- ***Basic Research***

Impact of Awareness Program for Carbon Footprint Mitigation among Nursing Students. A Step toward Sustainability.

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Abstract

Background: Nursing students should be engaged in a structured program that raises their awareness of carbon footprint (CF) mitigation to prepare them for their critical future role toward community health promotion and environmental sustainability, through the adoption of low-carbon lifestyle behavior and thereby reducing their CF.
Aim: Assess the impact of the awareness program for carbon footprint mitigation among nursing students as a step toward sustainability.
Research Hypothesis: The implementation of the awareness program will lead to mitigating the carbon footprint rate among nursing students.
Methodology: A stratified simple random sample comprising 276 nursing students from the Modern University for Technology and Information's faculty of nursing was employed in a quasi-experimental design Three instruments were applied: (**1**) The Structured Questionnaire for Nursing Students which is separated into two sectors to evaluate their personal characteristics and awareness of CF (**2**) Nursing students' low-carbon lifestyle behavior scale. (**3**) The Online Carbon Footprint Calculator.
Results: A statistically significant improvement was detected between students' mean scores in CF awareness, and low-carbon lifestyle behavior before and after the intervention *(P<0.000**).* Additionally, the students' mean score of CF rate was statistically significantly reduced pre-intervention from *3.550* TonCo2e, to *3.032* TonCo2e during follow-up phase *(P < 0.015*).*
Conclusions: The developed CF mitigation awareness program significantly improves students' knowledge, and encourages the adoption of de-carbonization lifestyle behavior which led to reduce their CF by approximately half a ton.
Recommendations: Integrating climate change-related issues into universities' nursing curricula with greater emphasis on innovative CF mitigation strategies, to equip upcoming health leaders with environmental sustainability measures and to become model a de-carbonized lifestyle for others.

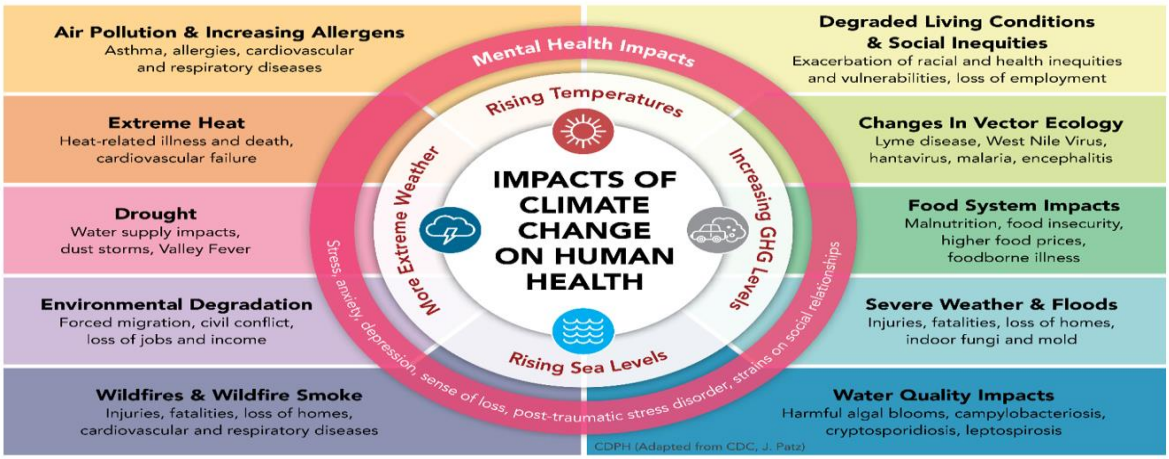
Keywords: Nursing students, Awareness Program, Carbon Footprint Mitigation, Sustainability.

1. Introduction:

Climate change (CC) is the most significant global health risk facing humanity that is not confined to one region but affects the entire planet [(1)]. The CC consequences, which are already evident and undeniably real, will be disastrous if action is not taken now, importantly the Intergovernmental Panel on Climate Change' (IPCC) sixth assessment signals an urgent "CODE RED" warning for humanity impacting the sustainable developmental goals (SDGs). Since the primary driver of CC is growing carbon dioxide (CO2) levels, reducing the carbon footprint (CF) is therefore of great importance for mitigating the effect of CC and safeguarding the earth for future generations. As a result, changing citizens' lifestyles is urgently needed to achieve decarbonized societies. Accounting-based consumption, or CF, is a useful indicator for assessing how human consumption is affecting climate by calculating CO2 and other greenhouse gases (GHG) produced during a specific time by various individual activities, organizations, services, or product manufacture and transportation in terms of Carbon dioxide equivalents (CO2-eq) [(2) & (3)].

From the outset of the industrial era, human activities- induced rising atmospheric CO2 emissions resulting from the combustion of nonrenewable fossil fuel, transportation and electricity generation, deforestation, intensive agriculture, farming livestock, and other human activities. As energy consumption continues to rise, so do CO2 emissions, it rose from an annual average of 280 billion tonnes in the late 1700s to 421 in 2022—a 50 % increase and predicted to increase at a rate more than 100 % higher than pre-industrial in about 55 years [(4)]. As atmospheric concentrations of carbon pollution increase, more heat is trapped, thus causing global warming. In 2023, the average global temperature surpassed the pre-industrial average by 1.40 ± 0.12 °C, making it the hottest year in the 174- calendar year meteorological record [(5)].

