Preventive Program for Heat Stress-related Illnesses Resulting from Climate Change among Farmers in Alignment with Sustainable Development Goals "Egypt Vision 2030"

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Abstract

Background: Heat-related illnesses are the most frequent health consequences of farmers' extended exposure to elevated temperatures. **Aim**: This study aimed to evaluate the effect of preventive program for heat stress-related illnesses resulting from climate change among farmers in alignment with sustainable development goals "Egypt Vision 2030". **Design**: A quasi- experimental design was utilized. **Setting:** The study was conducted at eight Agricultural Associations in Benha City. **Sampling**: Simple random sample was used to carry out the study. Total sample size included 160 farmers. **Tools of data collection**: One tool was used; An interviewing tool comprised of four parts as socio-demographic characteristics, medical history, farmers` knowledge about sustainable development goals, climate change and heat stress-related illnesses resulting from climate change and farmers` reported practices regarding prevention of the effects of heat stress resulting from climate change. **Results**: 6.9% of studied farmers had good knowledge regarding sustainable development goals, climate change and heat stress-related illnesses resulting from climate change pre preventive program that raised to 65.6% post preventive program, and 11.3% of studied farmers had satisfactory reported practices regarding prevention the effects of heat stress related illnesses resulting from climate change pre preventive program which enhanced to 76.9% post preventive program. **Conclusion**: Preventive program was efficient in improving farmers` knowledge and practices regarding heat stress-related illnesses resulting from climate change. **Recommendations**: Developing continuous preventive programs for farmers to raise the knowledge and practices about prevention of heat stress-related illnesses resulting from climate change.

Keywords: Climate Change, Farmers, Heat Stress-related Illnesses, Preventive Program, Sustainable Development Goals, Egypt Vision 2030

Introduction:

The global 2030 Agenda for Sustainable Development Goals (SDGs) was launched in September 2015 at a historic United Nations summit. In March 2016, Egypt announced "Egypt's Vision 2030," as its sustainable development plan, in accordance with the 2030 Agenda **(Ministry of international cooperation, 2016).** SDGs seek to protect the environment, improve health, and eradicate poverty and inequality. SDGs outline 17 Goals. The 3rd goal calls for promoting and ensuring healthy living for people of all ages. The achievement of all SDGs is at threat because of climate change. Between 2030 and 2050, climate change is predicted to cause more than 250.000 deaths annually on the globe **(World Health Organization (WHO), 2023).**

The goal thirteen of SDGs calls for measures to mitigate climate change and its effect. All countries are currently being affected by climate change. The national economy is being severely impacted by climate change, and has greater effects on people, communities, and nations today and tomorrow. Individuals are noticing the significant outcomes of climate change, that

include altering weather patterns and increasing sea levels. Climate change is mostly caused by greenhouse gas emissions from people's activities. The average global surface temperature will rise during the twenty-first century, probably surpassing 3ºC this century causing significant warmth to certain regions of the world (**United Nations Office for Outer Space Affairs, 2023).**

Climate change has become one of the greatest significant challenges of the time which is affecting future generations. According to WHO, climate change is the most serious health threat of the 21st century, with significant consequences to life, health, and the quality of life **(Hooste, 2023).** When the 21 century comes to an end, 1.2 billion individuals are predicted to be influenced by heat stress, which is nearly four times the number of populations already impacted by extreme heat. Exposure to elevated temperatures causes numerous negative effects on health. These can vary from acute health consequences to more serious diseases and in most severe circumstances, these can even be fatal **(El Khayat et al., 2022).**

Heat stress could happen among workers who are exposed to intense heat or work in high temperatures such as farmers **(Centers for disease control and prevention and National Institute for Occupational Safety and Health, 2020).** Heat Stress Related Illnesses (HSRIs) are the most prevalent health impacts recognized by farmers caused by the prolonged exposure to extremely high temperatures. HSRIs can result in heat stroke, heat exhaustion, heat cramps, or heat rashes ranged from mild symptoms such as excessive sweating, feeling dizzy, exhaustion, headache, vomiting, and cramps in the muscles to more serious ones like fatal heat strokes. Farmers are more likely to experience heat stress due to a wide range of work-related factors, such as performing intense manual labor, avoiding taking breaks to rest or drink enough water, not having control over workplace health and safety techniques, and not having enough access to shade and water. Agricultural workers also often live in poor living conditions **(El Khayat et al., 2022).**

Prevention is very crucial to prevent such health disasters and to preserve good health. It is essential to prevent heat stress as the temperatures of summer rise and the country's harvest season begins. The primary cause of heat stress is working in the fields in direct sunlight at temperatures of 90°F and more, although other variables such as age, level of fitness, pre-existing medical issues, and humidity can also be considered affecting factors. Prevention measures include drinking water, getting periodic breaks, and staying in the shade. In addition, farmers should not be exposed to direct sun, extreme heat and high humidity (**Association of Farmworker Opportunity Programs, 2023).**

Community Health Nurses (CHNs) play an essential role in maintaining the safety and health of workers and the surrounding workplace environments. CHNs act as advocates for healthier workers by improving the health, wellbeing and safety of the environments in which farmers live and work. CHNs encourages the adoption of heat safety guidelines, techniques, and policies to shield workers from illnesses related to heat stress **(The American Association of Occupational Health Nurses, 2020).**

Significance of study:

Egypt's location makes it particularly vulnerable to climate change. Workers in developing poor countries are more prone to climate change effects. Egyptian outdoor workers are impacted by climate change. Climate change affects all agricultural workers, including farmers and ranchers

