Effect of Heat Waves Adaptation Strategies on Outdoor Waste Collector Workers' Knowledge and Practice

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Abstract

Background: Heat waves are a significant consequence of climate change, threatening public health, especially those who work outdoors. Necessitating the implementation of practical mitigation and adaptation strategies. **Aim: to** evaluate the effect of heat waves adaptation strategies on outdoor waste collector workers' knowledge and practice. **Design:** A quasi-experimental design (one group pre- and post-test) was utilized. **Sample:** Purposive samples of 70 outdoor waste collector workers were participated in the study. **Setting:** Zabbaleen settlement, Cairo, Egypt. **The data collection tools:** include Waste Collector Workers' Heat Related Illnesses (HRIs) Risk Assessment, the Waste Collector Workers' Knowledge Questionnaire, and a self-reported checklist of the heat wave coping strategies. The adaptation strategies include wearing cotton clothes, hydration, rest breaks, a healthy diet, limiting caffeine intake, and sugar, wearing protective clothing, scheduling work times, and dealing with heat related illness (HRIs). **Results:** workers' knowledge improved significantly from the pretest (M = 22.57, SD = 4.84) to the posttest (M = 28.90, SD = 4.66) with a p-value < 0.001. They also improved significantly in their total practice scores from the pretest (M = 22.57, SD = 4.84) to the posttest (M = 28.90, SD = 4.66) with a p-value of 0.001. Interestingly, during heat waves, 72.9% of workers face high HRI risks. **Conclusion:** The study highlights the importance of implementing adaptation strategies to enhance workers' knowledge and practices regarding adaptation to extreme heat events. **Recommendations**: Further research is needed to understand the effectiveness of adaptation strategies across diverse populations and contexts.

Keywords: Heat waves, Adaptation strategies, outdoor door waste collectors.

Introduction

Heat-related health impacts are one of the most significant global public health risks posed by climate change in the coming decades **(Kunda, Goslin & Foody, 2024).** The occurrence and magnitude of climate extreme heat wave events have risen globally and are highly likely to continue to be more frequent and intense **(Marquez et al., 2023; Leal Filho et al., 2018).**

Occupational health-related illnesses (OHRIS) are conditions that occur when workers are exposed to high environmental temperatures or strenuous physical activity in hot conditions. These illnesses are a serious concern, particularly in industries like construction, agriculture, manufacturing, and outdoor work, where workers are more likely to be exposed to extreme heat. The risks can be further heightened by factors such as humidity, protective clothing, and personal health conditions (**Elshamy, Eladl & Zaitoun, 2024).**

Several reviews have highlighted how warming has impacted and will impact labour productivity as well as the health and well-being of out-door workers **(Masuda et al., 2024).** According to the Intergovernmental Panel on Climate Change (IPCC), between 2030 and 2050, there will likely be an additional 250,000 deaths from climate-related causes, such as heat stroke, with poorer nations being more vulnerable **(World Health Organization (WHO), 2023).** Climate change in Egypt is urgently affecting vulnerable populations, necessitating urgent measures to protect them from extreme temperatures and increased burden on national capacity, emphasizing the need for proactive climate governance in the country **(Al-Mailam, Arkeh, & Hamzawy , 2023; Bakhsh, Rauf & Zulfiqar, 2018).**

The waste collectors are the front-line who are isolated, susceptible, and ignored. They are at high risk for dehydration, heat stroke, exhaustion, and exposure to harmful microorganisms. About 91% of waste collectors in Brazil reported having at least one incident in the previous year related to climate change and 85% of respondents said they had experienced heat waves or unusual heat **(Dias, Ogando, Broto, Cypriano & Gonçalves., 2023).** Adapting to extreme heat which includes early heat waves warning, improved working areas, provision of adequate shade and ventilation, as well as access to cool sources of hydration is a major challenge for those vulnerable population groups **(Khalil, Ibrahim, Elgendy& Makhlouf, 2022) .**

The Impact of occupational heat related illnesses are primarily manageable and preventable. However, the options available to workers depend so substantially on the regulations, infrastructure, and training programs put in place by governments and employers **(Leal Filho et al., 2018).** Outdoor workers are crucial in putting adaptation plans into practice as well as, more broadly, in making the right decisions at work. Workers' perceived and actual knowledge, awareness, and understanding of the heat dangers associated with climate change limits the

effectiveness of heat adaptation measures **(Han et al., 2021).**

Heat wave adaptation strategies require a multi-faceted approach that involves community planning, infrastructure design, public health initiatives, and policy development. By prioritizing cooling measures, providing early warnings, and ensuring vulnerable populations are supported; communities can better withstand the impacts of heat waves and improve overall resilience to climate extremes **(Eladl, Elshamy, & Zaitoun, 2024).**

Significance of the study

The risk of heat-related illnesses (HRI) among solid waste disposal workers in Egypt is particularly severe, with studies showing that only 40% of workers possess adequate knowledge about heat-related risks, and merely 30% demonstrate appropriate adaptation behaviors **(Elshamy et al., 2024; Dias et al., 2023).**

This knowledge gap significantly increases their vulnerability to heat-related health complications. Increasing the number of research directed to this vital sector, (especially in hot climate countries like Egypt), developing and implementation of appropriate strategies to guide workers to follow healthy behaviors and prevent heat related illnesses is fundamentally an urgent need **(Eladl, 2023).**

