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Effect of an Educational Program on Safe Medical Waste Disposal Among Home-Based Caregivers

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Abstract

Background: Safe management of healthcare risk waste is critical yet often overlooked in home-based care settings. As home healthcare expands, caregivers play a pivotal role in preventing infection transmission through proper waste disposal. **Aim:** To evaluate the effect of an educational program for home-based caregivers regarding safe medical waste disposal generated from home healthcare. **Subjects and Method:** A quasi-experimental one-group pre/post-test design was employed at outpatient clinics in family health centers in New Damietta City. A purposive sample of **112** adult caregivers responsible for chronically ill patients participated. Data was collected using a structured knowledge questionnaire and a self-reported practice scale before and after the intervention. **Results:** The study revealed statistically significant improvements in post-intervention. Mean knowledge scores increased from 12.98 ± 2.73 to 18.77 ± 2.02 ($p < .001$), with the percentage of participants demonstrating "good" knowledge rising from 19.6% to 63.4%. Similarly, mean practice scores improved from 37.47 ± 6.57 to 51.66 ± 6.60 ($p < .001$). A strong positive correlation was found between knowledge and practice scores ($r = .730$; $p < .001$). **Conclusion:** The educational intervention effectively enhanced caregivers' knowledge and practices regarding safe medical waste disposal. Integrating such training into routine community healthcare services is recommended to promote safer home care environments.

Keywords:
Safe medical waste disposal – Caregivers – Home healthcare – Educational intervention

Introduction

Home-based care represents a fundamental component of primary healthcare, widely acknowledged as one of the most economical approaches for delivering essential health services to populations (Willcox et al., 2015). Such services are designed to address the needs of diverse populations requiring assistance, including elderly individuals, those with significant functional impairments, patients recuperating from illnesses, terminally ill persons, individuals living with HIV/AIDS or other long-term conditions, and other vulnerable groups (Zikhathile & Atagana, 2018).

According to Udofia, Gulis & Fobil (2017), medical waste encompasses any solid material discarded following activities related to health protection, diagnosis, treatment, and scientific research, extending to dental and veterinary services. In contrast, household waste comprises all materials discarded from human and animal activities, including food residues, paper, plastics, textiles, metals, and glass that originate primarily from residential settings (Fadhullah et al., 2022).

Ensuring the safe and efficient management of healthcare risk waste is a shared responsibility among all waste generators, including caregivers in home settings. While hospitals constitute the largest source of medical waste, the growing trend toward home-based healthcare services, earlier post-surgical discharge, and domiciliary disease management means that medical waste concerns extend well beyond institutional boundaries (Udofia, Gulis & Fobil, 2017).

Global waste generation has been estimated at 7 to 10 billion tons each year, with only around 2 billion tons classified as municipal solid waste; medical waste accounts for a comparatively small proportion of this total. Data suggests that roughly 80% of medical waste in developing nations is co-disposed with general household refuse, with biological waste comprising approximately 10–25% hazardous material and 75–95% non-hazardous components **(**Pattra, Thawng & Chaiwong, 2023).

Residential waste presents considerable risks to both public health and the environment due to the presence of potentially dangerous substances. Materials classified as hazardous in household waste exhibit characteristics such as flammability, corrosive properties, chemical reactivity, and toxicity. Exposure to such substances has been linked to various adverse health effects, including irritation of the skin, eyes, or throat, persistent headaches, and in severe cases, malignancy (Central Public Health & Environmental Engineering Organization [CPHEEO], 2016).

A critical element in healthcare waste management involves the segregation of contaminated materials from routine domestic refuse. Proper handling requires that home medical care waste

(HMCW) be gathered and disposed of in compliance with established medical waste regulations by trained personnel. Although visiting home care teams typically collect HMCW during treatment visits, limited documentation exists regarding the methods employed by caregivers and patients in managing waste from activities such as insulin administration, wound dressing, injections, colostomy care, and catheter maintenance at home (Sonmez, Nazik & Andi, 2018).

The management of home medical care waste encompasses processes designed to prevent disease transmission and safeguard environmental health, incorporating the collection, transportation, treatment, and final disposal of all associated materials (Barua & Hossain, 2021). All HMCW must undergo appropriate processing prior to disposal, with treatment protocols aimed at rendering infectious materials, anatomical waste, clinical refuse, and general medical waste safe for final handling (Padmanabhan & Barik, 2019).

Significance of the study

The delivery of healthcare services is essential for preserving life and promoting well-being; however, the by-products of these activities carry substantial risks of toxicity and disease transmission when not properly managed (Andeobu, 2023). Across the globe, recognition of the importance of safe biomedical refuse handling has been increasing, especially in resource-limited settings where waste management infrastructure remains underdeveloped (Anicetus et al., 2020). Within Egypt specifically, municipal solid waste volumes have surged by over one-third in recent years, driven largely by rapid population expansion. Yet recycling rates languish at just 11.5%, with the vast majority of collected waste exceeding four-fifths going unrecovered (Elmasry et al., 2022).

Substandard approaches to managing healthcare refuse place multiple stakeholder groups including patients, healthcare personnel, sanitation workers, and the broader community at elevated risk of harm. In many developing countries, medical refuse continues to be commingled with ordinary household garbage (Padmanabhan & Barik, 2019). Such mismanagement carries severe environmental and health consequences: improperly discarded infectious materials can propagate numerous communicable conditions, among them typhoid fever, viral hepatitis (types B and C), HIV infection, and bacterial illnesses caused by Escherichia coli, Staphylococcus aureus, and Pseudomonas aeruginosa (Mahmoud, Abdelrhman Alhanafy & Awad Negm, 2022).

Lack of education and awareness of effective waste management practices is one of the significant issues in developing countries. Most people lack interest in environmental issues. It means that they are not well informed, which affects their actions. It also makes them feel not

included in decision making on waste management (Dahlin et al., 2017; Bisenio et al., 2025). The family can play an essential role in protecting and promoting the health of the community and the environment. The family can manage hazardous wastes properly by proper planning. They can prevent from producing a considerable amount of leachate by separating the household hazardous waste at the site of production and collecting them separately (Amouei et al., 2014). So, this study aims to raise awareness regarding how to manage home medical waste in a manner that protects family and environment from potential hazards that arise from wrong management of wastes or accumulation of it in improper place of the environment.

Aim of the Study

The aim of this study was to evaluate the effect of an educational program for home-based caregivers regarding safe medical waste disposal generated from home health care.