Global warming is about to take a disastrous turn, and there is not much time left to stop it. Egypt is among the most severe countries impacted by extreme weather, responsible for more than one-third of Africa's fossil gas consumption, and accounted as the continent's second-biggest gas producer [(6)]. The Egyptian Meteorological Authority (2023) reports that air temperatures have risen at a rate never before observed, by more than 3–4 degrees above average [(7)]. The rapid emission growth in Egypt additionally with the overpopulation and its geographical location makes it highly susceptible to the adverse of CC including water scarcity, drought, floods, food insecurity, extreme heat, rising sea levels, rainfall retention, desertification, and zoonotic diseases. All determinants of health are impacted, which may irreversibly alter global ecosystems and are already having an impact on billions of people worldwide. Consequently, CC has also numerous negative effects on human health including a rise in infectious diseases, skin cancer, stroke, asthma, eye cataracts, gastroenteritis, and injuries. Increased mortality is also expected from circulatory and respiratory illnesses [(8)].The World Health Organization estimates that between 2030 and 2050, an extra 250,000 fatalities annually could result from CC due to heat stress, diarrhea, malaria, and malnutrition [(1) &(9)]. Additionally, In Egypt, there were approximately ninety-five thousand registered premature deaths in 2019 because of air pollution [(10)]. The following figure represents how CC affects human health **Figure (1):**



Cited in: Impact of climate change on human health (based on the CDC), USAID from the American People. https://cch.icddrb.org/types-threats-due-climate-change**.**

Even though the Egyptian government (EG) has taken significant action in response to these possible hazards, to fund large-scale renewable energy projects, such as encouraging the installation of wind and solar power, implementing several green initiatives, and supporting the adoption of electric cars. Egypt falls two positions to 22nd out of 63 nations in terms of climate Change Performance Index (CCPI) among the nations with a medium performance in the year 2024, compared to 20th rank place in the year 2023. Egypt's hosting of COP27 provided impetus for the country experts at CCPI to make significant progress towards meeting the 1.5°C target. Even so, Egypt lost the opportunity to improve its own goals [(6)] & [(11)]**.** Climate change generally poses serious obstacles to all African countries' efforts to achieve the SDGs, because of its weak resilience, unstable economy, and limited ability to adjust. Government actions should be combined with consumer cooperation to work together to lessen carbon emissions, therefore raising public awareness of CF and health is desperately required to facilitate the behavioral changes required for CF mitigation [(2)]**.**

In light of this, to protect the planet for coming generations, the CF calculates CO2 emissions that directly come from household energy consumption and transportation representing primary CF. Indirect carbon emissions resulting from the consumption of goods, food, and services are also included in the secondary CF [(12)]**.** As a first step towards a sustainable greener community, promote the adoption of de-carbonization lifestyle behavior by quantifying the total CF potentials for all the consumption domains and thereby reducing atmospheric carbon emission as the essential first step in reaching the 2015 Paris Agreement's targets of 45% through 2030 and net-zero CF through 2050 to restrict global warming of no more than 1.5°C [(13)] & [(14)]. CF mitigating will not only help to prevent catastrophic CC and stop millions of deaths, but it can also have a dramatic positive impact on health. Three major pathways to health were identified a reduction in atmospheric air pollution and the switch to clean, renewable energy; and also, support active lifestyle through a shift to healthier, more sustainable diets by converting high-beef meat diets to plant-rich diets and decreasing food loss and waste; also, more sustainable physical activity through the promotion of active mobility in conjunction with better public transport as an alternative driving an individual car. In addition, the health co-benefits of carbon mitigation initiatives would assist in addressing ill-health-related burdens shortly and improvements in personal health. Global evidence data indicates that efforts to end carbon emissions could avert millions of preventable deaths annually [(15)]**,** [(16)] & [(1)].

A fundamental truth of public health practice is to empower people with the essential information needed to prevent illness and promote health [(17)]. By actively taking part in public health initiatives to reduce CF, nurses often work on the front lines of healthcare and as reliable sources of health-related knowledge [(18)]. The professional obligation of nurses is to raise public awareness by spearheading action and advocacy in the fight against CC, enacting sustainability greener policies in practices and the use of energy-saving medical supplies [(9)]. Additionally, nurses can instruct individuals on sustainable healthy low-carbon lifestyle practices while promoting health, such as switching to a healthy decarbonized diet and clean renewable energy, reducing reusable plastic, increasing active travel, shutting off small appliances and lights when out of use, reusing old materials, and encouraging environmentally friendly waste management behaviors by implementing the principle of the 3Rs (Reduction–Reuse–Recycle) and ceasing to burn waste [(19)].

