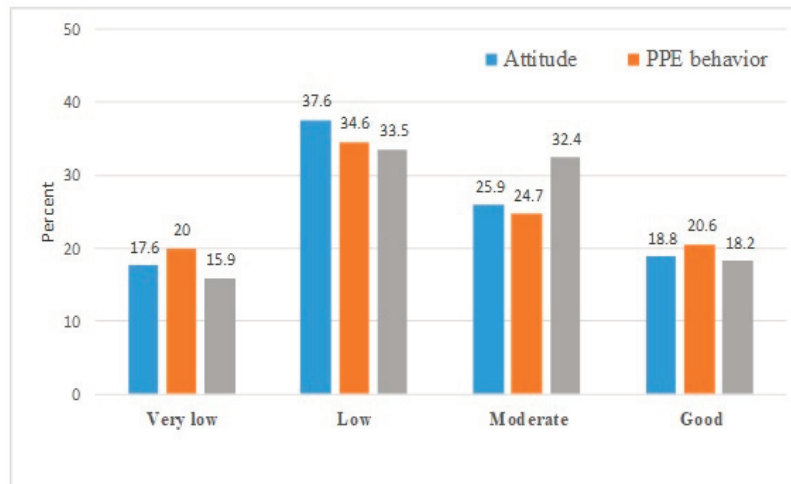


Figure 2. Levels of Attitude, Knowledge, and Safety and Health Behaviors as to the Use of Chemical Pesticides among Wheat Farmers (n = 170)

cides, 37.6 percent was relatively poor, 25.9 percent was relatively good, and 18.8 percent was good.

#### *Factors influencing wheat farmers' safety and health behavior toward the use of chemical pesticides*

The results of correlation analysis (Table 3) showed that the wheat farmers' safety and health behavior toward the use of chemical pesticides had a significant ( $p < 0.01$ ) relationship with the constructs of their attitude, knowledge, and information source. Further, these constructs were related to one another significantly ( $p < 0.01$ ), too.

The present study used SEM to identify the factors underpinning farmers' safety and health behaviors as to the use of chemical pesticides and used fit indices to assess the fit of the measurement models. It can be observed in Table 4 that the  $\chi^2/df$  ratio was 2.09, implying an acceptable status of the model. SRMR was also estimated at 0.080. The model is highly fitted if SRMR is  $< 0.05$  and is fitted if it is in the range of 0.05-0.08 (Byrne, 2013; Giles, 2002). RMSEA was also considered in this study. This index shows the acceptable fit of the model when it is  $< 0.05$ , relatively good fit when it is in the range of 0.05-0.08, moderate fit when it is in the range of 0.08-0.1, and weak fit when it is  $> 0.1$  (Kalantari, 2013). Since it was estimated to

be 0.080 for the present model, it confirmed the acceptable fit of the research model. The other indices, i.e. NNFI, NFI, CFI, IFI, GFI, and AGFI, show the better fit of a model in structural equations like path analysis when they are closer to 1 (Ping, 2004). Therefore, it can be concluded that all fit indices were at optimal levels, showing the appropriate fit of the test model with the collected data.

#### *Results of testing research hypotheses*

According to Table 5, given Hypothesis 1, the effect of the wheat farmers' attitude toward the use of chemical pesticides on their safety and health behavior was estimated to have a coefficient of 0.28. It was found to be positive and significant ( $p < 0.01$ ) with a statistic of 3.30, supporting hypothesis 1. Considering the coefficient of this relationship, it can be said that the higher the attitude of wheat farmers toward chemical pesticides, the more their safety and health behavior increases in the form of a linear function. The results for hypothesis 2 reflect the direct impact of knowledge of chemical pesticides on safety and health behavior with an estimated coefficient of 0.37 and a statistic of 3.10 which is positive and significant ( $p < 0.05$ ) indicating that this hypothesis is true. It means that the increase in wheat farmers' knowledge of the hazards of chemical pesticides corresponds to the increase in their safety