(**Ramadan and Mourad, 2022**). According to the Egyptian Ministry of Health's report in 2022, 76 death cases and 447 admission cases to hospitals resulting from current heat wave that led to heat exhaustion. Furthermore, according to the Egyptian Ministry of Health's Crisis Room, 1400 injuries and 95 fatal cases of heat stroke were recorded in 2020 (**Mohammad et al., 2023).**

According to the National Institutes of Health, agricultural workers are more vulnerable to die because of heat than other workers. Recommendations from the Occupational Safety and Health Administration for outdoor workers include modifying work hours in hot weather, providing water, shade and resting breaks. Eventually, researchers discovered that farmworkers in hot, humid regions of the world, such as Egypt were also suffering the disease. Farmworkers experienced frequent heat stress-related illnesses when their body temperature was over 100.4° F **(DiGregorio, 2023).**

Aim of study:

The aim of study was to evaluate the effect of preventive program for heat stress-related illnesses resulting from climate change among farmers in alignment with sustainable development goals "Egypt Vision 2030".

Research hypothesis:

Preventive program will raise knowledge and enhance practices of farmers about prevention of heat stress-related illnesses resulting from climate change in alignment with sustainable development goals "Egypt Vision 2030".

Subjects and Method:

Research design:

This study used a quasi-experimental design (one group pre/ and post-test).

Setting:

The study was carried out at eight Agricultural Associations in Benha City. These Associations were selected by cluster random sample of forty Agricultural Associations in Benha City that were divided into four directions, and from each direction were took 25% of associations; two associations from each direction. From South direction; Sandanhor and Marsafa Agricultural Associations. From North direction; Farsis, Damalo. Agricultural Associations. From East direction; Shablinga, Batamda Agricultural Associations. From the West direction, Met Elatar and Tahla Agricultural Associations.

Sampling:

Sample type: Simple random sample was utilized in the study.

The sample size: Was calculated by applying the following equation: **Stephen Thompson's equation (Fearon et al., 2017):**

$$n = \frac{N \times p\,(1-p)}{\left(\left(N-1 \times \left(d^2 \div z^2\right)\right) + p\,(1-p)\right)} = 160$$

N is the total number of farmers attended to previously mentioned settings = 12309; p is the ratio, which has a neutral attribute of 0.12; d is the error rate is equal to 0.05, and z is the class standard, which responds to the significance level = 1.96. The sample size included =160 farmers.

Agricultural Associations in Benha City	Number of farmers included
Sandanhor	20
Marsafa	20
Farsis	20
Damalo	15
Shablinga	25
Batamda	25
Met Elatar	20
Tahla	15
Total	160

Data collection tool:

One tool was employed for data collection. An interviewing tool that the researchers developed and translated into clear Arabic language, and included four parts to assess the following:

First part: The socio demographic characteristics and working hours of farmers contained age, sex, marital status, educational level, occupation beside farming, monthly income, number of working hours in the field daily, and number of hours are exposed to high temperature during working in the agricultural field daily.

Second part: Farmers` past medical history such as chronic diseases, and previous exposure to heat-related illness resulting from climate change.

Third part: Farmers' knowledge regarding sustainable development goals, climate change and heat stress-related illnesses resulting from climate change composed of (29) multiple choice type questions divided into seven dimensions, covered areas related to **sustainable development goals** (meaning, targets of goal 3, and targets of goal 13), **climate change (**meaning, causes, forms, vulnerable people, effects), **heat stress-related illnesses** (meaning, causes, risk factors, types and prevention), **heat exhaustion** (meaning, causes, signs and symptoms, and complications), **sunstroke** (meaning, causes, signs and symptoms, and complications), **heat cramps** (meaning, causes, signs and symptoms, and complications) and **skin heat rash** (meaning, causes, signs and symptoms, and complications).

Scoring system:

Each item of knowledge received score "2" for correct and complete answer, "1" for correct and incomplete answer, and "0" for don't know. The total score= 58 points. Three levels were used to categorize the total score: Good knowledge level was ≥75% (≥ 43 points), average knowledge level was 50-<75% (29<43 points), and poor knowledge level was <50% (<29 points).

Fourth part: Farmers` reported practices regarding prevention the effects of heat stress related illnesses resulting from climate change adapted from **Luque et al., (2020) & Sisolak et al., (2022)** to evaluate farmers practices which consisted of 47 questions partitioned into eight dimensions; **healthy nutrition** (8 questions), **protective clothes used during work** (7 questions), **rest and sleep** (7 questions), **ask for medical care** (2 questions), **precautions followed when heat exhaustion occurs** (6 questions), **when sunstroke occurs** (5 questions), **when heat cramp occurs** (4 questions), and **when skin heat rash occurs** (8 questions).

Scoring system:

Every practice question was done was assigned score "one"; for items not done, a score of "zero was assigned." A total score = 47 points There are two levels of total reported practices score: Satisfactory practices, which exceeded or equaled 60% (≥28 score), and unsatisfactory total practices, which was less than 60% (<28 score).

Administrative process:

The directors of the Agricultural Associations in Benha City received a formal letter from the Dean of Faculty of Nursing, Benha University to obtain both written consent and official authorization to conduct the study. This was done to obtain consent to carry out the research after explaining the goals of research and acquiring data regarding the number of farmers who attended the Agricultural Association.

Tool's validity:

A team of five Community Health Nursing experts from Benha University examined the tool to verify the information's

correctness and make sure it was relevant, applicable, and thorough.