Within occupational settings, findings suggest that effective interventions not only reduce the incidence of heat-related injuries but also contribute to improving workers' knowledge, attitudes, and practices regarding heat safety **(Ontario, 2024).**

Occupational health nurses (OHNs) and other community health professionals can play a vital role in protecting workers through investment into appropriate climate change adaptation measures. OHNs are equipped with the knowledge and abilities to assess, diagnose, and treat heat-related illnesses and injuries. They may also help reduce the negative health impacts of heat on outdoor workers by implementing heat protection programs and providing education **(American Association Of Occupational Health Nurse (AAOHN), 2020).**

Educational and community outreach interventions showed promise in improving knowledge, attitudes, and behaviors related to heat risks and were highly effective in reducing heat-related mortality and morbidity, especially among vulnerable populations **(Ontario, 2024; Hasan et al., 2021).**

The emphasis on structured educational programs on adaptation strategies focusing on hydration practices, symptom recognition, emergency procedures, protective equipment usage and peak heat hour adaptation strategies aligns with recommendations from multiple studies examining heat stress management among Egyptian waste collectors **(Mohammad et al., 2023).**

The effectiveness of adaptation strategies educational interventions in enhancing occupational safety and heat adaptation strategies is corroborated by research demonstrating significant improvements in workers' knowledge

and behavioral outcomes **(Elshamy et al., 2024).** This study adds to the limited body of research on heat adaptation strategies for outdoor workers in developing countries, particularly in the waste management sector

Therefore, the current study aims to evaluate the effect of the heat waves adaptation strategies on outdoor waste collector workers' knowledge and practice. This could provide valid evidence for updating current workplace heat intervention practices to reduce the likely increasing adverse impact of climate change on waste collector workers' health and safety.

Aim of the Study

The aim of this study was to evaluate the effect of heat waves adaptation strategies on the outdoor waste collector workers' knowledge and practice.

Research hypothesis

H1: Waste collector workers who participate in the heat wave adaptation strategies program will have higher mean knowledge scores in the post-test than in the pretest.

H2: Waste collector workers who participate in the heat waves adaptation strategies program will have higher mean practice scores in the post-test than in the pretest.

Subjects and Methods

Research Design

A quasi-experimental design (one group pre / post-test) was utilized in the current study. A quasi-experimental study utilizes independent variables to examine their impact on dependent variables, using a single group pretest-posttest design, assuming that any alterations in outcomes can be attributed to the educational program **(Reichardt, 2019).**

Setting

This study was conducted at the Zabbaleen settlement. The Zabbaleen settlement was established in 1970. Located in the eastern part of Greater Cairo, Manshiet Nasser is home to a large community of garbage collectors. Approximately 9,000 families in Manshiet Nasser rely on money from sorting and recycling 5,000 tons of garbage daily, which constitutes about one-third of Cairo's total waste collection (Sabry, 2020). The Zabbaleen system has an enormous capacity, with an estimated 80,000 to 150,000 Zabbaleen Copts living in the poor urban area known as "Garbage City" around Manshiet Nasser **(Abouelmagd, 2020**).

Sample

The population size was 475. A purposive sample of 70 waste collector outdoor workers at the Zabbaleen settlement was selected. The sample size was calculated using (Epi-info statistical package, version 7.2, designed by the CDC (Centre for Disease Control and Prevention) with 80 percent power, a value of 2.5 is chosen at the acceptable limit of precision (D) at 95 percent confidence level (C1), with expected prevalence 10%, worst acceptable 25%. Researchers approached the workers while they were collecting garbage on the street. All workers fulfilling the following criteria and are available at the time of the assessment phase (The first month, 2 days /week of the data

collection period) was involved in the study.

The inclusion criteria are being an adult, can read and write and working in garbage collection for at least one year to be able to respond from his working experience about heat waves exposure and its negative consequences.

Tools of data collection

After reviewing the related national and international literature on heat waves and climate change three tools of data collection were developed by the researchers to assess outdoor waste collector workers' knowledge and practice regarding heat waves.

1- **Waste collector workers' Heat Related Illnesses (HRIs) risk assessment**: it was developed based on **World Health Organization (2020)** Checklists to assess vulnerabilities in the context of climate change. It includes demographic information related to age, sex, educational level and marital status. Also, it included 19 question related to heat wave risk assessment including questions related to past exposure to heat waves which include a pre-determined list of symptoms from which participants have to indicate their actual exposure at the last three months. Also, questions about workplace exposure, temperature, humidity, clothing, and work hours.

This tool uses a scoring system, with high-risk items scored 2, and no risk items scored 1 but one question its responses ranged from 3 to 1 score. The total heat wave risk assessment scores are categorized as high risk (15- 20 score, ≥75%), moderate risk from 10 - to less than 15 score (50% to < 75%) and no risk less than 10 score (<50%) out of total score of 20.

2- The waste collector workers' heat waves knowledge questionnaire: it was developed based on **Narocki (2021); Habib et al. (2021).** It consisted of 15 multiple-choice questions about heat stress, stroke, exhaustion, common symptoms, risk factors, first aid, and severity of heat stroke, consequences, and actions to take when someone is overheated. For each yes or no question, a correct answer was scored 1 and 0 score for the incorrect one. Some questions are formulated as multiple – choice questions; where more than one alternative can be selected; correct and complete answer was scored 2, correct and incomplete answer scored 1 and incorrect answer was scored 0. Total knowledge was categorized as good from 27- 36 score (≥75%), fair from 18- to less than 27 score (50% to < 75%) and poor knowledge less than 18 score (<50%) out of total score of 36.