Research hypothesis

H1: Home based caregivers who participate in the safe medical waste disposal educational program .will have higher mean knowledge scores in the post-test than in the pretest

H2: Home based caregivers who participate in the safe medical waste disposal educational program will have higher mean practice scores in the post-test than in the pretest.

Subjects and Methods

Research Design

Quasi-experimental design (one group pre / post-test) was utilized in the current study. One group (pre / post-test) design was one type of quasi-experimental design, which the outcome of interest is measured 2 times: once before and once after exposing a non-random group of participants to a certain intervention/treatment.

Setting

This study was conducted at outpatient clinics in family health centers at new Damietta city, Damietta governorate. General medical center, which was composed of one floor divided into different outpatient clinics serving different target group from new born babies to elderly personnel and the center work every day from 8 am till 2 pm.

Sample

A purposive sample was used for selection of caregivers at the outpatient clinics in family health centers. All caregivers fulfilling the following criteria and were available at the time of the collection process were involved in the study.

Inclusion criteria

1. Adult caregivers (aged 18 years or older).
2. Caring for chronic ill patients and dealing with medical waste at home.

Tools of data collection

After reviewing the related national and international literature on safe medical waste disposal generated from home health care, two tools of data collection were developed by the researcher to assess caregivers' knowledge and practice regarding safe medical waste disposal generated from home health care.

Tool I: Safe medical waste disposal caregiver's knowledge structured questionnaire:

It included three parts:

***1st part*: Demographic Data Sheet:**

This part includes demographic characteristics of caregivers related to age, sex, educational level, occupation, number of family members, income and responsible personnel who apply medical care at home. This part was used only before the application of program.

***2nd part:* Family's Health Status Data Sheet:**

This part was used to evaluate health status of the family and included 6 multiple choice questions where more than one alternative could be selected related to; determine ill person at the family, types of chronic diseases at the family, infectious disease among family members, types of wound that need medical care at home, reason for utilizing needles at home, and categories of medical wastes generated daily by home care. This part was used only before the application of program.

***3rd part*: Caregiver's Knowledge Regarding Safe Medical Waste Disposal:**

This part included 9 questions related to the concept of medical waste, types of medical wastes, proper method to dispose medical wastes ,proper method to dispose needles and sharp objects, damage resulting from accumulation of medical wastes at home, health risks resulting from incorrect handle of medical wastes at home, types of personal protective measures caregiver use during medical care at home, colors of bags to store medical waste at home ,and the source of information about safe medical disposal at home. This part was used as pre and posttest.

Scoring system of caregiver's safe medical waste disposal knowledge questionnaire:

Only one question was answered by yes or no; where yes was scored 1 and no was scored 0. And the remaining 8 questions were multiple choice questions; where more than one alternative could be selected: correct and complete answer were scored 3, correct and incomplete answer scored 2 and incorrect or don't know answer were scored 1. A total score of knowledge was computed by summing correct responses of all questions. Total knowledge was categorized as good from 18-24 score (≥75%), fair from 12- to less than 24 score (50% to < 75%) and poor knowledge less than 12 score (<50%) out of total score of 24.

Tool II: caregiver's self-reported practices regarding safe medical waste disposal scale:

It was used to assess reported practices of caregivers related to safe medical waste disposal. It contains 21 questions related to how the caregiver follow instruction of doctor when dealing with medical waste at home, whether caregiver separate medical waste from household waste at home, utilizing medical tools more than one time at home. This tool was used as pre /posttest.

Scoring system of caregiver practices concerning safe medical waste disposal questionnaire:

The scale composed of 21 questions with 3 responses: always, sometimes and never. A total score of practice scale was computed by summing correct responses of all questions. Total practice scores were categorized as good from 47.25 - 63 score (≥75%), fair from 31.5 to less than 47.25 score (50% to < 75%) and poor practice score less than 31.5 score (<50%) out of total score of 63.

Content validity and reliability

Content validity of the study tools was done by a panel of five professors in community health nursing and medical surgical departments. The researcher asked the experts to link each objective with its respective items , assess the relevancy of the item to the content addressed by objectives and judge if they believe the items on the tool adequately represent the content in the domain of interest .Then , the researcher employed the alpha coefficient as the index of content validity .The resulting alpha coefficient quantified the extent to which there was agreement between the experts rating of the items .A coefficient of 0.00 indicated lack of agreement between the experts and a coefficient of 1.00 indicated complete agreement Cronbach's Alpha was used to determine internal consistency, yielding a reliability coefficient of 0.87.

Ethical considerations

This study was approved by the Research Ethics Committee at the Faculty of Nursing, Damietta University (Code: **Du Rec no 49 on Dec 1, 2024**) and was conducted in accordance with the ethical principles of the Declaration of Helsinki. All participants were informed about the purpose and benefits of the study. All participants were informed that their participation was voluntary, and the data collected will be used only for the purpose of the study. Written informed consent was obtained from all participants. Also, measures were taken to ensure confidentiality through data collection and coding.

Procedure

1- **Preparation phase:**

A review of related literature covering various aspects of the problem was carried out, using available books, journals, and internet to get acquainted with the research problem and develop the research tools. An official permission was granted from the research ethics, Faculty of Nursing at Damietta University to proceed with the study and an official permission was granted from the administrator of family health centers.

2- Assessment phase:

In the pre-test phase, tools were completed by the caregivers who agreed to participate in the study as baseline information and to develop the content of the health education intervention. Researchers distributed the tools through outpatient clinics at the selected family health centers. Each questionnaire took about 30 minutes to complete, and the interviewers were finalized.

3- The implementation phase of the study:

This phase started after the results of the pre-test had been analyzed. The intervention (safe medical waste disposal educational program) was developed by the researchers based on the data collected in the assessment phase and reviewing of related literature. The Program was done at twice-weekly sessions, 45–60 minutes each. Every session ended with 5-10 minutes to review the session's content and taken feedback from the caregivers. Each session had its title and objectives according to its content. The program was a total of 8 sessions over a one-month period. The teaching materials included brochures, and posters. Brainstorming and discussion were used as teaching methods.

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 changes in caregiver's knowledge and self-reported practice related to safe medical waste disposal using the same tools (post-test).