1.1 **Significance of the study:**

The world is faced with a "dangerous future," according to health experts. A significant portion of the global warming crisis can be ascribed to the health sector, whose goal is to safeguard and promote human health. The CF of the healthcare sector is equal to 5.02% of net carbon global emissions and would be the fifth biggest polluter on Earth if it were a country. Arguably, a stable climate is the most fundamental determinant of human health. However, the planet's climate is changing at an unprecedented speed [(20) & (1)]. Nurses profession serves as the backbone of every healthcare system globally and plays a vital role in addressing CC's effects on the healthcare industry. Among the SDGs, the planetary health paradigm emphasizes human well-being and environmental sustainability, positioning nurses at their core to guarantee its achievement. Therefore, nursing students must be highly educated, competent, and prepared for future professional roles supporting eco-friendly care [(21)].

However, there is still little focus on sustainability and CC in nursing education, with no explicit information in the nursing education courses for the necessary nursing competencies for environmental sustainability [(14)]. In this regard, awareness programs for CF mitigation should be offered to nursing students to empower the present and future generations of nurses with foundational knowledge and environmental-based competencies required for their crucial role toward CC mitigation that contribute to innovative approaches to reduce CF. Importantly, CF calculation of the academic setting can induce students' sense of environmental responsibility to adopt eco-friendly sustainable green behaviors [(22)]. However, there are still few published studies about awareness of CF mitigation strategies among higher nursing students, especially in the Egyptian community. Thus, the current research is among the original studies in developing program interventions for increasing CF mitigation behaviors.

2. The Study Aims:

Assess the impact of the awareness program for carbon footprint mitigation among nursing students as a step toward sustainability through:

- Assessing the awareness level of the nursing students.
- Assessing low-carbon lifestyle sustainable practice of the nursing students.
- Assessing carbon footprint rate among students of nursing.
- Designing and implementing the awareness program for CF mitigation among nursing students.
- Evaluating the impact of the awareness program on awareness, low-carbon lifestyle sustainable practice, and CF rate among nursing students.

3. Research Hypothesis:

The implementation of the awareness program will lead to mitigating the carbon footprint rate among nursing students.

4. Methodology:

4.1. Research Design:

The study design used was quasi-experimental, with one group pre and posttest.

4.2. Research Setting:

The research was carried out at the nursing faculty/ Modern University of Technology and Information (MTI), Cairo, EGYPT, a private institution under the Ministry of Higher Education's supervision. One undergraduate a bachelor of nursing science program (BSN) is offered by the nursing faculty. The program includes 6th departments of nursing sciences throughout eight semesters and four levels/academic years, with an internship year.

4.3. Sample type and size:

The research employed a stratified simple random sample. The academic nursing students were divided into four levels according to the BSN nursing program, and 25% of the students were randomly selected from each level. The following equation from the Raosoft sample size calculation soft program was used:

$$\text{Sample size, } n = N * \frac{\frac{Z^2 * p * (1-p)}{e^2}}{[N - 1 + \frac{Z^2 * p * (1-p)}{e^2}]}$$

N represent the size of population that was 967 nursing students engaged in the MTI academic faculty during the academic year 2022–2023, Z^2 is the normal distribution's critical value, which was 1.96., p is a sample proportion, and e is margin of error 0.5%, at 95% confidence level that the real value is within ±5% of the measured value, Consequently 276 nursing students were anticipated to be the final sample size. Nursing students of both genders registered during the 2023 academic year, were included in the study, while students who refused to participate in the research or provided incomplete questionnaire responses were eliminated.

Technical Design:

4.4. Tools of the Data Collection:

To fulfill the study's objectives, three tools were applied.

Tool (1): Nursing Students' Structured Questionnaire was developed by the researchers in both Arabic and English after examining the relevant literature and articles from around the global and was modified according to the study setting [(23), (24), &(25)]. The questionnaire was divided into two sectors:

- **1st sector: Nursing Students' Demographic Characteristics** include the following; their age, gender, academic year, marital status, cumulative grade point average (CGPA) and living with whom. In addition, usual transportation, family monthly income, household income, residence place of family (Living area).
- **2nd sector: Nursing Students' awareness of CF Questionnaire (pre/follow-up),** It was used pre/follow-up awareness program, include **40** multiple choice and true/false questions, covering the following six categories: **1**) Concept of CF (2 questions), **2**) basic facts about CC and global warming (5 questions), 3) United Nations Sustainable Development Goals (SDG) & Egyptian government efforts against CC &CF (5 questions), **3**) The significance of measuring and reducing the CF size (3 questions), **4**) factors contributing to carbon emission (5 questions), **5**) impact of CC and carbon

emission on human health (10 questions), and 6) CF mitigation strategies (10 questions). Finally, one question regarding source of information.