Tool's reliability:

Cronbach's Alpha coefficient test was used to assess reliability; the tool included homogenous items, as shown by the tools' high reliability. The internal consistency of the knowledge questionnaire was 0.99 and farmers reported practices' internal consistency was 0.97.

Ethical consideration:

This study has been permitted by The Scientific Research Ethical Committee of the Nursing Faculty at Benha University. The researchers gave each farmer an explanation of the study's goals to get their informed consent to participate in the research. The farmer had the freedom to leave the study at any time. The researchers also informed the participants that all data was utilized only for study.

Pilot Study:

It was performed on 10% (16 farmers) of the studied sample. It was done to make sure that the study tools were easy to understand and applicable. Furthermore, to determine any difficulties or problems that the researchers may encounter when collecting data. The farmers who took part in the pilot were also included because no modifications were made.

Preventive program implementation:

Assessment, planning, implementation, and evaluation constituted the main methods utilized to conduct the study. The study was conducted from the beginning of January 2023 until the end of May 2023. The researchers attended the previous setting three days/week from 9:00 am to 12:00 pm. Data was collected from farmers during they are waiting in the Agricultural Associated to distribute agricultural supplies such as chemical fertilizer and pesticides. The researchers scheduled and prepared meetings with farmers to enable them to receive the program and the instructional materials and content.

A. Assessment phase:

The farmers were given interviews during the assessment phase to obtain baseline data. The pretest phase lasted for about eight weeks, and the researchers were present three days a week (Saturday, Monday, and Thursday) from 9.00 am to 12:00 pm. At the onset of the interview, the researchers welcomed each farmer, explained the goals, schedule, research activities, and received their oral consent. The researchers evaluated farmers' knowledge and reported practices through interviews. It required 15 to 30 minutes. The numbers of farmers were interviewed based on their attendance and commitment to be included in the study.

B- Planning phase:

The researchers developed the preventive program based on the needs identified during the farmer assessment phase and in light of relevant literature. The researchers ascertained the number and content of the sessions, different teaching methods, and media based on the farmers' level of understanding using simple Arabic language. After that, objectives of the program were made as follows:

General objectives:

The general objective of the preventive program was to enhance farmers knowledge and reported practices about heat stress-related illnesses resulting from climate change alignment with sustainable development goals "Egypt Vision 2030.

Specific objectives:

After the preventive program, the studied farmers should be able to:

A-Knowledge objectives:

- Mention meaning of SDGs, targets of SDG 3, and SDG 13
- Mention meaning of climate change, causes, forms, vulnerable people, and effects of climate change.
- Mention heat stress-related illnesses meaning, causes, risk factors and types of heat stress-related illnesses.
- Discuss meaning, causes, signs and symptoms, and complications of heat exhaustion, sunstroke, heat cramps and skin heat rash.
- Identify prevention of heat stress-related illnesses.

B- Practical Skills:

- Have healthy nutritional practices.
- Wear protective clothes.
- Ask for medical care.
- Follow precautions when heat exhaustion occurs.
- Perform appropriate precautions when sunstroke occurs.
- Do appropriate precautions when heat cramp occurs.
- Perform appropriate precautions when skin heat rash occurs.

C- Implementation phase:

The preventive program was applied in the implementation phase. The intervention included eight scheduled sessions. Each session lasted between 30 and 45 minutes. farmers were divided into small groups of 8–10 farmers. A combination of methods, such as lectures, group discussions, questions and answers, and educational slides were utilized. On the first day of the preventive program, all farmers were given an educational booklet. A brief introduction to the preventive program for heat stress-related illnesses resulting from climate change and Its goal was accomplished at the beginning of the first session. Every session began with an explanation of the previous one. The sessions of the program were utilized to implement the preventive program. The farmers received a total of (8) sessions. 4 practical sessions and 4 sessions for the theoretical part. These sessions were provided for each group.

Theoretical sessions (4 sessions):

- **The first session:** Included an explanation about meaning of SDGs, targets of SDG 3, and SDG 13
- **The second session:** Included meaning of climate change, causes, forms, vulnerable people, and effects of climate change on health.
- **Third session:** Included meaning, causes, risk factors and types of heat stress-related illnesses and meaning, causes, signs and symptoms, and complications of heat exhaustion and sunstroke.
- **Fourth session:** Included meaning, causes, signs and symptoms, and complications of heat cramps and skin heat rash and prevention of heat stress-related illnesses.

Practical sessions (4 sessions)

- **The first session:** The researchers showed farmers how to perform the healthy nutritional practices and wear protective clothes during work.
- **The second session:** Emphasized on how to ask for medical care and followed precautions when heat exhaustion occurs.
- **The third session:** Explained how to perform appropriate precautions followed when sunstroke occurs, and perform appropriate precautions followed when heat cramp occurs.
- **The fourth session:** Was on how to perform appropriate precautions when skin heat rash occurs.

D- Evaluation phase:

The effectiveness of the preventive program was evaluated through a posttest that was conducted through further visits to the Agriculture Association by using the same tool utilized pre-program to compare the

change in the farmers knowledge and reported practices immediately after implementation of the program.

Statistical analysis:

Data was verified before entering the computer. This was accomplished by tabulating the data following its analysis with version 26 of the Statistical Package for Social Sciences (SPSS). There was application of descriptive statistics, such as mean, standard deviation, frequency, and percentages. The distribution of the numbers and percentages was determined using chi square, and the association between the total knowledge score and practices was established using the Spearman correlation test (r). P values were considered highly significant when $p \leq 0.001$, significant when $p \leq 0.05$, and insignificant when $p > 0.05$.