Statistical Analysis

Data were statistically described in terms of mean, standard deviation, frequencies, and percentages when appropriate. Comparison of numerical variables between the pre- and post-intervention phases was done using the paired samples t-test. For comparing categorical data, the Chi-square (χ^2) test was performed. Fisher's Exact test was used when the expected frequency was less than 5. Pearson correlation coefficient was used to assess the relationship between knowledge and practice scores. Two-sided *p*-values less than 0.05 were considered statistically significant. All statistical calculations were done using the computer program IBM SPSS (Statistical Package for Social Science; IBM Corp, Armonk, NY, USA) release 22 for Microsoft Windows.

Results

Table (1) shows that, the majority of participants fall within the 30–<40 age group (44.6%), followed by those aged 20– <30 (25.0%) and 40– <50 (20.5%). Only a small portion are under 20 (3.6%) and over 50 (6.3%). The mean age is 34.21 years with a standard deviation of ±5.11, indicating that most respondents are middle-aged adults with relatively little variation in age. Regarding the gender, the sample is predominantly female (82.1%), with only 17.9% male participants. In relation to the father's educational level, the majority of fathers have received at least a secondary school education, with 29.5% completing secondary school, 25.0% obtaining a university education, and 3.6% holding a postgraduate degree. However, a notable portion have low educational attainment; 8.9% are illiterate and 24.1% can only read and write.

Moreover, mothers generally have slightly lower educational attainment compared to fathers. While 32.1% have completed secondary school and 29.5% have a university degree, a significant percentage are illiterate (15.2%) or have only basic literacy skills (11.6%). Only 2.7% have pursued postgraduate education. In relation to father's occupation**,** most fathers are engaged in the private sector (44.6%) or government work (33.0%), while 22.3% do not work. Also, a majority of mothers (59.8%) do not work. Among those who are employed, 34.8% work in the government sector and only 5.4% in private jobs. The same table shows that over half of the

families (55.4%) report that their income is "not enough," while 44.6% consider it "enough". Concerning family size, most families consist of 3–5 members (74.1%), a smaller proportion have more than five members (22.3%), and very few consist of only the father and mother (3.6%).

Figure (1) reveals that mothers are the predominant caregivers, accounting for 66.1% of cases, which highlights their central role in providing care within families. This is followed by the father, who serves as the caregiver in 24.1% of cases. Other caregiver roles are significantly less common, with sons or daughters providing care in 6.3% of instances, nurses in only 0.9%, and others (such as extended family or friends) comprising just 2.7%. These results underscore the heavy reliance on maternal figures for caregiving responsibilities and suggest a limited involvement of professional or alternative caregivers in the home care setting.

Table (2) reveals that the father is the most common medication user (30.4%), followed by the mother (23.2%) and grandparents (20.5%). A notable 18.8% reported no one in the household is on medication. Smaller percentages report multiple users: grandparents and sons (3.6%), or parents and grandparents (0.9%), while only 2.7% reported a son/daughter taking medications, suggesting chronic illness in children is relatively uncommon in this sample. Regarding the prevalence of chronic disease, hypertension (27.7%) and diabetes mellitus (12.5%) are the most common chronic conditions, with 22.3% reporting both. Fewer participants reported liver diseases (4.5%), kidney diseases (0.9%), while 32.1% reported no chronic illness.

Regarding the prevalence of infectious diseases, a large majority (79.5%) reported no infectious diseases. Respiratory infections were the most reported (8.0%), followed by H. Pylori (5.4%), hepatitis, and dermatological infections (both 3.6%). Pertaining to experience with wound care, 83% of participants reported no involvement in wound care. The most common wound care experience involved surgical wounds (6.3%), diabetic foot care (5.4%), and newborn navel care (2.7%). Very few encountered accident wounds, colostomies, or other specialized wound needs.

Concerning the reasons for injections at home, the most common reason was intramuscular (IM) injections (40.2%), followed by “all of the above” (21.4%), suggesting multiple injection uses. IV infusions (10.7%), blood glucose monitoring (8.0%), and IV

injections (3.6%) were also noted, while 16.1% reported not using injections at all. About the Types of Medical Waste Produced, the most reported types of waste were needles and sharps (33.9%), and ampoules (26.8%), indicating widespread use of injectable medications. Other types include wound care materials (8.9%), urine collection bags (6.3%), nebulizers (6.3%), and oxygen masks (1.8%). A small number reported colostomy bags (0.9%), all of the above (8.0%), or none (7.1%).

Table (3) illustrates that pre-intervention scores ranged between 8 and 22, with an average score of 12.98 ± 2.73, suggesting a moderate level of knowledge and considerable variability among participants. Following the intervention, the mean score rose notably to 18.77 ± 2.02, indicating a marked enhancement in knowledge. The decrease in standard deviation implies that participants' knowledge levels became more uniform. Additionally, the p-value of .000 denotes a highly significant difference.

Figure (2) shows the participants' knowledge levels before and after an educational program. Prior to the intervention, the majority of participants were classified as having poor knowledge (46.5%), followed by fair (33.9%), and only 19.6% demonstrated good knowledge. However, after the educational program, there was a marked improvement. The proportion of participants with good knowledge increased significantly to 63.4%, while those in the fair and poor knowledge categories dropped to 17.9% and 18.7%, respectively. These findings clearly indicate that the educational intervention had a substantial positive impact on participants' knowledge levels.

Table (4) shows a significant improvement in participants' total practices score following the intervention. Before the intervention, scores ranged from 24 to 61, with a mean of 37.47 ± 6.57, indicating generally moderate practice levels with some variability among participants. After the intervention, the mean score increased notably to 51.66 ± 6.60, reflecting a substantial enhancement in practical application or behavior. The results of the t-test ($t = 52.77$, $p = .000$) confirm that this improvement is highly statistically significant ($p < 0.001$), strongly suggesting that the intervention was effective in improving participants' practices.

Concerning the total practices level, figure (3) displays the participants' practical skill levels before and after an educational program. Prior to the program, the majority of participants exhibited fair (47.3%) and poor practices (41.1%), while only 11.6%

demonstrated good practices. After the intervention, there was a significant shift: the proportion of participants with good practices increased dramatically to 66.1%, while those with fair and poor practices declined to 20.5% and 13.4%, respectively. This substantial improvement indicates the positive impact of the educational program in enhancing practical knowledge and behaviors, effectively elevating participants' performance from lower levels to a more competent and consistent practice level.