Table 3  
The Correlation of Research Variables with the Safety and Health Behavior of Wheat Farmers as to the Use of Chemical Pesticides

Variables	Behavior	Attitude	Knowledge	Information source
Attitude	0.761**	-	-	-
Knowledge	0.789**	0.693**	-	-
Informaiton source	0.765**	0.668**	0.721**	-

\*\*  $p < 0.01$

Table 4  
Fit Indices for the Structural Model of the Safety and Health Behavior of the Wheat Farmers as to the Use of Chemical Pesticides

Index	$\chi^2/df$	SRMR	RMSEA	NNFI	NFI	CFI	IFI	GFI	AGFI
Optimal level*	$1 \leq \chi^2/df \leq 3$	$p < 0.10$	$p < 0.08$	NNFI > 0.90	CFI > 0.90	CFI > 0.90	CFI > 0.90	GFI > 0.80	AGFI > 0.80
Reported value	2.09	0.071	0.80	0.97	0.95	0.97	0.97	0.71	0.67

\* (Kalantari, 2013; Ping, 2004)

and health behavior linearly. The results as to hypothesis 3 show the direct influence of the wheat farmers' information source on their safety and health behavior with a coefficient of 0.32 and a statistic of 3.22, which is positive and significant ( $p < 0.01$ ). Thus, hypothesis 3 was confirmed too. The coefficient shows that farmers display linearly more safety and health behaviors as their use of information sources increases. The results for hypothesis 4 showed the direct effect of the wheat farmers' knowledge on their attitude towards the use of chemical pesticides with a coefficient of 0.74 and a statistic of 6.51, which is positive and significant ( $p < 0.01$ ). This hypothesis is, therefore, confirmed and the coefficient means that wheat farmers' attitude increases linearly as they gain more knowledge as to the application of chemical pesticides. The indirect effect of the farmers' knowledge on their safety and health behavior with a mediating role of their attitude was estimated to have a coefficient of 0.10. So, the results of the fitted model in the studied sample of the derived structural equations 3 will

be as follows. So, it is evident that the most important variable underpinning wheat farmers' safety and health behavior among the respondents is their attitude toward the use of chemical pesticides followed by the variables of knowledge and information source. These three variables, together, accounted for 79 percent of the variance in wheat farmers' safety and health behavior. It also shows that knowledge is deeply influential on attitude so that the variable of knowledge captured 55 percent of the variance in wheat farmers' attitudes toward chemical pesticides. Given the structural model, the safety and health behavior of the wheat farmers could be explained by the derived relationships. Figure 3 shows the fitted structure of the path analysis for the safety and health behavior of the wheat farmers.

### DISCUSSION

Inappropriate use of chemical pesticides and their consequences are becoming concerning (Jones et al., 2020). Some negative effects include the resistance of pests, diseases,

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Table 5

Direct and Indirect Impacts on Wheat Farmers Safety and Health Behaviors as to the Use of Chemical Pesticides

Dependent variable	Independent variables	Direct effect	t-value	Indirect effect	Total causal effect	R <sup>2</sup>
Attitude	Knowledge	0.74	6.51**	-	0.69	0.55
	Information source	0.37	3.10**	0.10	0.47	0.79
Behavior	Attitude	0.28	3.30**	-	0.41	
	Information source	0.32	3.22**	-	0.29	