Questionnaire Rating and Scoring:

In the CF awareness questionnaire, nursing students were requested to either select the correct answer or indicate whether the question was true or false. Model answer was used to verify responses; each item was weighted so that one mark was awarded for a correct answer and zero for an incorrect one. Therefore, the overall knowledge score varied from 0 to 40, with high mean scores denoting higher awareness. The students were further classified into three categories as the followings;

Categories	Scores	Percentage %
Low CF awareness	< 20	<50.0%,
Moderate CF awareness	20-29	50.0% to <75.0 %
High CF awareness	≥ 30	≥ 75.0%

Tool (2): Nursing Students' Low-Carbon Lifestyle Choices scale (pre/follow-up), was developed by the researchers after extensive reviewing of the relevant articles and studies [(23), (25) & (26),] this scale act as a competency model for low-carbon (de-carbonization) lifestyle choices, to assess students' personal action to reduce carbon emission (CF), included multiple-answer questions with 25 lists of CF mitigation strategies, divided into the following four consumption domains: 1) food choices (5 statements), 2) home energy conservation for electricity, gases & water use (10 items), 3) Transportation (3 items), 4) Consumption and recycling/ waste reduction (7 items).

Scale Rating and Scoring:

The **Low-Carbon lifestyle sustainable practice scale** used a three-element Likert scale, with the options "all the time, sometimes or never." The scale score ranges from "2 to zero", and the study subjects were requested to submit their responses. Students who demonstrated high levels of personal action or practice for reducing carbon emissions all the times received a score of 2, while those who never engaged in a low carbon lifestyle received a score of zero. The mean value of the total scores was computed, ranging from 0 to 50, a greater mean scores referring to better personal lifestyle practice to reduce carbon as a crucial measure toward the achievement of net zero–carbon emissions (green lifestyle). The students were further categorized according to their practice level "adoption rate" of de-carbonizing behaviors into **the following three categories:**

Categories	Scores	Percentage %
Low de-carbonization lifestyle	< 25	<50.0%,
Average de-carbonization lifestyle	25-37	50.0% to <75.0 %
High de-carbonization lifestyle	≥ 38	≥ 75.0%

Tool (3): Online Carbon Footprint Calculator (pre/follow-up): this tool was utilized to estimate and calculate the nursing students' personal carbon footprint based on individuals and households annual emissions, using the standards of an online carbon footprint calculator that has been validated and is accessible at website; https://www.carbonfootprint.com [(25)]. Based on the IPCC special report which was referenced in the Egyptian study by ***Madkour (2019)*** [(27),] the study employed an electricity conversion factor of 0.672 Kg CO2e/kwh,

The following six categories of individual' lifestyles were assessed by the web's based carbon footprint calculator.

- ***1st category*** dealt with calculating individual household CF, consisted of seven elements: electricity, natural gas, propane, coal, LPG, heating oil, and wooden pellets.
- ***2nd category*** dealt with CF of flights and involved three fields: itinerary for flights, class, and total number of trips. It also had an optional field if there would be a stopover on the flight.
- ***3rd category*** engaged with vehicle CF calculator, four factors were considered: vehicle type, manufacture, mileages, and model to determine efficiency and type of fuel used.
- ***4th category*** which dealt with the CF calculator for motorcycles included two questions pertaining mileage and vehicle type for efficiency calculations.
- ***5th category*** measured CF of public transport through a mileage calculation for buses, coaches, long distance trains, local or commuter trains, subways, trams and taxis.
- ***6th category*** calculate secondary CF, included a total of 14 elements: dietary products and beverage, pharmaceutical products, textiles, clothes and footwear/shoes, printed materials such as magazines, books, and newspapers and other paper-based products, computer and information technology equipment, radio TV, and telephone, cars (fuel excluded), home furnishings and other manufactured item, restaurants, hotels, and pubs etc., mobile/cell phone, call expenses, banking and finance transection, insurance coverage, education and leisure, cultural and athletic activities.

Scoring system:

Using the carbon footprint calculator available on the web, the total and each CF category were automatically calculated for every student. The four categories of the transportation CF scores were calculated; including the transport routes air flights, vehicle/car, motorcycle, and public transport. Using statistical measures from data inputs into SPSS, the total mean score of students' personal carbon footprint is computed by adding the carbon emissions in three major categories, namely household energy, transportation, and secondary CF.

4.5.Tools Validity:

The students' structured questionnaires and the low-carbon lifestyle scale were initially constructed by the researcher in English and then translated into Arabic, and back into English by non-medical experts to ensure clarity and consistency. The online carbon footprint calculator on the aforementioned website was also translated into Arabic and back into English by a non-medical professional. The final Arabic translation version compared to the original taking conceptual and cultural factors into account, and also was validated by consulting five community health nursing professionals from MTI University and Ain Shams University's nursing faculties, and a statistician. Final modifications were made after the experts determined the structure, consistency, layout, relevance, accuracy of knowledge, and competencies, in addition to their rating and scoring.

4.6. Tool Reliability:

The Cronbach's alpha coefficient (α) test was applied to test the reliability for internal consistency reliability. The test of spearman's rank correlation coefficient (r_s) was also applied to analyze the three-week test-retest correlation reliability. The online research tools were submitted to the pilot subjects twice, and a three-week time interval was allowed between the two tests. Considering that α value of at least 0.6 signifies good reliability and r_s values of 0.4 and 7.0 denote moderate and high correlation **(28 cited and 29)**, the statistical results in the following

table proved that the study tools showed internal consistency reliability and high stability correlation.