Results:

Table (1): Displays that; 54.4% of the studied farmers aged 35 years and more with mean was 39.68 ± 8.826, 93.1% of them were male, 68.8% were married and 36.9% of them had basic education. Also, 75.0% of studied farmers didn't have an occupation besides farming, and 68.1% of them hadn't enough monthly income. 49.4% of studied farmers worked at fields for 8 hours and more daily, and 61.3% of farmers exposed to direct sun rays daily from 4 to less than 6 hours.

Figure (1): Illustrates that; 49.4%, 38.8%, 36.9% and 29.4% of studied farmers suffered from skin problems, respiratory diseases, hypertension and musculoskeletal diseases respectively as a medical history.

Figure (2): Illustrates that; 55.6%, 43.8%, 31.2% and 30.6% of studied farmers exposed to dry skin, dyspnea, muscle pain and sunstroke respectively.

Table (2): Shows that; there were highly statistically significant differences between all items of the studied farmers` subtotal knowledge dimensions about sustainable development goals, climate change and heat stress-related illnesses resulting from climate change pre and post preventive program implementation $p<0.001$.

Figure (3): Illustrates that; 6.9% of studied farmers had good total knowledge level regarding sustainable development goals, climate change and heat stress-related illnesses resulting from climate change pre preventive program implementation which raised to 65.6% post preventive program implementation, while 78.8% of them had poor total knowledge pre preventive program implementation and declined to 13.8% post preventive program implementation.

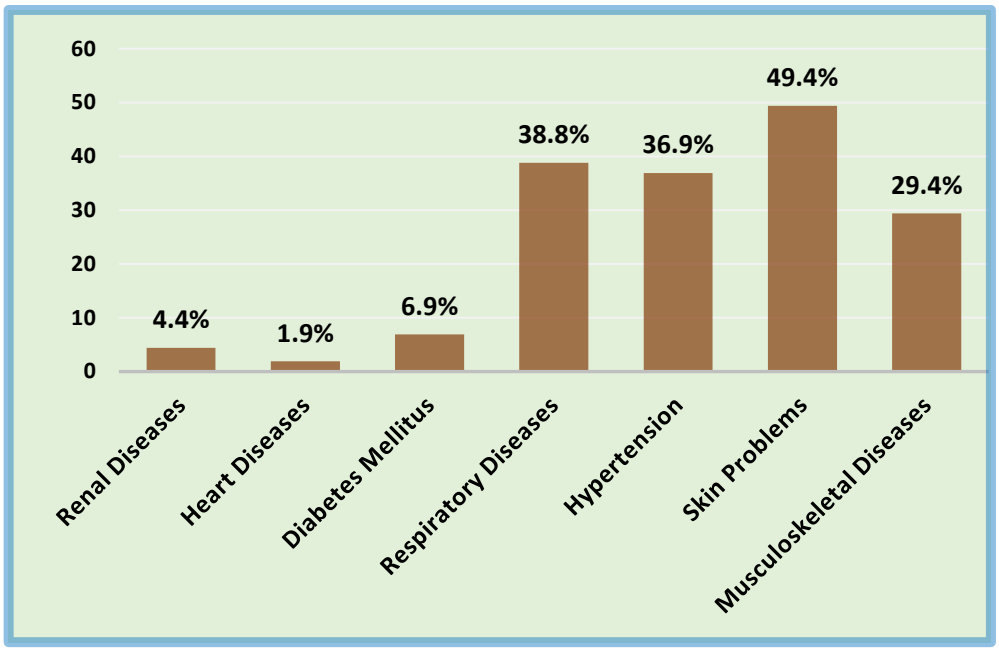
Table (3): Reveals that; there were highly statistically significant differences between all items of the studied farmers` subtotal reported practices dimensions about prevention the effects of heat stress related illnesses resulting from climate change pre and post preventive program implementation $p<0.001$.

Figure (4): Illustrates that; 11.3% of studied farmers had satisfactory total reported practices about prevention of the effects of heat stress resulting from climate change pre preventive program implementation which enhanced to 76.9% post preventive program implementation, while 88.7% of them had unsatisfactory total reported practices pre preventive program implementation that reduced to 23.1% post preventive program implementation.

Table (4): Presents that there was highly positive statistically significant correlation between farmers` total knowledge scores and their total practices scores regarding prevention the effects of heat stress related illnesses resulting from climate change at pre and post implementation of preventive program.

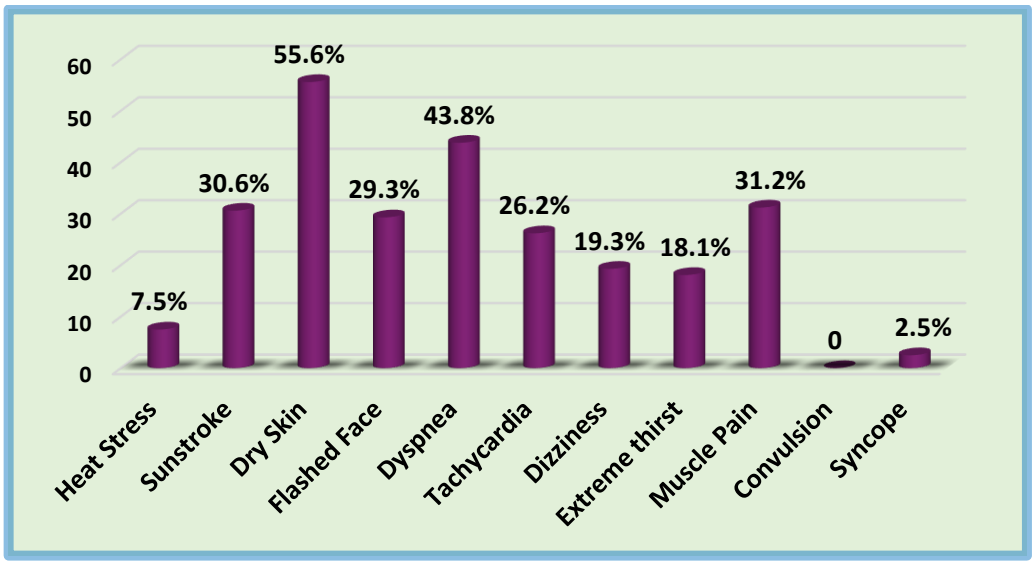
Table (1): Distribution of the studied farmers regarding their socio-demographic characteristics and working hours (n=160).