The results in table (5) show a strong and statistically significant positive correlation between total knowledge and total practices, both before and after the educational program. Prior to the intervention, the correlation coefficient was r = 0.717 with a p-value of .000, indicating a significant relationship between the level of knowledge and the quality of practices. Following the intervention, this positive relationship slightly increased, with a correlation of r = 0.730 and the same highly significant p-value of .000. These findings suggest that as participants' knowledge improved, their practical behaviors also enhanced. The strengthened correlation after the program further emphasizes the effectiveness of the educational intervention in reinforcing the connection between theoretical understanding and practical application.

The regression analysis results for both pre- and post-educational program periods reveal insightful patterns regarding the predictors of total knowledge. Before the educational program, gender and mother's occupation were statistically significant predictors of total knowledge. Specifically, being female (B = 1.352, ***p*** = .042) and having a mother with a certain occupation (B = 0.626, ***p*** = .033) were positively associated with higher knowledge scores. Other variables such as age, parental education levels, father's occupation, and family income did not show statistically significant effects, although father's occupation approached significance (***p*** = .075), indicating a possible trend worth exploring further.

Following the educational program, none of the predictors, including those previously significant, remained statistically significant. The lack of significance across all variables post-intervention (with all *p*-values > .05) suggests that the educational program may have leveled the playing field, reducing the impact of demographic and socioeconomic factors on knowledge scores. This outcome could imply the program's effectiveness in providing equitable knowledge gains across diverse participant backgrounds.

The regression analysis examining the predictors of total practices both before and after the educational program provides valuable insights into the influence of various

demographic and socioeconomic factors. Prior to the educational program, only father's occupation emerged as a significant predictor of total practices (B = 2.954, p = .002), indicating that participants whose fathers had certain occupations demonstrated significantly better practice scores. Although gender approached statistical significance (B = -2.690, p = .090), suggesting that males might have had slightly lower practice scores, the result was not conclusive. Other variables, including age, parental education, mother's occupation, and family income, were not significant predictors of practices in the pre-program phase.

After the educational program, the pattern of predictors shifted. Father's occupation remained a significant predictor (B = 4.775, p = .010), reinforcing its consistent influence on practice behaviors. Additionally, father's educational level became a significant factor post-program (B = 2.393, p = .024), suggesting that participants with more educated fathers showed improved practice scores after receiving the educational intervention. Other variables, including age, gender, mother's education and occupation, and income, did not show a significant impact after the intervention. Overall, the results emphasize the persistent role of paternal occupation and the emerging importance of paternal education in influencing health or behavioral practices post-intervention.

Table 1: Frequency distribution of studied caregivers regarding their demographic characteristics (N=112)

Items	***No.***	***%***
Age (Years)		
Less than 20	**4**	**3.6**
20 – < 30	**28**	**25**
30 – < 40	**50**	**44.6**
40 – < 50	**23**	**20.5**
50 or more	**7**	**6.3**
Mean ± SD	**34.21 ± 5.11**	
Gender		
Male	**20**	**17.9**
Female	**92**	**82.1**
Fathers' Educational Level		
Illiterate	**10**	**8.9**
Read and write	**27**	**24.1**
Primary school	**10**	**8.9**
Secondary school	**33**	**29.5**
University education	**28**	**25**
Postgraduate education	**4**	**3.6**

Mothers' Educational Level		
Illiterate	**17**	**15.2**
Read and write	**13**	**11.6**
Primary school	**10**	**8.9**
Secondary school	**36**	**32.1**
University education	**33**	**29.5**
Postgraduate education	**3**	**2.7**
Fathers' Occupation		
Government work	**37**	**33**
Private work	**50**	**44.6**
Don't work	**25**	**22.3**
Mothers' Occupation		
Government work	**39**	**34.8**
Private work	**6**	**5.4**
Don't work	**67**	**59.8**
Monthly Family Income		
Enough	**50**	**44.6**
Not enough	**62**	**55.4**
Family Members		
Father and mother only	**4**	**3.6**
3–5 members	**83**	**74.1**
More than 5 members	**25**	**22.3**

Figure (1): Percentage distribution of studied caregiver provider (N=112).

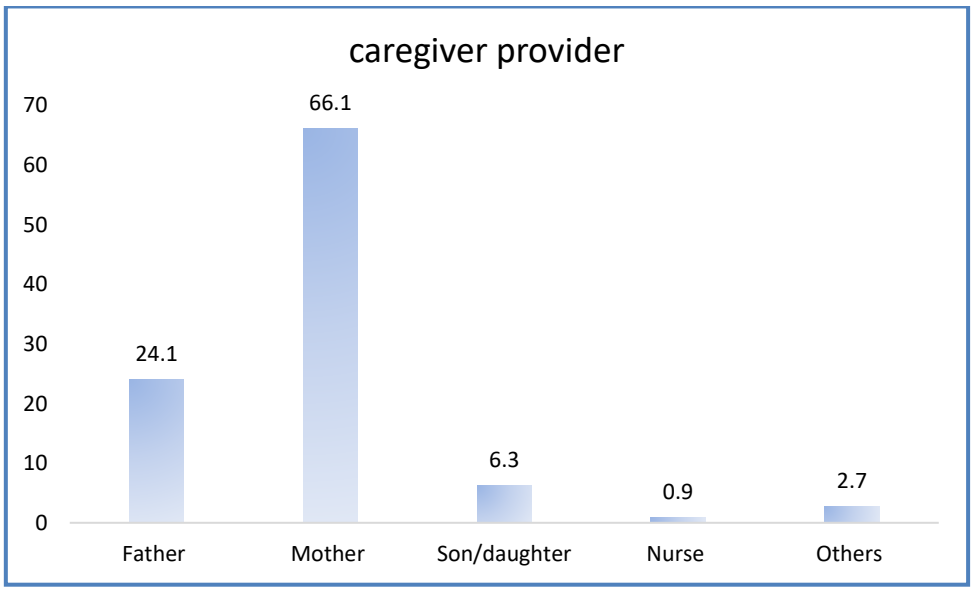


Table (2): frequency distribution of studied caregivers regarding their medical health status (N=112).