The Data collection Tools	Test-Retest Reliability	Internal Consistency
	r_s	α
Carbon footprint calculator questionnaire (The Arabic translated version).	0.82	0.77
Nursing Students' awareness of CF Questionnaire.	0.70	0.71
Nursing Students' Low-Carbon Lifestyle Choices scale.	0.75	0.73

4.7. A Pilot Study:

A pilot study, which comprised 10.0% of all study participants, was assigned randomly to assess the content, and consistency of the research tools as well as as the time frame of data collection. The final analysis did not include the students who participated in the pilot study.

4.8. Ethical considerations:

The Scientific Research Ethics Committee, the Nursing Faculty, MTI University registered its authorized acceptance before the study was started. The students were informed of the purpose of the research and accordingly an ethical oral informed consent was also obtained. Additionally, the students were assured of the confidentiality of the data collected, their study' participation is entirely voluntary, and they may withdraw from it at any time, for any reason.

4.9. Statistical design:

The statistical package for the social sciences (SPSS v 21.) was utilized for the statistical presentation and analysis of the current study. Continuous and quantitative data were represented by the mean (X) and standard deviation (SD). Data that were categorized or qualitative were presented as percentages and numbers. Inferential statistics, Chi-square test (X^2), was employed to determine the distinction between qualitative variables pre and follow-up awareness program. The relationships and differences between the quantitative variables were evaluated using the student's t-test and the ANOVA test. Correlation Coefficient (R) was applied to detect the correlation between average CF of the nursing students and their total scores of CF awareness and de-carbonization lifestyle pre and follow-up CF awareness program. Additionally, r_s test and **α** test were utilized to assess the questionnaires' reliability. Statistics were considered significant if the $p \leq 0.05$.

Operational Design:

4.10. Field Work:

The actual data collection process took place over ten months from March 2023 to December 2023. Before data collection, the researcher interviewed the nursing students face-to-face, outlining the research objectives and significance and the instructions for completing the questionnaires. The data collection tools were available in English language for the Foreign Nigerian students and in Arabic for the Egyptian students. All nursing students were asked to answer to the study's questionnaires, using the Google application website that was submitted

to the students through WhatsApp groups and social networking sites. Calculation of Students' CF was completed by gathering each student's CF record, and the Arabic forms that the students had submitted were examined, and re-entered the data into a website carbon footprint calculator. It was estimated that each student would require 30 to 45 minutes to complete their questionnaire. The researcher started the awareness program after the pre-test ended.

4.11. Preparatory Phase:

To cover the CF mitigation aspects, a survey of the current and historical research on CF mitigation was carried out, using textbooks, scholarly articles, and online resources, to understand the true scope and magnitude of CC and CF in Egypt and globally. Additionally, it served as a reference for constructing the data collection tools and the program's materials for CF mitigation awareness.

4.12. Program development:

CF mitigation awareness program was developed under the following four phases:

1) Competency-based Needs Assessment Phase:

Preprogram assessment surveys (pretest) served as the foundation for constructing the CF awareness program in which nursing students' competencies for CF mitigation were assessed by calculating their average carbon footprint, identifying their CF awareness, and their decarbonizing lifestyle behaviors, thus the development needs were identified.

2) Program Planning Phase:

Competency-based skills were established and areas that need improvement were determined according to the findings of the assessment phase. The program compromised of one face to face preliminary session that were conducted along eight times for every student's group enrolled in the eight semesters over the four academic years. In addition to, five online sessions for all the students that were gathered on the Microsoft team platform, one session was applied weekly and each session lasted between 45 to 60 minutes.

The following is a summary of the topics covered in these sessions:

- **Preliminary session:** in this session the researcher met the participants face to face & explained the objectives, contents, and the methods of teaching program , and starting the electronic pretest questionnaires (45 minutes),
- **First session:** Introduction and basic facts about CC and global warming, what is the concept of CF, causes and contributors of CF.
- **Second session:** Impact of CC and CF (on Environment and human health globally and nationally), and significance of reducing and measuring CF size.
- **Third session:** The Global, Egyptian national agreements, and policies relevant to environmental health, and Sustainable developmental goals (SDGs) related to CF and Egypt vision 2030.
- **Fourth session:** CF mitigation strategies and lifestyle sustainable practices; for food and home energy conservation (electricity, water and gases).
- **Fifth session:** Continue CF mitigation strategies and lifestyle sustainable practices; regarding CF transportation and waste reduction (Practice **5Rs:** Reduce, Refuse, Reuse, Repurpose and Recycle). Finally, revision and summary of the overall program content.

3) Program Implementation Phase:

The program was implemented through online sessions over two months, utilizing a range of instructional strategies including; lectures, interactive discussions and brainstorming. The researcher also employed a variety of audiovisual aids such as PowerPoint, sharing pictures, and depleting CF through mind maps, a short video on the global warming crisis.

4) Program Evaluation Phase:

The effect of the CF awareness program on the nursing students was assessed by contrasting the students' pre- and follow-up assessments four months after the program's finalization, regarding their knowledge, de-carbonization lifestyle behavior, and, lastly, the CF rates using the same pre-intervention format. To ensure adherence to the program guidelines and low-carbon lifestyle choices and initiatives, the researcher distributed weekly tips and reminders on CF sustainability awareness through the WhatsApp group.