Socio-demographic characteristics and working hours	No.	%
Age / years		
15-	14	8.8
25-	20	12.5
35-	87	54.4
45+	39	24.4
$\bar{x} \pm$S.D 39.68 ± 8.826		
Sex		
Male	149	93.1
Female	11	6.9
Marital status		
Single	37	23.1
Married	110	68.8
Divorced	4	2.5
Widowed	9	5.6
Educational level		
Cannot read and write	21	13.1
Read and write	37	23.1
Basic education	59	36.9
Secondary education	31	19.4
University education	12	7.5
An occupation besides farming		
Yes	40	25.0
No	120	75.0
Monthly income		
Enough and save	19	11.9
Just enough	32	20.0
Not enough	109	68.1
Number of working hours in farm daily		
4-	21	13.1
6-	60	37.5
8+	79	49.4
Number of exposure hours to extreme heat in farm daily		
4-	98	61.3
6-	62	38.7
8+	0	00.0



The answers are not mutually exclusive

Figure (1): Percentage distribution of the studied farmers regarding their medical history (n= 160).



The answers are not mutually exclusive

Figure (2): Percentage distribution of the studied farmers regarding previous exposure to heat stress-related illnesses resulting from climate change (n= 160)

Table (2): Distribution of the studied farmers' subtotal knowledge dimensions regarding sustainable development goals, climate change and heat stress-related illnesses resulting from climate change pre and post preventive program implementation (n=160).

Sub-Total Knowledge Dimensions	Pre preventive program implementation						Post preventive program implementation						X^2	p-value
	Complete& correct answer		Incomplete & correct answer		Don't know		Complete& correct answer		Incomplete & correct answer		Don't know			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Sustainable development goals	2	1.3	15	9.4	143	89.4	99	61.9	32	20.0	29	18.1	174.8	0.000**
Climate change	16	10.0	34	21.3	110	68.8	136	85.0	17	10.6	7	4.4	194.3	0.000**
Heat stress-related illnesses	13	8.1	16	10.0	131	81.9	117	73.1	31	19.4	12	7.5	185.3	0.000**
Heat exhaustion	6	3.8	17	10.6	137	85.6	112	70.0	29	18.1	19	11.9	187.6	0.000**
Sunstroke	11	6.9	29	18.1	120	75.0	131	81.9	20	12.5	9	5.6	198.5	0.000**
Heat cramps	4	2.5	9	5.6	147	91.9	111	69.4	24	15.0	25	15.6	192.9	0.000**
Skin heat rash	4	2.5	15	9.4	141	88.1	99	61.9	32	20.0	29	18.1	167.5	0.000**

(**) highly statistically significant at ($p<0.001$)

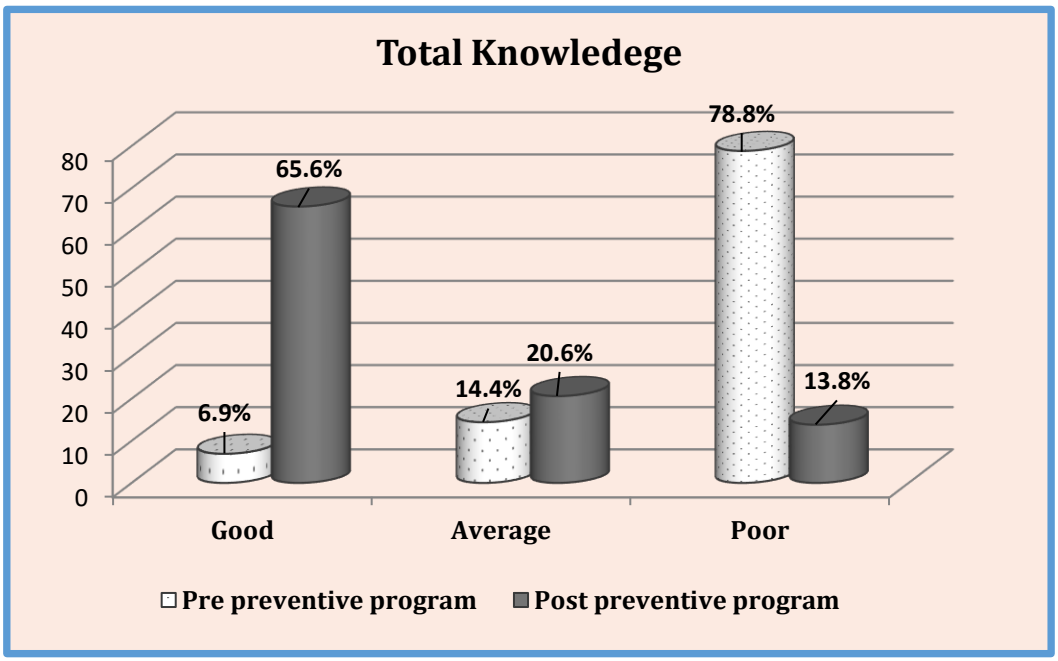


Figure (3): Percentage distribution of the studied farmers' total knowledge level regarding sustainable development goals, climate change and heat stress-related illnesses pre and post preventive program implementation (n=160).