Items	*No.*	*%*
Q1: Medication Users in Household		
Father	**34**	**30.4**
Mother	**26**	**23.2**
Grandpa / Grandma	**23**	**20.5**
Son / Daughter	**3**	**2.7**
No One	**21**	**18.8**
Parents and Grandparents	**1**	**0.9**
Grandparents and Sons	**4**	**3.6**
Q2: Prevalence of Chronic Diseases		
Hypertension	**31**	**27.7**
Diabetes Mellitus (DM)	**14**	**12.5**
Combined DM / Hypertension	**25**	**22.3**
Liver diseases	**5**	**4.5**
Kidney diseases	**1**	**0.9**
None	**36**	**32.1**
Q3: Prevalence of Infectious Diseases		
Respiratory Infections	**9**	**8**
H. Pylori	**6**	**5.4**
Hepatitis	**4**	**3.6**
Dermatology	**4**	**3.6**
None	**89**	**79.5**
Q4: Experience with Wound Care		
Surgical Wound	**7**	**6.3**
Diabetic Foot	**6**	**5.4**
Changing newborn navel	**3**	**2.7**
Colostomy	**2**	**1.8**
Accident Wound	**1**	**0.9**
None	**93**	**83**
Q5: Reason for Injections at Home		
Intramuscular (IM)	**45**	**40.2**
All of the above (multiple types)	**24**	**21.4**
No injections used	**18**	**16.1**
IV Infusion	**12**	**10.7**
Blood glucose measurement	**9**	**8**
Intravenous (IV)	**4**	**3.6**
Q6: Types of Medical Waste Produced		
Needles and Sharps	**38**	**33.9**
Ampoules	**30**	**26.8**
Wound Care Materials	**10**	**8.9**
All of the above	**9**	**8**
None of the above	**8**	**7.1**
Urine Collection Bag	**7**	**6.3**
Nebulizer	**7**	**6.3**

Oxygen mask	**2**	**1.8**
Colostomy bag	**1**	**0.9**

Table 3: Mean and standard deviation of studied caregiver knowledge pre and post intervention (N=112)

Variable	*Pre-intervention*	*Post-intervention*	*Paired t-test*	*p-value*
Total Knowledge Score			**37.922**	**.000****
Mean ± SD +4	**12.98 ± 2.73 +4**	**18.77 ± 2.02 +4**		
Range (Min – Max) +4	**8 – 22 +4**	**—**		

****Highly Statistically Significant at p < .001.**

Figure (2): percentage distribution of studied caregivers regarding their knowledge pre and post intervention (N=112).

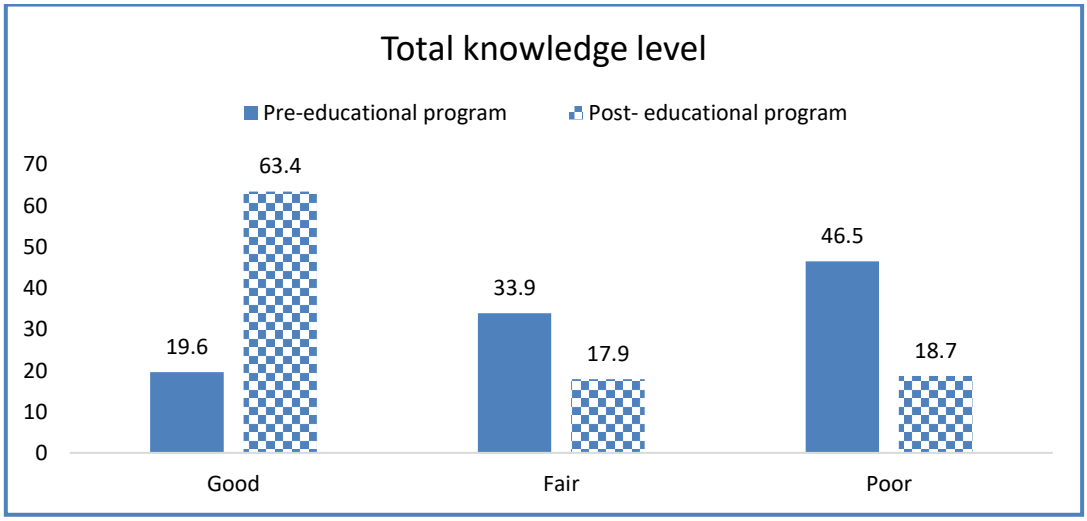


Table 4: Mean and standard deviation of studied caregivers' practice pre and post intervention (N=112)

Variable	*Pre-intervention*	*Post-intervention*	*Paired t-test*	*p-value*
Total Practices Score			**52.77**	**.000****
Mean ± SD	**37.47 ± 6.57**	**51.66 ± 6.60**		
Range (Min – Max)	**24 – 61**	**—**		

****Highly Statistically Significant at p < 0.001.**

Figure (3): percentage distribution of studied caregivers regarding their Practices pre and post intervention (N=112).

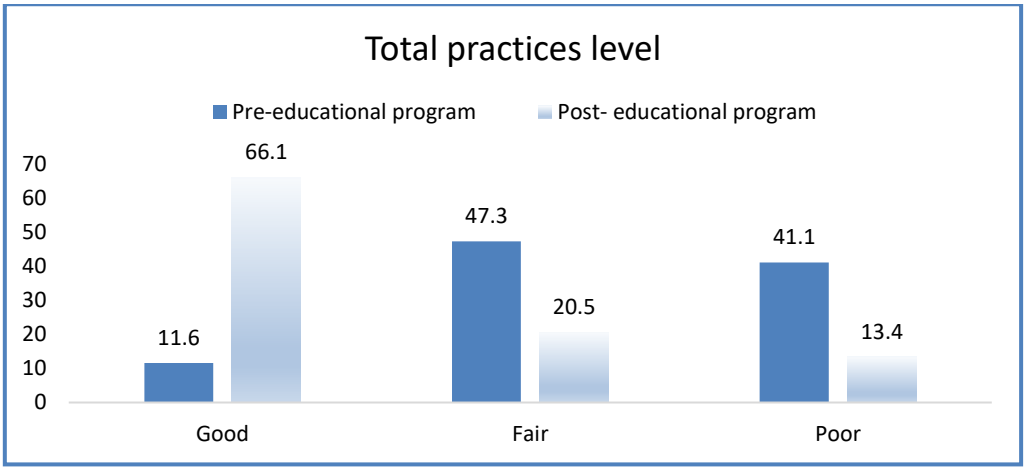


Table 5: Correlation between total knowledge and total practices among studied caregivers pre and post educational program (N=112)

Variable	*Total Knowledge (Pre-program)*	*Total Knowledge (Post-program)*
Total Practices		
Correlation Coefficient (r)	**.717 +2**	**.730 +3**
p-value	**.000** +2**	**.000** +3**