\*\*  $p < 0.01$  level

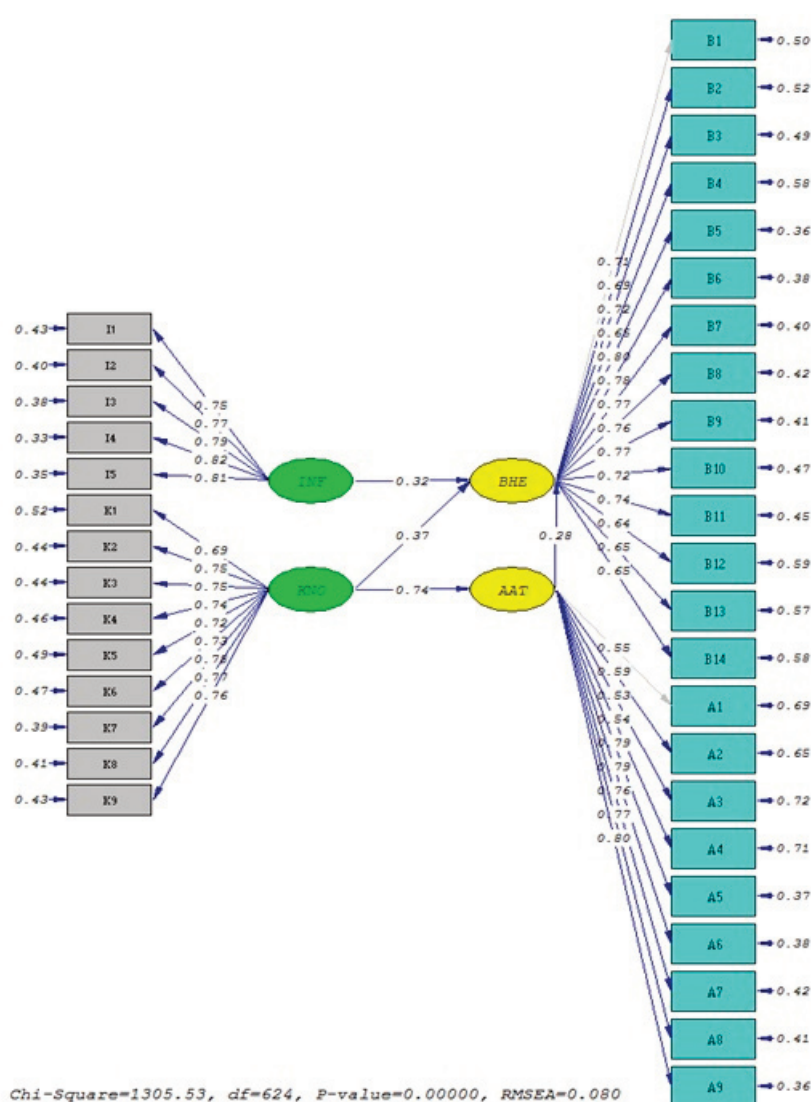


Figure 3. The Structural Model - Path Analysis Model (PEH= behavior, ATT= attitude, KNO = knowledge, INF= information source)

and weeds to chemical pesticides, toxicities, degradation and severe erosion of soil, human health threats, and incidence of ail-

ments and disorders like skin diseases, cancers, neural disorders, diabetics, respiratory diseases, embryo disorders and diseases,

congenital disorders, fertility problems, sexual issues, genetic disorders, toxicities resulting in death, and environmental deterioration (Coman et al., 2020; Jones et al. 2020; Neghab et al., 2014; Bondori et al., 2018; Sookhtanlou et al., 2022). Handling these essentially toxic chemicals, including their preparation and application, is very hazardous to farmers who are on the front-line of working with these chemicals (Sookhtanlou et al., 2022; Jones et al., 2020). So, the present study focused on exploring wheat farmers' safety and health behavior in using chemical pesticides.

Based on results, 25 percent of the farmers displayed moderate-level behaviors when using chemical pesticides such as wearing a mask and a hat and using safety equipment. Some researchers suggest that incorrect ideas can seriously influence farmers' behaviors as to their protection against hazards (Salameh et al., 2003; Ghasemi & Karami, 2009). According to the results, 24 percent of the farmers had moderate knowledge of how to use chemical pesticides. The improvement of farmers' knowledge and consciousness can potentially reduce pesticide use by 10-15 percent (Chen et al., 2013). This finding is consistent with some studies such as Bondori et al. (2018), Hooshmandan Moghaddam Fard and Shams (2016), Nazarian et al. (2009), Al-Zadjali et al. (2015), Isin and Yildirim (2007), Gün and Kan (2009) and Weng and Black (2015). It has also been documented that farmers have poor knowledge of the hazards of pesticides (Aghilinejad et al., 2006; Fan et al., 2015; Sankoh et al., 2016). We found that 32 percent of the farmers had moderate attitudes toward the use of chemical pesticides. Changing attitudes is an effective instrument to manipulate farmers' attitudes toward chemical pesticides (Sookhtanlou et al., 2022; Jones et al., 2020; Yazdanpanah et al., 2019; Ghasemi & Karami, 2009; Nazarian et al., 2009). Our research is in agreement with Bondori et al. (2018), Nazarian et al. (2009), Molaei (2013), and Mahboobi and Ahmadigorji (2017). It has