Table (3) Frequency distribution of the studied farmers` subtotal practices dimensions regarding prevention of effects of heat stress related illnesses resulting from climate change pre and post preventive program implementation (n=160).

Sub-Total Practices Dimensions	Pre preventive program implementation				Post preventive program implementation				X^2	p-value
	Satisfactory ≥ 60%		Un-satisfactory < 60%		Satisfactory ≥ 60%		Un-satisfactory < 60%			
	No.	%	No.	%	No.	%	No.	%		
Healthy nutrition	27	16.9	133	83.1	129	80.6	31	19.4	130.1	0.000**
Wear protective clothes during work	26	16.3	134	83.8	132	82.5	28	17.5	140.4	0.000**
Rest and sleep	33	20.6	127	79.4	135	84.4	25	15.6	130.3	0.000**
Ask medical care	18	11.3	142	88.8	123	76.9	37	23.1	139.7	0.000**
Precautions followed when heat exhaustion occurs	8	5.0	152	95.0	118	73.8	42	26.3	158.4	0.000**
Precautions followed when sunstroke occurs	29	18.1	131	81.9	129	80.6	31	19.4	125.0	0.000**
Precautions followed when heat cramps occur	6	3.8	154	96.3	114	71.3	46	28.8	١٥٥,٥	0.000**
Precautions followed when skin heat rash occurs	3	1.9	157	98.1	109	68.1	51	31.9	154.3	0.000**

****Highly statistically significant difference (p<0.001)**

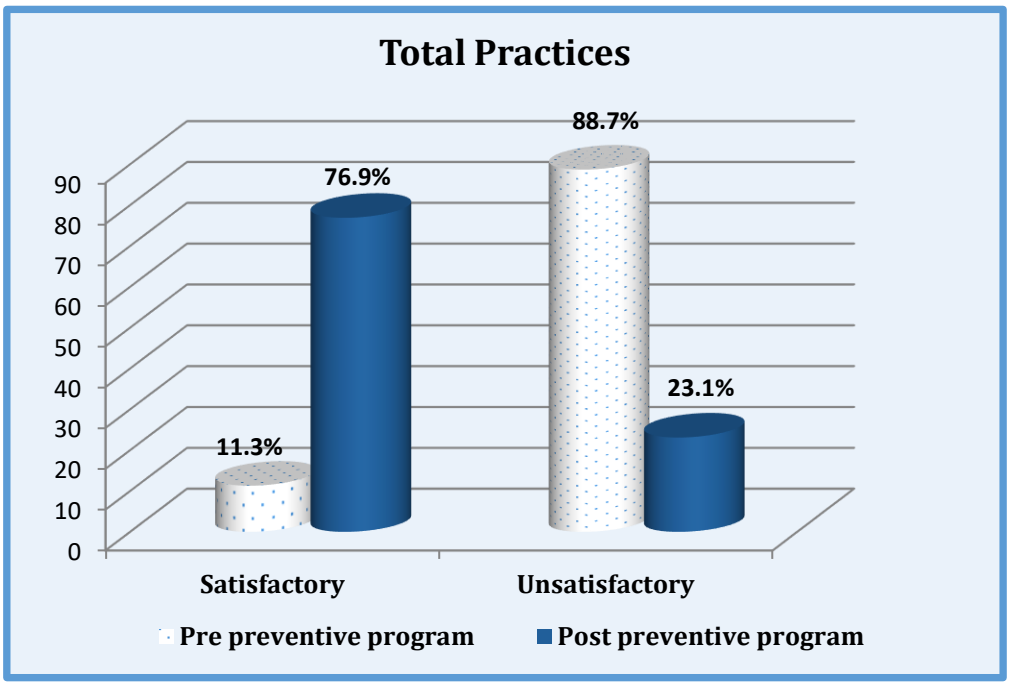


Figure (4): Percentage distribution of the studied farmers' total practices level regarding prevention of the effects of heat stress related illnesses resulting from climate change pre and post preventive program implementation (n=160).

Table (4): Correlation between studied farmers` total knowledge scores and total practices scores regarding prevention of the effects of heat stress related illnesses resulting from climate change pre and post preventive program implementation (n=160).

Items	Total knowledge scores			
	Pre preventive program		Post preventive program	
	r	p-value	r	p-value
Total reported practices scores	0.719	0.000**	0.911	0.000**

****Highly statistically significant correlation (p<0.001)**

Discussion:

Agricultural activities are mostly carried out outdoors and can be influenced directly by the outdoors temperature. Hence, Farmers may experience heat stress which have severe health effects, and older farmers may be more vulnerable. Examining the level of heat exposures in hot surroundings is crucial since these circumstances can impact mental, heart, respiratory and heat-related illnesses such as fatigue, cramps, collapse, and exhaustion **(Jung & Kim, 2022).**

Regarding socio-demographic characteristics of the studied farmers, the current study revealed that; more than half of the studied farmers aged 35 years and more with mean were 39.68 ± 8.826, most of them were male, more than two thirds of them were married and more than one third of them had basic education. Also, three quarters of studied farmers didn't have an occupation besides farming and more than two thirds of them didn't have enough monthly income.