5. Results of the study:

Based on **Table (1):** The MTI nursing students' mean age was ***20.72*** ± 1.89 years old, ***57.97%*** were males, ***47.83%*** lived with friends. Rural areas accounted for ***50.72%*** of the students. Additionally, ***71.74%*** tend to use public transportation.

Table (2): revealed a highly significant difference ***(P<0.000**)*** in the mean percent total score of students' CF awareness at follow-up program implementation ***(75.82%) vs. 46.97%*** at preprogram implementation.

Figure (2): revealed that, at the follow-up phase, ***61.59%*** and ***21.74%*** of the students of nursing, respectively, had high and moderate CF awareness levels, compared with ***9.05%*** and ***35.87%*** before program implementation. This difference was highly statistically significant ***(p < 0.000**).***

Table (3): referred to a highly significant statistical difference ***(P<0.000**)*** in the total mean percent of students' sustainable practices of a low-carbon lifestyle at follow-up program phase ***(70.14%)*** compared to preprogram phase ***(43.96%).***

Figure (4): presented that Internet was the main source of information (92.21%), while schools and academic institutions represent in (30. 43%).

Figure (5): revealed that, at the follow-up, CF awareness program phase, 27.90% and 49.64% of the students, led a high and moderate de-carbonization lifestyle respectively, in contrast to 9.42% and 27.17%, respectively, before program implementation. This difference was highly statistically significant (p < 0.000**).

Table (4): documented that at the follow-up awareness program phase, the students' mean CF was ***3.032 ± 0.401*** TonCo2e, which was lower than the preprogram phase ***3.550 ± 0.564*** TonCo2e, which was a statistically significant ***(p < 0.015*).***

Figure (6): presented a comparison of the average CF of the students' pre- and follow-up program intervention with the average CF globally ***(4.8 TonCo2e)*** and in Egypt ***(2.5 TonCo2e).***

Table (5): indicated a negative correlation ***(P<0.048*)*** between total mean CF of students and their CF awareness levels through preprogram implementation. While students' practice of Low-Carbon Lifestyle was negatively with their mean CF through preprogram and follow-up phases ***(P<0.025* & P<0.016**** respectively**)**.

Table (6): demonstrated that the mean CF of male students was greater than that of female students with statistically significant differences ***(P<0.033*)***. Also, the mean CF of working students was higher than that of non-working students ***(P<0.050*)***. Statistical significant differences ***(P<.000**)*** were observed in the mean CF of students who lived alone,

had higher household incomes, or frequently used private transportation. Moreover, higher CF was significantly correlated with those from urban areas ***(P<0.042*).***

Table (1): Demographic Data of the Nursing Faculty Students (N. 276)

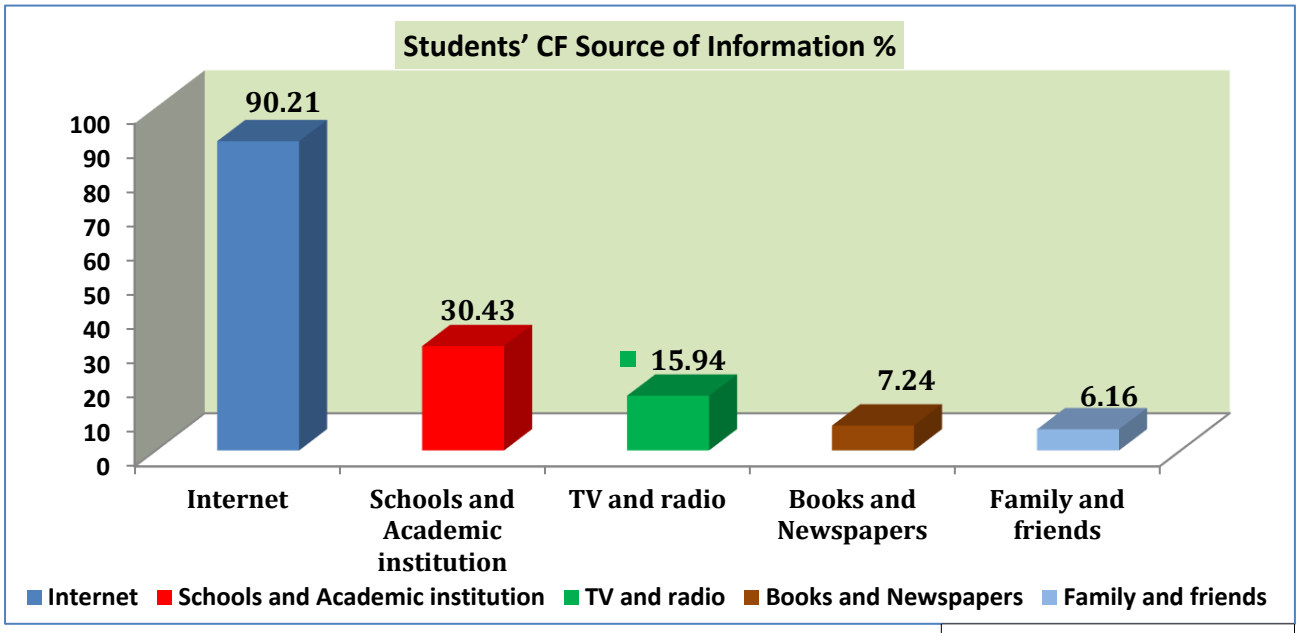
Variables	Level	N	%
Age by year:	- 18 ≤ 20 Years	159	57.61
	- >20 Years	117	42.39
	Mean ± SD 20.72 ± 1.89 **Median=** 20.00 **Min-Max= 18-28**		
Gender:	- Male	160	57.97
	- Female	116	42.03
Nationality:	- Egyptian	270	97.88
	- Nigerian	6	2.17
Academic level:	- Level one (1^{st} and 2^{nd} semester)	81	29.35
	- Level two (3^{rd} and 4^{th} semester)	76	27.53
	- Level three (5^{th} and 6^{th} semester)	52	18.84
	- Level four (7^{th} and 8^{th} semester)	67	24.27
Marital status:	- Married	3	1.087
	- Single	273	98.91
Working condition:	- Working	124	44.93
	- Not working	152	55.07
Students' Grade Point Average Scale (GPA):	- A	29	10.50
	- B	123	44.57
	- C	119	43.11
	- D	5	1.82
Residence place (Housing):	- Alone	43	15.58
	- With family members	88	32.25
	- With friends	132	47.83
	- Next to relatives.	13	4.71
Usual Transportation:	- Public	198	71.74
	- Private	78	28.26
Household income:	- 6000: 8000	111	40.21
	- >8000: 10000	91	32.97
	- >10000	74	26.81
	Mean ± SD 8513. 63 ± 4904 **Median** $\tilde{x}$ 7950		
Residence place of family: (Living area)	- Rural Status	142	50.45
	- Urban Status (Cairo-Alex….etc.)	134	48.55