3- **The self-reported practices of heat waves and heat stress coping strategies checklist:** It was developed based on **Narocki (2021); Habib et al. (2021).** It consisted of six questions explore behavioral responses, first aid for heat stress, heat stroke and heat cramps, and protective measures taken during extreme heat exposure. The total score of practice was calculated by summing correct responses of all questions. Total practice scores were categorized as good from 13.5- 18 score (≥75%), fair from 9 to less than 13.5 score (50% to < 75%)

and poor practice less than 9 score (<50%) out of total score of 18.

Content validity and reliability

In this study, a panel of five professors in the Community Health Nursing Department assessed the study tools. They linked each objective to its respective items, assessing item relevancy and whether they adequately represented the content. Cronbach's Alpha was used to determine internal consistency of the developed tools which was (0.774 for risk assessment tool, 0.960 for knowledge questionnaire and 0.87 for self-reported practice checklist).

Ethical considerations

An approval from the research ethics committee of the Faculty of Nursing, Cairo University, Egypt with the final approval number RHDIRB 2019041701 was obtained to carry out the current study. All participants were informed about the purpose and benefits of the study, participation was voluntary, and the data collected will be used only for the purpose of the study. Written consent was taken. Measures were taken to ensure confidentiality through data collection and coding.

Procedure:

1-Preparation phase:

Comprehensive literature review was conducted utilizing accessible books, journals, and online resources to formulate the research tools. An ethical approval to conduct the study was obtained. Additionally, formal authorization was obtained from the Manshiet Nasser district in Cairo Governorate.

2-Assessment phase:

In the pre-test phase, tools were completed by the outdoor waste collector workers who will agree to participate in the study as baseline information and to develop the content of the health education intervention. Researchers distributed the tools through outdoor visits to the selected Zabbaleen settlement. Each questionnaire took about 30 minutes to complete, and finalize the interview.

3- **The implementation phase of the study:**

This phase was started after the results of the pre-test had been analyzed. The intervention (the heat waves adaptation strategy) that was developed by the researchers based on the data collected in the assessment phase and after reviewing of related literature. The Program was twice-weekly sessions, 45–60 minutes each. Every session ended with 5-10 minutes to review the session's content and get feedback from the outdoor workers. Each session had its title and objectives according to its content. Outdoor workers were divided into small groups; each group involved 8 or 10 workers.

The heat waves adaptationstrategy program description:

- The heat waves adaptation strategy program was one-month educational program that educated workers on health risks and practical strategies to mitigate them. It included lectures, discussions, and demonstrations of the first aid of heat stroke, heat stress, and heat cramps that were held during the break time of workers at the assembling points to help

workers recognize signs of heat-related illnesses and respond effectively. We distributed booklets to provide guidance on staying safe in hot conditions. Feedback was given during each session.

The program included eight sessions covering heat waves, risk factors, heat exhaustion, heat stroke, heat cramps, heat damage, adaptation strategies, and health advice. The first session was introductory, focusing on building rapport and educating the worker on heat stress and heat waves. The following adaptation strategies were used with workers to help them cope with heat waves and heat stroke: wearing appropriate cotton clothing, staying hydrated by drinking lots of fluids while working, taking a break from the sun after working for a long time, eating a healthy diet rich in fruits and vegetables and avoiding hot meals, limiting the use of caffeine, and sugar, wearing protective clothing at all times, scheduling work time, and teaching workers about dealing with HRIs as (heat exhaustion, heat stroke, heat cramps, dehydration), and health advice on preventing heat wave effects.

4- **Evaluation phase:**

This is the final phase of the program; the final two sessions were used to terminate the program using the study tools to collect data for post-program assessment. The evaluation was done by comparing the change in outdoor waste collection workers knowledge and self-reported practice using the same tools (post-test).

Statistical Analysis

Data were coded and entered using SPSS version 28 (IBM Corp., Armonk, NY, USA). Quantitative variables were summarized using mean and standard deviation. Categorical variables were summarized using frequencies and relative frequencies. Comparisons were done using unpaired t-tests compared 2 groups. ANOVA with post hoc tests compared more than 2 groups. Paired t-tests assessed pre-post changes (Chan, 2003a). Pearson correlation coefficient examined quantitative variable relationships (Chan, 2003b). P-values < 0.05 were considered statistically significant.

Results

Regarding workers' demographic characteristics, **Table (1)**: conveys that the 61.4% of workers were male, while 38.6% were female. Regarding age, 28.6% of workers have the same distribution for the 35-45 and 45-55 age groups whereas 4.3% are aged more than 55. In terms of educational level, 47.1% could read and write, while 1.4 have secondary education. Marital status revealed that 78.6% of workers were married while 4.3 % were widowed or divorced/separated.

Figure (1): revealed that, feeling hot was the most commonly reported symptom, affecting 54.3% of workers, followed by headache occurred in 52.9% of workers. Muscle cramps (51.4%), insomnia (50.0%), sleep disturbances during heat waves were highlighted as a potential health issue. Difficult breathing affected 47.1% of workers and unconsciousness (44.3%). Additionally, "Poor Diet" was

reported by 38.6% of workers, and elevated body temperature occurred in 37.1% of cases. Finally, vomiting and dizziness were usually reported at 12.9% and 24.3% respectively.