These findings agreed with **Marquez et al. (2023)**, who performed an educational study in Central/Eastern Washington State, USA among 83 agricultural workers to assess their knowledge and reported that the mean age of participants is 44 ± 16 years. 65 % of study participants were male, and 51% of participants reported an education level of primary school or less and 45% were working in agriculture for 10 or more years.

The current study revealed that approximately half of studied farmers worked at fields for 8 hours and more daily, and less than two thirds of farmers exposed to direct sun rays daily for 6 hours and more. This finding was in the same line with **Kiatkitroj et al. (2022),** who made a study in Thailand Kanpitcha to assess risk factors linked to heat-related illness among 200 sugarcane farmers and reported that 68.0% of farmers exposed to heat for ≥5 hours. This might be due to the nature of farmers` occupation, in which farmers spend a lot of time outdoors and farming is the main job and source of income of three quarters of them.

The current research indicated that; more than one third of studied farmers suffered from hypertension and minority of them suffered from diabetes. This finding disagreed with **Luque et al.(2020)**, who studied knowledge and practices of 101 Hispanic farmworkers in Florida-Georgia Line to avoid heat-related illness, and reported that 4% of participants suffered from diabetes, and 8% of participants had hypertension.

The present study disclosed that; approximately half of studied farmers had stated skin problems as medical history. This finding was compatible with **Yovi et al. (2023),** who studied the repercussions of occupational health promotion facing climate change effects in Indonesia and assess heat-related knowledge among 215 Indonesian Forestry workers and farmers, risk perception and precautionary practice of them and found that 42% of farmers and 35% of forestry workers stated experiencing skin disease as itching and rashes on the hands and feet because of coming into touch with bark, grass, and muddy soil. This might be due to the farmers spending a lot of time in fields in all types of weather, especially in summer heat and humidity cause potentially life-threatening illnesses like skin diseases.

The current study illustrates that; more than half of studied farmers had dry skin, less than one third had muscle pain and third of them had sunstroke and less than fifth of them had dizziness's problems associated with previous exposure to heat stress-related illnesses resulting from climate change. These findings disagreed with **Sadiq et al. (2019),** who performed a study among 396 maize farmers in a tropical climate region in Gombe

State, Nigeria, to assess effect of heat on health and productivity of farmers and found that the studied farmers noticed the earlier symptoms of heat stress included heat rash (34.30%), tiredness (76.80%), dizziness (76.30%), headache (71.20%), fever, and rapid pulse. On the other hand, late symptoms including dizziness, cramping in the muscles, fainting, heated, dry skin, and unconsciousness were seldom or absent. This might be due to daily farm tasks, and many farmers work in conditions where shade not provided during hot and humid weather, so farmers move in and out of these conditions that can cause heat illness.

Concerning farmers' subtotal knowledge regarding dimensions of sustainable development goals and climate change, this study disclosed that; there were highly statistically significant differences of the studied farmers` subtotal knowledge about dimensions of sustainable development goals and climate change pre and post preventive program implementation $p<0.001$. According to **(United Nation and Department of Economic and Social Affairs, 2023**), stated that the targets of the goal 13 and goal 3 of SDGs aim to improve education, raise awareness of the human on climate change adaptation, reduce impact and early warning. This might be due to the prevention program increased the knowledge of farmers regarding to sustainable development goals and climate change.

The present study showed that; there were highly statistically significant differences of the studied farmers` subtotal knowledge regarding dimension of heat stress-related illnesses resulting from climate change pre and post preventive program implementation $p<0.001$. This finding concurred with **Marquez et al. (2023),** who mentioned that there was a higher improvement in pre-post knowledge scores in the study group versus the control group and the involvement heat training was successful in raising farmworker heat knowledge in the training of a summer season. This might be due the positive effect of prevention program on farmers' knowledge regarding heat stress-related illnesses resulting from climate change.

The existing study showed that a minority of studied farmers` had correct and complete answers about heat stress-related illnesses dimension pre preventive program implementation. These findings aligned with **Smith et al. (2020),** who declared that 77% of studied sample identified at least three symptoms of HRI, 35% were able to know at least 6 symptoms of HRI, and only 7% were able to identify at least 9 symptoms of HRI.

As regards total knowledge of farmers, the current study demonstrated that; minority of studied farmers had good total knowledge about sustainable development goals, climate change and heat stress-related illnesses resulting from climate change pre preventive program implementation which raised to approximately two thirds of them post preventive program implementation. These findings disagreed with **Elias & Sreejesh (2022),** who conducted a designed teaching program in Sikkeri village, Bagalkot, to enhance knowledge of 120 farmers about heatstroke and its prevention, and showed that, (70%, 20% and 10%) of farmers had average, poor and good knowledge respectively in the pretest, which changed to (75%, 13.3% and 11.6%) having average, poor and good knowledge respectively in the post-test.

The present study displayed that; there were highly statistically significant

differences between all items of the studied farmers` reported practices about precautions followed to prevent the effects of heat stress resulting from climate change pre and post preventive program implementation p<0.001. This finding supported by **Luque et al. (2020),** who reported that all farmers confirmed positive evaluation of HRI prevention training based on the outcomes of the evaluation rubric. Also, continuous training programs are recommended to farm workers to emphasize the importance of HRI prevention. This might be due to the prevention program improving their practices to prevent risks for heat related illness.