been reported that farmers in Iran, Ghana, and Ethiopia have weak attitudes toward the hazards of pesticides (Ghasemi & Karami, 2009; 23. Agmas & Adugna, 2020). Since retailers of chemical pesticides are the leading information source for farmers and TV and radio broadcasts are in the last rank as an information source, indirect extension of chemical inputs via these retailers and plant protection clinics requires the manipulation of knowledge, attitude, and beliefs among the experts of these centers in the first place and this is the responsibility of Agricultural Extension and Education Service of Agricultural Jihad Organization. This finding is in line with Bondori et al. (2018), Ghasemi and Karami (2009), Hutter et al. (2018), and Hooshmandan Moghaddam Fard and Shams (2016). Our results show that the respondents' attitudes, knowledge, and information sources had a positive and significant relationship with their safety and health behaviors. As well, a significant correlation was found between the knowledge of pesticide hazards and the attitude toward the use of chemical pesticides as reported by Bondori et al. (2018), Bondori et al. (2019), Ghala-vandi et al. (2018), Salameh et al. (2004), Ghasemi and Karami (2009), Nazarian et al. (2009), and Agmas and Adugna, (2020), too. Based on the results of path analysis, the variables of attitude, knowledge, and information source accounted for 79 percent of the variance in the variable of safety and health behavior in using chemical pesticides. In addition, knowledge captured 55 percent of the variance in the wheat farmers' attitudes toward chemical pesticides.

## CONCLUSIONS

The present study aimed to explore the safety and health behavior of wheat growers when using chemical pesticides in Qorveh County. The results revealed the significant effect of three variables of knowledge, attitude, and information source on the dependent variable, i.e. safety and health behavior of the farmers, with an  $R^2$  of 0.79. This means

that the three variables accounted for 79 percent of the variance in safety and health behavior. Among these three variables, the variables of knowledge and awareness of chemical pesticides in farming ( $\beta=0.37$ ) were the most influential factors on wheat farmers' safety and health behavior as to the use of chemical fertilizers. Since people's knowledge of an issue affects their attitude, it is first necessary to enhance wheat farmers' knowledge of the hazards of chemical fertilizers. Understanding people's attitudes can help manipulate how they think and act. When attitudes toward an issue are strengthened, the need for thinking and making new decisions will diminish and their behavior will turn into a habit so that they will be predictable. Farmers' consciousness of the destructive impacts of chemical pesticides should be continuously enhanced by individual, group, and mass media because enhancing farmers' knowledge of these impacts will make them take on responsibility for their safety and health behavior. Also, organizations in charge, e.g. Agricultural Jihad Organization and Agricultural Extension Service Centers, should hold training courses to familiarize wheat farmers with the hazards of conventional farming practices and the benefits of IPM practices, so a positive attitude can be fostered among farmers – here, wheat farmers – about the production of safe crop and the health issues during chemical pesticide application on farms can be alleviated. Also, as Jones et al., (2020) pointed out, the extension of smart farming (digitalization and the use of new technologies) has been the subject of much attention in the sector, being identified as one of the few innovations that could potentially bring about a paradigm shift in productivity as well as healthiness of farmers

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#### CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

#### AUTHORS' CONTRIBUTIONS

Each of the authors contributed to the development of the article.

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