****Highly Statistically Significant at p < 0.001.**

Table 6: Linear regression of studied caregiver regarding their knowledge in relation to demographic characteristics pre and post educational program (N=112)

Period	*Model Variable*	*Unstandardized B*	*Std. Error*	*Beta*	*t*	*Sig. (p)*
Pre-educational Program	**(Constant)**	**16.751**	**2.219**	**—**	**7.55**	0
	Age	-0.384	0.274	-0.13	-1.402	0.164
	Gender	1.352	0.657	0.19	2.058	**.042***
	Father's educational level	0.077	0.228	0.036	0.338	0.736
	Mother's educational level	0.068	0.232	0.034	0.293	0.77
	Father occupation	0.716	0.398	0.194	1.8	**0.075**
	Mother occupation	0.626	0.29	0.216	2.157	**.033***
	Monthly family income	0.471	0.535	0.086	0.88	0.381
Post-educational Program	(Constant)	20.136	1.729	—	11.647	0
	Age	-0.078	0.214	-0.036	-0.367	0.714
	Gender	0.625	0.512	0.119	1.221	0.225
	Father educational level	0.2	0.178	0.128	1.127	0.262

Mother educational level	0.06	0.181	-0.04	0.333	0.739
Father occupation	0.281	0.31	0.103	0.906	0.367
Mother occupation	0.082	0.226	0.038	0.361	0.719
Monthly family income	-0.092	0.417	-0.023	-0.221	0.826

Note: Dependent Variable: Total knowledge.
*** Statistically significant at p < 0.05**

Table 7. Linear regression of studied caregivers regarding their practices in relation to demographic characteristics pre and post educational program (N=112)

Period	*Model Variable*	*Unstandardized B*	*Std. Error*	*Beta*	*t*	*Sig. (p)*
Pre-educational Program	**(Constant)**	**45.46**	**5.313**	**—**	**8.557**	**0**
	Age	0.249	0.656	0.035	0.38	0.705
	Gender	-2.69	1.573	-0.157	-1.711	0.09
	Father educational level	0.084	0.546	0.017	0.154	0.878
	Mother educational level	0.101	0.556	0.021	0.182	0.856
	Father occupation	2.954	0.953	0.332	3.101	**.002***
	Mother occupation	1.016	0.695	0.146	1.463	0.146
	Monthly family income	0.777	1.28	0.059	0.606	0.546
Post-educational Program	**(Constant)**	50.39	10.165	—	4.957	0
	Age	0.308	1.256	0.023	0.245	0.807
	Gender	0.188	3.009	0.006	0.062	0.95
	Father's educational level	2.393	1.044	0.25	2.292	**.024***

Mother's educational level	1.717	1.064	0.188	1.614	0.11
Father occupation	4.775	1.823	0.285	2.62	**.010***
Mother occupation	0.194	1.329	0.015	0.146	0.884
Monthly family income	1.991	2.45	0.08	0.813	0.418

Note: Dependent Variable: total practices.
*** Statistically significant at p < 0.05.**

Discussion

Demographic & Gender Patterns

Individuals receiving inpatient care frequently present with severe conditions that increase their vulnerability to hospital-acquired infections both during hospitalization and following discharge. However, expanding the delivery of **healthcare services to home settings** offers a promising approach to reducing these nosocomial infection risks by enabling higher-risk patients to receive treatment within their own residences rather than in institutional environments. Nevertheless, this transition introduces an important concern regarding the proper management and disposal of medical and pharmaceutical waste generated during domiciliary care. Home care services serve an essential function in supporting patients who encounter barriers to accessing healthcare facilities, and in light of growing environmental awareness, the role of environmental factors in microbial transmission between individuals has received increased scholarly attention.

Home-based healthcare is expanding rapidly as more individuals require care that allows them to remain in their homes as they age. General in-home care services provide non-medical services such as help with daily tasks, while home health care provides medically necessary care and is covered by insurance. This care may include long-term skilled nursing care for patients with chronic illnesses or disabilities. Many patients who receive care in their home also receive medication and utilizing at-home medical care allows them to maintain comfort and independence, while managing expenses. In addition, medication received at home may include intravenous chemotherapy treatments, blood collection, injections for diabetes, vitamin injections and more. The treatments often involve using **sharps**, as well as tubing, gauze, and other items that contain blood and other

infectious fluids and pathogens. Home-based caregivers often generate this type of medical waste that requires proper disposal. The guidelines for handling, transporting, and disposing of medical waste are essential to ensure safety and compliance with local regulations. (Webber, 2024). Therefore, the aim of this study was to evaluate the effect of an educational program for home-based caregivers regarding safe medical waste disposal generated from home health care.

Demographics

The findings of the present study emphasize the necessity of implementing targeted educational programs to strengthen caregivers' understanding and practices related to safe medical waste disposal. The demographic profile indicates that the sample was predominantly composed of middle-aged female caregivers serving as primary care providers within their households, with male caregivers representing only 17.9% of participants. This gender distribution reflects the reality that caregiving activities tend to be physically demanding, making them less suitable for elderly family members, and within the study community, younger mothers typically assume responsibility for home-based patient care. Furthermore, a notable proportion of participating families reported limited educational backgrounds and inadequate financial resources, with 55.4% indicating insufficient income levels, a pattern that may be attributable to prevailing economic conditions.

On other hand, Home-Based Caregivers are not only responsible for providing quality medical care through their home-health care for patients. They are also responsible for ensuring the safe collection and disposal of medical waste that is generated during that care. Therefore, this demographic context highlights the importance of implementing educational health programs that consider the caregivers' socio-economic and educational levels. The present study findings in line with a study by Zikhathile & Atagana, (2018) to determine Challenges Facing Home-Based Caregivers in the Management of Health Care Risk Waste and found that the majority of caregivers were middle-aged females. From the study sample only two caregivers were males while 78 were females.

Moreover, the findings reveal that mothers are the predominant caregivers, accounting for 66.1% of cases, which highlights their central role in providing care within families and underscores the heavy reliance on maternal figures for caregiving responsibilities and suggest a limited involvement of professional or alternative caregivers in the home care

setting**.** According to Zikhathile & Atagana, (2018) services provided by caregivers are nursing care, physical care, patient support, domestic chores, and psychological care. Nursing care includes dressing wounds, administering medication, and supervised treatment support (directly observed treatment support). Physical care includes assisting patients to use toilets, feeding and bathing patients, changing patients, and helping patients exercise.