The present findings illustrated that fifth of studied farmers had satisfactory practices regarding rest and sleep pre preventive program implementation which improved to majority of them post preventive program implementation. This finding supported by **El Khayat et al. (2022)**, who stated that moving to air-conditioned settings during or after work, taking breaks in shady regions, and rearranging work hours and activities and taking prolonged breaks were the most preferred administrative preventative measures among survey participants. This might be due to the nature of work in the agricultural field that requires great effort and causes exhaustion, so it requires periods of rest and sleep.

Regarding to total practices level of farmers, the current study illustrated that; minority of studied farmer had satisfactory total reported practices regarding precautions followed to prevent the effects of heat stress resulting from climate change pre preventive program implementation which improved to more than three quarters of them post preventive program implementation, while majority of them had unsatisfactory total reported practices pre preventive program implementation that reduced to more than fifth of them post program implementation. According to **Wästerlund, (2018),** who stated that occupational safety and educational programs are important aspects of helping in improving practices of agricultural farmers. Also, heat stress can be controlled by performing simple measures, but these needs raising awareness and continuous training among farmers workers. Workers should be aware that implementation measures are important regarding preventing heat-related illnesses and believe that workers will be able to adapt their practices accordingly. This might be due to the preventive program help farmers in understanding the appropriate necessary preventive measures regarding effects of heat stress resulting from climate change.

There were highly positive statistically significant correlations between farmers` total knowledge and practices regarding prevention of heat stress-related illnesses resulting from climate change at pre and post implementation of program. This finding was in line with **Yovi et al. (2023),** who reported that the findings showed a mediated connection between precautionary behaviors and knowledge. These findings show that risk perception serves as a mediator between awareness and behaviors, and that increasing knowledge about heat-related problems motivates preventive behavior. This might be due to knowledge that has an immediate and significant impact on farmers' practices toward prevention of risks regarding heat related illness.

Conclusion:

Preventive program was succeeded in increasing knowledge and improving practices of farmers regarding prevention of heat stress-related illnesses resulting from climate change. Minority of studied farmers

had good knowledge regarding sustainable development goals, climate change and heat stress-related illnesses resulting from climate change pre preventive program implementation which raised to two thirds post preventive program implementation. Slightly more than tenth of studied farmer had satisfactory reported practices regarding prevention of heat stress related illnesses resulting from climate change pre preventive program implementation that enhanced to more than three quarters post preventive program implementation.

Recommendations:

- Continuing prevention programs for farmers to increase their knowledge and practices about heat stress-related illnesses resulting from climate change.
- More studies on sizable samples of farmers are necessary to prevent heat stress-related illnesses resulting from climate change and its complications.
- Implementation of coordinated initiatives to combat climate change, including training, education, and research, through internet, social media, and television to share information and encourage farmers to adopt practices that are environmentally friendly.

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برنامج وقائي للأمراض المرتبطة بالإجهاد الحراري الناتجة عن تغير المناخ بين الفلاحين وفقًا لأهداف التنمية المستدامة "رؤية مصر ٢٠٣٠"

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تعتبر الأمراض المرتبطة بالحرارة العواقب الصحية الأكثر شيوعًا لتعرض المزارعين لفترات طويلة لدرجات الحرارة المرتفعة. لذا هدفت هذه الدراسة إلى تقييم تأثير البرنامج الوقائي للأمراض المرتبطة بالإجهاد الحراري الناتجة عن تغير المناخ بين الفلاحين وفقًا لأهداف التنمية المستدامة "رؤية مصر ٢٠٣٠". وقد تم إستخدام تصميم شبه تجريبي. وقد أجريت هذه الدراسة في ثماني وحدات زراعية بمدينة بنها على عينة عشوائية مكونة من ١٦٠ فلاح. وتم استخدام أداة واحدة لتجميع البيانات مكونه من أربعة أجزاء هي الخصائص الاجتماعية والديموغرافية للفلاحين والتاريخ الطبي ومعلوماتهم بأهداف التنمية المستدامة وتغير المناخ والأمراض المرتبطة بالإجهاد الحراري الناتجة عن تغير المناخ وممارساتهم فيما يتعلق بالوقاية من آثار الإجهاد الحراري الناتج عن تغير المناخ. وبناء على نتائج الدراسة الحالية كان لدى ٦,٩٪ من الفلاحين معلومات جيدة فيما يتعلق بأهداف التنمية المستدامة وتغير المناخ والأمراض المرتبطة بالإجهاد الحراري الناتجة عن تغير المناخ قبل البرنامج الوقائي والتي ارتفعت إلى ٦٥,٦٪ بعد البرنامج الوقائي، وكان لدى ١١,٣٪ من الفلاحين ممارسات مُرضية فيما يتعلق بالوقاية من آثار الأمراض المرتبطة بالإجهاد الحراري الناتجة من تغير المناخ قبل البرنامج الوقائي والتي ارتفعت إلى ٧٦,٩٪ بعد البرنامج الوقائي , كما كان البرنامج الوقائي فعالاً في تحسين معلومات وممارسات المزارعين فيما يتعلق بالأمراض المرتبطة بالإجهاد الحراري الناتجة عن تغير المناخ. وقد أوصت نتائج الدراسة بتطوير برامج وقائية مستمرة للمزارعين لرفع مستوى معلوماتهم زممارساتهم حول الوقاية من الأمراض المرتبطة بالإجهاد الحراري الناتجة عن تغير المناخ.