Figure (2): shows that, 72.9% of workers face high risks for heat waves related to health complication during heat waves and 25.7% have a moderate risk. While, 1.4% of them are at low risk.

Table (2): revealed a significant increase in workers' knowledge about climate change from the pretest to the posttest, with a mean of 2.21 (SD = 0.80). Extreme heat waves were identified as a factor in high mortality rates, with a mean of 1.57 (SD = 0.50) and a mean of 1.87 (SD = 0.34). However, there was no significant difference in the perceived time to adapt or awareness of health problems caused by heat waves.

Also, **Table (2)** showed that, awareness of heat exhaustion improved significantly (M = 1.46, SD = 0.50; posttest: M = 1.86, SD = 0.35), $p < 0.001$. There was also a significant increase in knowledge about risk factors associated with heat exhaustion in the posttest (M = 2.40, SD = 0.60) compared to the pretest (M = 1.49, SD = 0.50). Common symptoms of heat cramps were better recognized in the posttest (M = 2.41, SD = 0.69), $p < 0.001$. Dehydration signs were recognized more accurately in the posttest (M = 2.43, SD = 0.73), and knowledge about heat rashes significantly increased (M = 1.27, SD = 0.45; posttest: M = 2.04, SD = 0.71). Prevention of heat-related illnesses, such as appropriate clothing for working in hot weather, was recognized (M = 1.41, SD = 0.52; posttest: M = 1.77, SD = 0.62). The total knowledge score increased from pretest (M = 22.57, SD = 4.84) to Posttest mean scores (M = 28.90, SD = 4.66) with a p-value < 0.001.

Table (3): reveals that workers' practices regarding preventing heat-related illnesses significantly improved from pretest to posttest, with a mean difference of 0.68, SD = 0.68. Adaptation practices also showed significant improvement, with a mean difference of 0.53, SD = 0.53, and a mean difference of 0.67, SD = 0.67. First aid practices for heat stroke, heat cramps, heat rash, and patients with heat-related illnesses also showed significant improvement. Posttest mean scores (M = 28.90, SD = 4.66) were significantly higher than pretest scores (M = 22.57, SD = 4.84), with a p-value of less than 0.001.

Figure (3): illustrates the overall knowledge levels and practice scores before and after an intervention. Prior to the intervention, 65.7% of the workers had moderate knowledge and 12.9% possessed high knowledge. Following the intervention, there was a significant increase in high knowledge to 68.6%, and the proportion of workers with low knowledge dropped to 2.9%. Moreover, before the intervention, 52.9% of workers had low practice scores, but after the intervention, high practice scores improved remarkably to 52.9%, and only 8.6% remained with low total practice scores.

Table (4): demonstrated that, no significant difference between total knowledge between male and female workers in pre and posttest. Regarding total practice scores, male workers had a mean of 9.23 (SD = 2.73), whereas female workers scored 8.04 (SD = 1.89), with a significant difference (p = 0.034). Post-intervention, male workers' knowledge increased to a mean of 29.70 (SD = 4.59), and female workers' knowledge reached 27.63 (SD = 4.56), with no significant difference. Practice scores post-intervention was 13.60 (SD = 2.78) for males and 13.11 (SD = 3.34), showing no significant sex-based difference.

Table (5): shows that, before the intervention, workers aged 18-25 had a mean total knowledge score of 20.54 (SD = 4.93), while those aged 25-35 scored slightly higher with a mean of 23.79 (SD = 4.44) but the difference was not statistically significant. Regarding practice scores, the 35-45 age group had the highest mean (9.75, SD = 2.73), followed by the 45-55 age group (mean = 8.35, SD = 2.28). After the intervention, workers aged the 45-55 age group demonstrated the highest knowledge level (mean = 30.25, SD = 4.42), closely followed by the 18-25 age group (mean = 30.00, SD 3.58) while workers aged more than 55 demonstrated the highest practice level (mean = 15.00, SD = 1.00).

Table (1): Percentage distribution of outdoor waste collectors workers related to demographic characteristics (N=70)

Demographic characteristics		NO	%
Sex	Male	43	61.4
	Female	27	38.6
Age	18-25	13	18.6
	25-35	14	20.0
	35-45	20	28.6
	45-55	20	28.6
	More than 55	3	4.3
Educational Level	Can Read and Write	33	47.1
	Primary Education	16	22.9
	Preparatory Education	6	8.6
	Secondary Education	1	1.4
	Others	14	20.0
Marital Status	Single	9	12.9
	Married	55	78.6
	Widowed	3	4.3
	Divorced/Separated	3	4.3