Table (2): Distribution of the Nursing Students' According to their CF Awareness Domains pre and follow-up Program Implementation (n=276)

CF Awareness Domains	The Awareness Program Phases						X^2	P
	Preprogram Implementation			Post-Program Implementation				
	High	Moderate	Low	High	Moderate	Low		
	N (%)			N (%)				
CF Definition.	3 (1.08)	22 (7.97)	251 (90.94)	191 (69.20)	47 (17.03)	38 (13.77)	47.08	<0 .000 ***
Basic facts and awareness about CC & global warming	45 (16.30)	147 (53.26)	84 (30.07)	169 (61.23)	71 (25.72)	36 (13.04)	117.54	<0 .000 ***
SDG & Egyptian government' efforts toward CC & CF.	17 (6.16)	62 (22.46)	197 (71.37)	103 (37.32)	100 (36.23)	73 (26.45)	119.84	<0 .000 ***
Carbon emission causing factors	48 (17.39)	154 (55.79)	74 (26.81)	184 (66.66)	56 (20.29)	36 (13.04)	138.58	<0 .000 ***
Impacts of CC & carbon on environment & human health	44 (15.94)	158 (57.24)	74 (26.09)	174 (63.04)	52 (18.84)	50 (17.48)	135.67	<0 .000 ***
The significance of measuring and reducing the size of CF.	3 (1.08)	15 (5.43)	258 (93.48)	194 (70.29)	47 (17.03)	35 (12.68)	371.42	<0 .000 ***
CF mitigation strategies.	17 (6.16)	118 (42.75)	141 (51.08)	175 (63.40)	62 (22.46)	39 (14.13)	205.24	<0 .000 ***
Total $\bar{x}$ ± SD Total $\bar{x}$ (%)	**18.79 ± 7.73 (46.97%)**			**30.33 ± 4.07 (75.82%)**				
Mean difference	**11. 54**							
Paired T-test	**T=−20.67**			**P= 0.000****				

X^2 =Chi-square, $\bar{x}$= mean, $\bar{x}$ %= mean percentage, SD = stander deviation,
*** very highly statistical significance at p < 0.001

Figure (2): Distribution of nursing Students According to their Source of Information



Not mutually exclusive

Figure (3): Distribution of Nursing Students by Levels of Total CF Awareness Score pre and follow-up Program Phases