Caregivers regarding their medical health status:

The current study findings reveal that the father is the most common medication user, followed by the mother and grandparents. Regarding the prevalence of infectious diseases, a large majority reported no infectious diseases. Respiratory infections were the most reported, followed by H. Pylori, hepatitis, and dermatological infections. Our study findings reflect the growing burden of non-communicable diseases in community settings and highlight the importance of caregiver support in chronic disease management. Most of the participants reported no involvement in wound care and most common wound care experience involved surgical wounds, diabetic foot care and newborn navel care,very few encountered accident wounds, colostomies, or other specialized wound needs. Concerning the reasons for injections at home, the most common reason was intramuscular (IM) injections and suggesting multiple injection uses, IV infusions blood glucose monitoring and IV injections were also noted.

The medical waste produced

With respect to the categories of waste reported, the study found that needles, sharps, and ampoules were the most frequently encountered types, reflecting the extensive use of injectable medications in home settings. Additional waste categories identified included wound dressing supplies, urinary collection devices, nebulizer equipment, and oxygen delivery apparatus, with a minority of caregivers reporting colostomy bag disposal. These observations align with the findings **of** Zikhathile & Atagana (2018), who noted that nursing care generates materials contaminated with bodily fluids or blood, including bandages, cotton wool, and gauze soiled with secretions such as pus or exudate. Similarly, diapers utilized by immobilized patients and discarded pharmaceutical packaging constitute healthcare risk waste. Notably, scholarly and regulatory attention has historically prioritized institutional healthcare waste over that produced in home

settings. Related research **by** Soliman et al. (2024) documented widespread use of insulin pens among diabetic patients, with approximately three-quarters of participants administering twice-daily injections. These results are comparable to those **of** Hassan et al. (2021), who reported that 73.2% of their study participants followed an equivalent injection schedule.

Caregivers' knowledge, practices at pre and post intervention:

Regarding the participants' knowledge, the current study denotes a highly statistically significant difference in their knowledge and indicates a marked enhancement in knowledge regarding safe medical waste disposal generated from home health care. Prior to the intervention, the majority of participants were classified as having poor knowledge, followed by fair and only 19.6% demonstrated good knowledge. However, after the educational program, there was a marked improvement. The proportion of participants with good knowledge increased significantly to 63.4%, while those in the fair and poor knowledge categories dropped to 17.9% and 18.7%, respectively. These findings clearly indicate that the educational intervention had a substantial positive impact on participants' knowledge levels. Our study results in aligning with existing literature emphasizing the role of education in improving waste management practices in healthcare settings.

Similar improvements in knowledge outcomes were documented **by** Soliman et al. (2024), who observed that participants exposed to an educational intervention demonstrated statistically significant knowledge gains. The sustained retention of acquired knowledge among participants suggests effective comprehension and long-term information maintenance. These results are further corroborated by El Gendi et al. (2017), whose Egyptian study at Banha University demonstrated an increase in mean knowledge scores from 57.2 ± 27.8 at baseline to 85.2 ± 16.2 following the intervention, accompanied by a rise in the proportion of participants achieving good knowledge levels from 65.2% to 85.4%. Additionally**,** Herardi et al. (2023**)** reported findings from an Indonesian study indicating that educational interventions delivered by healthcare professionals produced significant improvements in patient knowledge.

Concerning participants' practical behaviors related to safe medical waste disposal, the study results revealed statistically significant improvements in total practice scores

following the educational intervention. Mean practice scores increased from 37.47 to 51.66, reflecting a notable shift from predominantly inadequate and moderate practice levels toward predominantly adequate performance. These improvements demonstrate the beneficial effects of structured education on both practical skills and behavioral outcomes, enabling participants to advance from lower competency levels to more consistent and proficient practice. Furthermore, the study identified a robust, statistically significant positive relationship between knowledge and practice scores at both assessment points. The enhanced strength of this correlation following the intervention highlights the program's effectiveness in bridging theoretical knowledge with practical application. The findings also point to the continuing influence of paternal occupational status and the growing significance of paternal educational attainment as determinants of health-related practices after the intervention. The importance of increasing awareness about proper home medical waste management to safeguard family members and the surrounding environment from risks associated with improper handling or storage of waste materials cannot be overstated. Comparable results were reported by Islam et al. (2025), whose Bangladeshi study identified significant variations in knowledge, attitudes, and practices concerning medical waste management across different healthcare settings in Dhaka.

Conclusion:

Based on the findings of the current study, there was a significant improvement in participants' total score of knowledge and practices following the intervention. This substantial improvement indicates the positive impact of the educational program in enhancing behaviors, effectively elevating participants' performance from lower levels to a more competent and consistent practice level. Moreover, it showed that there was a strong and statistically significant positive correlation between total knowledge and total practices both before and after the educational program reinforcing the connection between theoretical understanding and practical application.

Recommendations

1. Our study recommends for future studies focus on prevention health risk and environmental pollution concern due to its hazardous characteristics.

2. It is important to implement educational and continuous training programs to raise health awareness regarding how to manage home medical wastes in a manner that protects the family and environment.
3. Families and the environment should be protected from potential risks caused by improper handling or accumulation of waste in unsuitable locations. It is essential for home healthcare caregivers to have proper knowledge and practices regarding the disposal of medical waste to ensure safe and effective waste management.
4. Engaging community health workers and primary health centers can help prevent health risks by ensuring proper waste management from generation to disposal and by promoting safe disposal practices while supporting home healthcare caregivers.

Limitations

Several limitations of this study should be noted. First, the reliance on self-reported practices may introduce social desirability bias, potentially creating a discrepancy between reported and actual caregiver behaviors. Second, the sample size was relatively small (N = 112), which may limit statistical power and the stability of regression findings. Third, data were collected from a single geographic location (outpatient clinics in family health centers in New Damietta City) using a purposive sampling approach, restricting the extent to which results can be generalized to other regions or healthcare settings. Fourth, the one-group pre-test/post-test quasi-experimental design, while appropriate for evaluating within-group change, does not include a concurrent control group; therefore, observed improvements cannot be definitively attributed to the educational intervention alone, as temporal maturation or testing effects may have contributed.

Declarations

Ethical approval: This study was approved by the Research Ethics Committee at the Faculty of Nursing, Damietta University (Code: Du Rec no 49 on Dec 1, 2024) and was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Consent to participate: Written informed consent was obtained from all individual participants included in the study.