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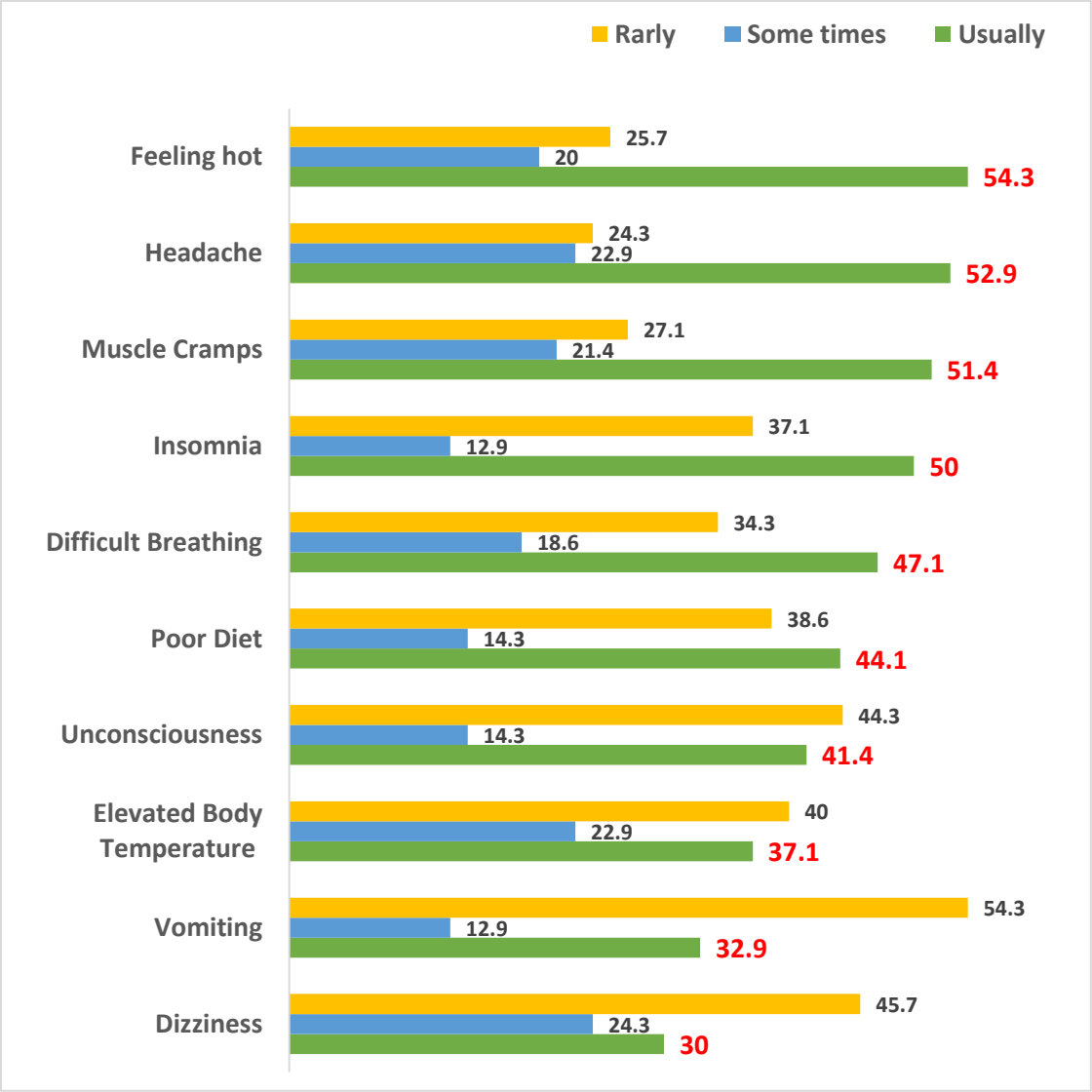

Figure (1): Outdoor waste collector workers' common health related complains during heat waves (n=70).

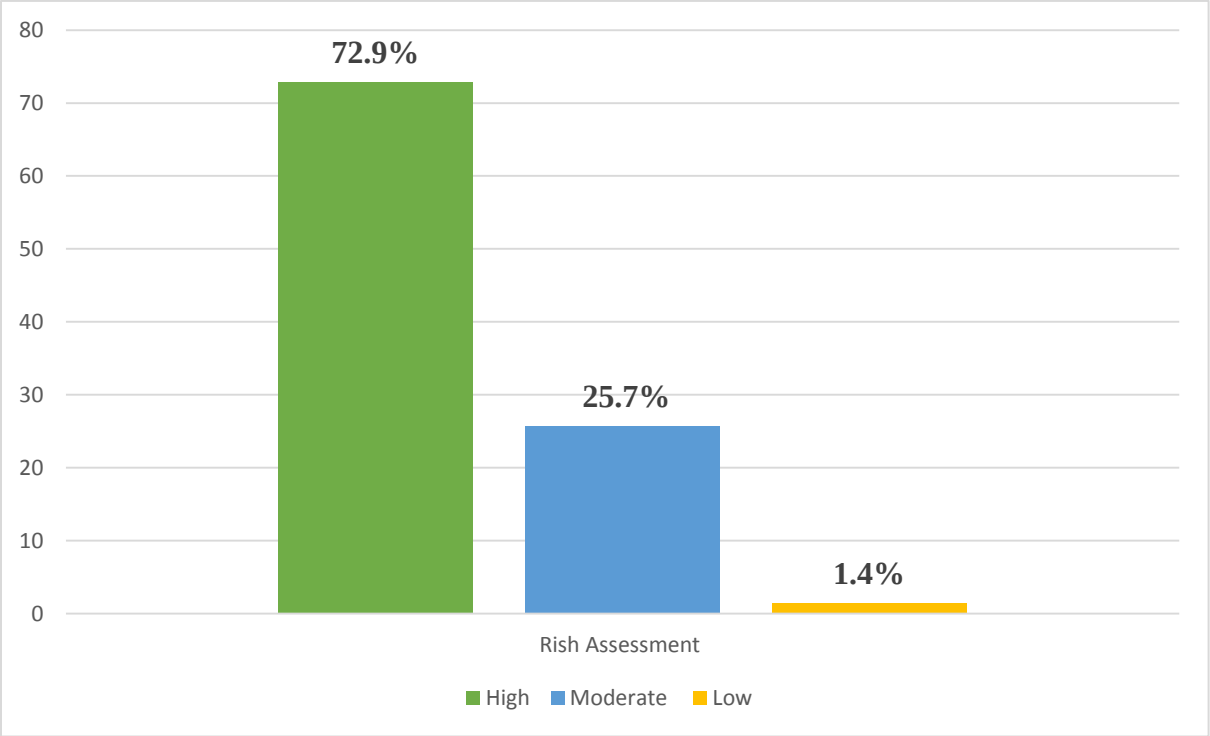

Figure (2): Distribution of workers related to their total risk scores of heat waves related to health complications (N=70).

Table (2): Difference between the mean scores of outdoor waste collectors workers knowledge regarding heat waves health effect in the pretest and posttest (N=70).

Knowledge about heat waves health effect in the pretest and posttest (n=70)	Pre		Post		T test	P value
	Mean	SD	Mean	SD		
Heat waves						
What is climate change?	1.54	0.56	2.21	0.80	-5.58	< 0.001
Can heat waves cause serious health problems?	1.71	0.62	1.87	0.34	-1.78	0.078
Extreme heat waves/heat events can contribute to a high mortality rate?	1.57	0.50	1.87	0.34	- 4.03	< 0.001
How long does it take for your body to get used to working in hot weather?	1.10	0.30	1.21	0.45	- 1.81	0.073
Heat Stroke						
Have you ever heard of heat stroke?	1.70	0.49	1.91	0.33	- 2.93	0.005
The common symptoms of heat stroke?	1.73	0.61	2.46	0.67	-6.05	< 0.001
Heat Exhaustion						
Have you ever heard about heat exhaustion?	1.46	0.50	1.86	0.35	-6.02	< 0.001
Risk factors of heat exhaustion?	1.49	0.50	2.40	0.60	-3.31	< 0.001
Heat Cramps						
What is the most serious form of heat cramps?	1.37	0.52	1.51	0.50	-1.74	0.086
Common symptoms of heat cramps?	1.67	0.63	2.41	0.69	-6.84	< 0.001
Dehydration						
The signs of dehydration?	1.71	0.76	2.43	0.73	-5.05	< 0.001
Heat Rashes	1.27	0.45	2.04	0.71	-7.55	< 0.001
Prevention of heat illnesses						
Clothing for work in hot weather	1.41	0.52	1.77	0.62	-3.31	0.001
Water intake	1.19	0.43	1.19	0.46	0.000	1.000
Changing working schedules	1.64	0.51	1.74	0.47	-1.15	0.253
Total knowledge scores	22.57	4.84	28.90	4.66	-7.07	< 0.001

***The mean difference is significant at the 0.05 level**

Table (3): Difference between the mean scores of outdoor waste collectors workers related to their reported practices about heat waves health effect in the pretest and posttest (N=70).

Practice	Pretest		Post test		t-test	P value
	Mean	SD	Mean	SD		
Prevention of heat related illnesses	1.67	0.68	2.47	0.65	-6.68	< 0.001
Adaptation to work during heat waves	1.47	0.53	2.30	0.67	-7.56	< 0.001
First aid for heat stroke	1.46	0.56	2.34	0.72	-7.40	< 0.001
First aid for heat related muscle cramps	1.37	0.54	2.46	0.72	-9.47	< 0.001
First aid for heat rash	1.33	0.50	1.89	0.60	-5.63	< 0.001
Care for patient with heat related illnesses	1.47	0.50	1.96	0.49	0.00	< 0.001
Total practice score	8.77	2.50	13.41	3.00	-9.23	< 0.001