Consent to publish: All participants provided written informed consent for the publication of their anonymized data. No identifiable personal information, images, or case details are included in this manuscript.

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References

Amouei, A., Hoseini, R., Asgharnia, H., Fallah, H., Faraji, H., & Aghalari, Z. (2014). Investigation of household hazardous waste production in Amirkola, Iran, in 2012–2013. Iranian Journal of Health Sciences, 2(3), 8–14. https://doi.org/10.18869/acadpub.jhs.2.3.8

Andeobu, L. (2023). Medical waste and its management. In The Palgrave Handbook of Global Sustainability (pp. 761-789). https://doi.org/10.1007/978-3-031-01949-4_53

Anicetus, H., Saria, J., & Mohamed, H. (2020). Estimation of different categories of healthcare waste generated at two different hospital categories in four hospitals in Dar es Salaam City. Journal of Environmental Protection, 11(10), 872–888. https://doi.org/10.4236/jep.2020.1110055

Barua, U., & Hossain, D. (2021). A review of the medical waste management system at Covid-19 situation in Bangladesh. Journal of Material Cycles and Waste Management, 23(6), 2087–2100. https://doi.org/10.1007/s10163-021-01291-8

Bisenio, S. J. A., Martin, A. R., & Dalumay, F. B. (2025). Service-learning project on solid waste management for high school science. DMMMSU Research and Extension Journal, 9(SI2), 1–35. https://doi.org/10.62960/dmmmsu.v9i1.69

Central Public Health and Environmental Engineering Organisation (CPHEEO). (2016). Municipal solid waste management manual: Part I — An overview. Ministry of Urban Development, Government of India. https://mohua.gov.in/upload/uploadfiles/files/Part1(1).pdf

Dahlin, J., Nelles, M., & Herbes, C. (2017). Biogas digestate management: Evaluating the attitudes and perceptions of German gardeners towards digestate-based soil amendments. Resources, Conservation and Recycling, 118, 27–38. https://doi.org/10.1016/j.resconrec.2016.11.020

El Masry, A., El Ghonemy, F., AbuGazia, I., & El Khater, R. (2022). *Reforming the solid waste management system: The case of rural areas in Egypt* (Policy Paper No. 33). The American University in Cairo, Public Policy Hub. https://fount.aucegypt.edu/studenttxt/102

Fadhullah, W., Imran, N. I. N., Ismail, S. N. S., Jaafar, M. H., & Abdullah, H. (2022). Household solid waste management practices and perceptions among residents in the East Coast of Malaysia. BMC Public Health, 22(1), 1-20. https://doi.org/10.1186/s12889-021-12274-7

Hassan, N. M., Shalaby, S. E. S., Atalla, A. O., & Younis, E. A. (2021). Toward safe environment: injection device disposal among diabetic patients attending tertiary care academic clinic in Middle Delta, Egypt. *Environmental science and pollution research international*, *28*(18), 23193–23203. https://doi.org/10.1007/s11356-021-12393-z

Herardi, R., Djajawiguna, H. N., Wahyuningsih, S., & Lestari, K. W. (2023). Factors associated with improving appropriate medical sharps disposal practice among diabetic patients using insulin therapy. F1000Research, 12, 1290. https://doi.org/10.12688/f1000research.141978.3

Islam, M. T., Rafi, M. A., & Hasan, M. J. (2025). Knowledge, attitude and practice of health care workers on solid medical waste management in two urban hospitals of Bangladesh: A mixed-method study. Journal of Health, Population and Nutrition, 44, 34. https://doi.org/10.1186/s41043-025-00748-y

Mahmoud, S. F., Alhanafy, S. I. A., & Negm, H. E. A. (2022). Effect of an educational program for Nurses working in Maternal and Child Health Care Centers about Health Care Waste Management. *Egyptian Journal of Health Care, 13*(1), 70–83. https://ejhc.journals.ekb.eg/article_214077.html.

Padmanabhan, K. K., & Barik, D. (2019). Health hazards of medical waste and its disposal. In Energy from Toxic Organic Waste for Heat and Power Generation (pp. 99–118). Elsevier. https://doi.org/10.1016/B978-0-08-102528-4.00008-0

Pattra, S., Thawng, C. N., & Chaiwong, S. (2023). "Four Joints of Power" innovation of community involvement in medical waste management of bed-bound patients in Thailand. *Sustainability, 15*(2), 1669. https://doi.org/10.3390/su15021669.

Soliman, H. M. H., El-Zoka, A. H., Fetohy, E. M., et al. (2024). The effect of an educational program on the knowledge and practices of diabetic patients regarding sharps waste disposal at home. Scientific Reports, 14, 30590. https://doi.org/10.1038/s41598-024-81308-y

Omac Sonmez, M., Nazik, F., & Andi, S. (2018). Home medical care waste collection by caregivers in Turkey. Medicine Science, 7(4), 733–735. https://doi.org/10.5455/medscience.2018.07.8872.

Stericycle. (2025, April 23). At-home care: Medical waste disposal assistance. https://www.stericycle.com/en-us/resource-center/blog/effective-at-home-medical-waste-disposal-for-patients-providers

Udofia, E. A., Gulis, G., & Fobil, J. (2017). Solid medical waste: a cross sectional study of household disposal practices and reported harm in Southern Ghana. *BMC public health*, *17*(1), 464. https://doi.org/10.1186/s12889-017-4366-9

Webber, K. (2024, August 20). A guide to medical waste disposal for home-based caregivers. Trihaz Solutions. https://www.trihazsolutions.com/a-guide-to-medical-waste-disposal-for-home-based-caregivers/

Willcox, M. L., Peersman, W., Daou, P., Diakité, C., Bajunirwe, F., Mubangizi, V., Mahmoud, E. H., Moosa, S., Phaladze, N., Nkomazana, O., Khogali, M., Diallo, D., De Maeseneer, J., & Mant, D. (2015). Human resources for primary health care in sub-Saharan Africa: Progress or stagnation? Human Resources for Health, 13, 76. https://doi.org/10.1186/s12960-015-0073-8

Zikhathile, T., & Atagana, H. (2018). Challenges facing home-based caregivers in the management of health care risk waste. International Journal of Environmental Research and Public Health, 15(12), 2700. http://dx.doi.org/10.3390/ijerph15122700