***The mean difference is significant at the 0.05 level**

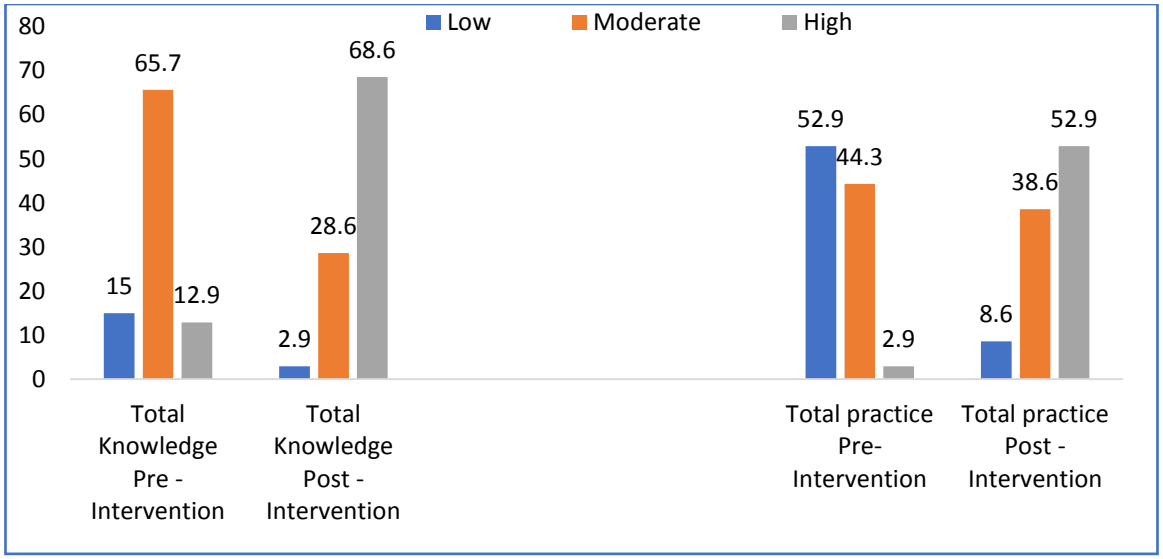

Figure (3): Distribution of workers related to their total knowledge and practice scores in pre and posttest (N=70).

Table (4): Difference between the mean scores of total knowledge and total practice among male and female workers in pre and posttests (N=70).

	Sex					
	Male		Female		t- test	P value
	Mean	Standard Deviation	Mean	Standard Deviation		
Total knowledge scores pre	21.81	5.32	23.78	3.75	-1.81	0.075
Total practice score pre	9.23	2.73	8.04	1.89	2.16	0.034
Total knowledge score post	29.70	4.59	27.63	4.56	1.84	0.070
Total practice score post	13.60	2.78	13.11	3.34	0.66	0.506

***The mean difference is significant at the 0.05 level**

Table (5): Difference between the mean scores of total knowledge and total practice among workers at different age group in pre and posttests (N=70).

	Age											
	18-25		25-35		35-45		45-55		more than 55		F	P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Total knowledge scores pre	20.54	4.93	23.79	4.44	24.70	4.53	21.05	4.67	21.67	5.03	2.47	0.053
Total practice score pre	8.15	2.44	8.36	2.37	9.75	2.73	8.35	2.28	9.67	2.52	1.32	0.270
Total knowledge score post	30.00	3.58	27.43	3.98	28.00	5.85	30.25	4.42	28.00	2.65	1.178	0.329
Total practice score post	14.08	1.98	12.29	2.73	13.05	3.62	13.90	3.13	15.00	1.00	1.076	0.375

***The mean difference is significant at the 0.05 level**

Discussion

Occupational exposure to high temperatures, particularly in outdoor settings, poses significant health risks ranging from minor conditions like heat rash and dehydration to life-threatening heat stroke **(Han et al., 2021).** The effectiveness of heat adaptation strategies hinges on workers' comprehension and risk perception of climate-related hazards, as their understanding directly shapes both policy development and implementation. Although heat stress in occupational settings is preventable, knowledge deficits and varying awareness levels among workers continue to pose significant barriers to successful adaptation program outcomes **Hochman et al., (2022).**

Waste collector workers' Heat Related Illnesses (HRIs) risk.

In the context of Heat Related Illnesses (HRIs) risk assessment, results of current study found that the majority of waste collector workers face high risks of (HRIs). Additionally, they commonly experience heat-related complaints during heat waves. The most frequently reported symptom is feeling hot,

followed by headache, muscle cramps, and vomiting or dizziness.

These results were consistent with the Egyptian study conducted by **Elshamy et al., (2024)** to assess knowledge and adaptation behavior to heat-related illness among solid waste disposal workers, researchers found that, waste disposal workers often fell ill between June and November due to long hours of work under direct sunlight. Also, **(Mohammad et al., (2023)** assessed heat stress exposure among outdoor cleansing workers at Helwan University and discovered that up to 80% of workers experienced sunburn, while 90% were exposed to sunstroke in the past 12 months.

Similarly, **Luque et al., (2020)** also noted that 19% of Hispanic farmworkers reported symptoms like headache, dizziness, and nausea from working in the heat. **Ngwenya, Oosthuizen, Cross & Frimpong (2018)** studied 123 street vendors in Zimbabwe, revealing that 85.5% of vendors spent long hours under direct sunlight, indicating a significant risk of heat stress and related illnesses. **Das, (2019)** observed that low-income urban workers in India faced health issues during heat waves, including fever (15%), tiredness (12%), and respiratory problems (8%), loss of consciousness (5%), blurred vision (8%), nausea (10.3%), and body aches (4%).

Furthermore, **Han et al., (2021)**, found that excessive sweating (59.1%) was the primary symptom among Chinese construction workers in hot weather, followed by dizziness (40.9%), dark-colored urine (31.8%), weakness and fatigue (27.7%), sunburn (27.0%), and reduced urine volume (24.8%). These variations in symptoms may be influenced by different climates and temperature levels across countries, as well as varying exposure durations. Add more, these findings underscore the need for adaptation strategies to prevent heat-related issues among workers, aligning with the focus of our current study.

Waste collectors' knowledge and practice prior to the intervention

Before the intervention, our study found that the majority of workers demonstrated moderate knowledge, while the minority had high knowledge regarding heat wave adaptation strategies. Additionally, more than two third of workers exhibited low practice levels. **Elshamy et al., (2024)** reported similar findings, with 40% of participants having adequate knowledge and 30% showing appropriate adaptation behavior. Also, **Mohammad et al., (2023)**, observed that 60% of outdoor cleansing workers at Helwan University had poor knowledge and unsatisfactory practice, The scarcity of climate change and heat wave knowledge among Egyptian outdoor workers highlights the urgent need for awareness and education regarding climate impacts.

Interestingly, **Dias et al., (2023)** documented a different scenario. Their qualitative survey study on 61 waste pickers in Minas Gerais, Brazil, revealed a high awareness rate of climate change during the assessment phase. Waste pickers demonstrated understanding of climate change causes, human-generated emissions, and observed impacts.

Discrepancies may stem from country-specific policies, socio-demographic differences, and exposure to training programs. The limited understanding of climate change and heat wave impacts among workers underscores the urgent necessity for enhanced awareness programs addressing current climatic shifts and their direct occupational implications.

The effect of heat waves adaptation strategies on outdoor waste collector workers' knowledge and practice

Results of the current study indicated a significant improvement in workers' knowledge levels after implementing adaptation strategies. Specifically, they recognized extreme heat waves as contributing to high mortality. Additionally, workers' knowledge about climate change, heat stroke, heat exhaustion, and dehydration showed significant improvement. Furthermore, practices related to heat-related illness prevention, adaptation, and caring for patients with heat-related illnesses also improved significantly ($p < 0.001$).

In a similar vein, **Marquez et al., (2023)** evaluated participatory heat education among outdoor farmworkers in the USA. The intervention group demonstrated greater improvement in pre-post knowledge scores (average difference 1.6, SD = 2.0) compared to the comparison group (average difference 0.41, SD = 1.7) ($p = 0.04$), with average knowledge scores increasing from 4.6 (SD = 1.5) to 6.3 (SD = 2.0) pre to post season.

In addition, **Grzywacz et al. (2019)**, evaluated a heat and pesticide safety curriculum that had a facilitator guide with key learning objectives, scripts for teaching the content, and ideas for encouraging student participation in the learning process. Farm workers allocated to the heat sickness were observed to have higher knowledge and behavioral intentions regarding the disease than those assigned to the insecticide.

Results of the present study suggested that implementation of the adaptation strategies successfully increased workers' practices regarding prevention of heat-related illnesses and adaptation practices were significantly improved. Notably, the importance of appropriate clothing for hot weather improved ($p = 0.001$), but water intake practices remained consistent. First aid practices for heat stroke and caring for workers with heat related illnesses were improved significantly.

Similarly, **Razzak et al., (2022)** observed greater practice improvement in the intervention group compared to the control. Post-intervention, the intervention group found practices like taking showers to reduce body temperature (OR: 0.68), avoiding afternoon outdoor exposure (OR: 2.78), and adjusting cooking time (1.94) more acceptable. Furthermore, **Luque et al. (2020)** evaluated the acceptability of the OSHA (Occupational Safety and Health Administration) heat safety app using a cross-sectional study. The app highlights the need of rest, water, and shade in averting heat-related illnesses. Crew leaders rated this app highly for value, relevance, privacy, and utility.

Furthermore, **Santos et al., (2022)** investigated worker education and a heat awareness mobile application that alerts managers to high temperatures this coming week and offers safety tips for employees. The physiological strain index decreased more in the intervention group than in the comparison group after correcting for the maximum work-shift ambient Heat Index, especially for higher labor exertion levels, while the differences were not statistically significant.

A retrospective study of the Voluntary Heat Stress Awareness Program (HSAP), which was offered to US municipal workers in Central Texas from 2009 to 2017 was carried out by **McCarthy et al (2019)**. The HSAP included medical monitoring and training for registered personnel. There was a considerable drop in heat-related illness (HRI) across the 9-year period. Comparing 2009 to 2011 and 2012 to 2014, the probabilities of an HRI declined by 91% and 66%, respectively (OR: 0.092, 95% CI: 0.034, 0.250; and OR: 0.338, 95% CI: 0.122, 0.936).

Conclusion

In conclusion, outdoor waste collector workers were at high risk for heat related illnesses. The study highlighted the deficiency in worker's knowledge and adaptation practice regarding heat waves. The intervention program reflecting notably success in enhancing the outdoor waste collector workers knowledge and practices regarding adaptation to heat waves related problems. That confirms the crucial role of community health nurses in raising the outdoor waste collector workers' awareness regarding the concept of heat waves and how to adapt to it and prevent its consequences.

Recommendations

-Implement comprehensive heat adaptation strategies and occupational health policies specifically designed for outdoor waste collectors, including standardized safety protocols and climate-responsive work schedules.

-Establish essential infrastructure improvements including cooling stations, water points, and shade structures at strategic work locations.

- Develop and expand heat safety training programs incorporating regular health monitoring and emergency response protocols for heat-related incidents.

-Conduct research to evaluate long-term effectiveness of interventions and their scalability to larger worker populations across different climatic conditions.

-Create collaborative networks for knowledge sharing and develop region-specific guidelines to address the 72.9% of workers facing high heat-related illness risks during heat waves

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The study acknowledges the valuable contributions of outdoor waste collector workers in Cairo's Zabbaleen settlement to the heat waves adaptation strategies program. Their dedication to improving knowledge and practices regarding heat-related health risks is commendable. The insights gained will inform future interventions and policies to protect workers from extreme heat events. The study's trust, openness, and collaboration

demonstrate the resilience of the Zabbaleen community.

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