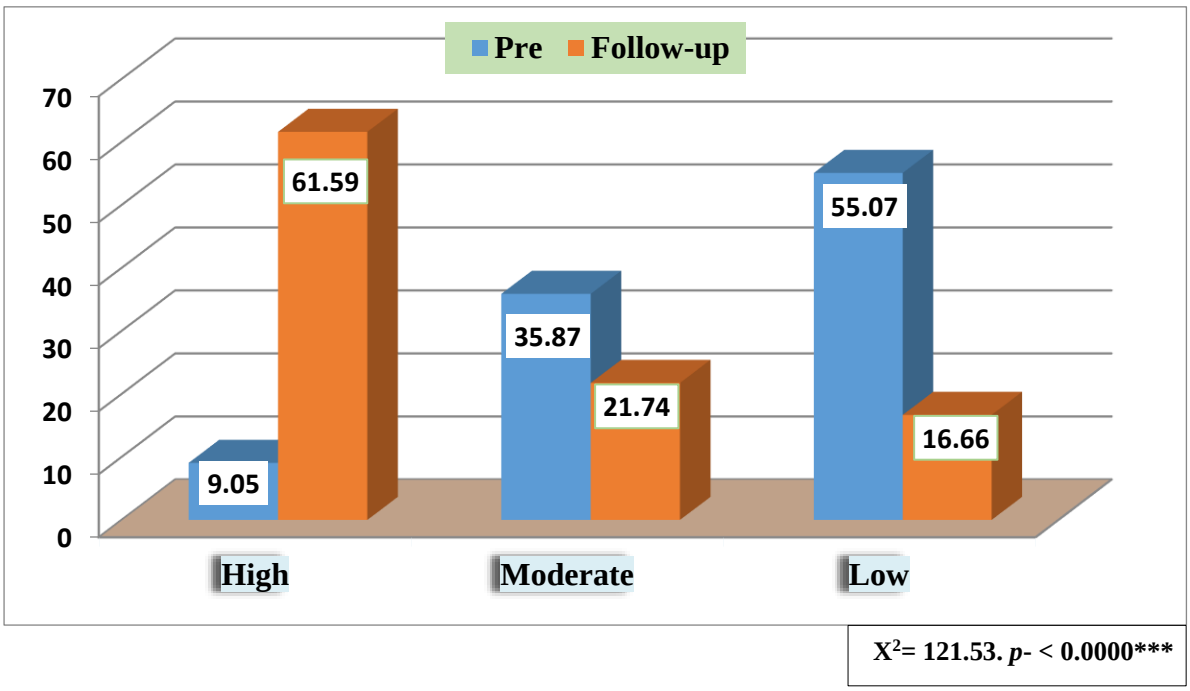
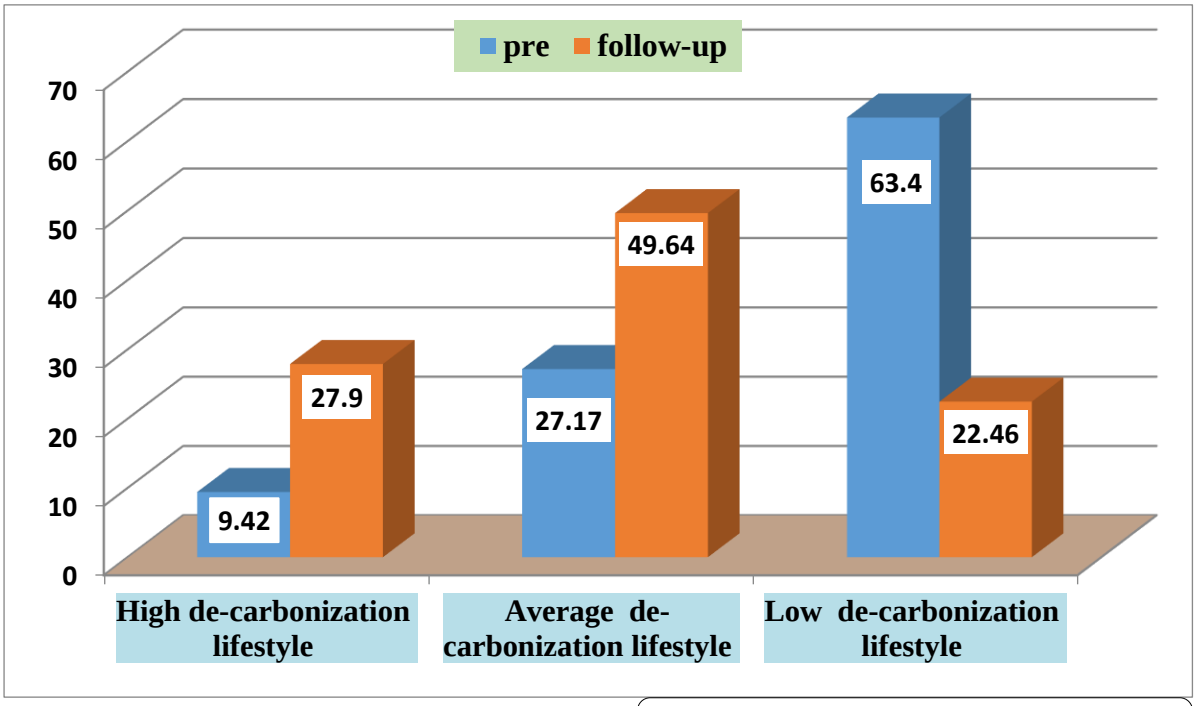


Table (3): Nursing Students' Distribution Based on their Low Carbon Lifestyle Domains pre and follow-up Awareness Program Implementation (n=276)

Low-Carbon Lifestyle.	Max. score	The Awareness Program Phases		Mean difference	T	P
		Preprogram Implementation	Follow-up Program Implementation			
		Mean ± SD (Mean %)	Mean ± SD (Mean %)			
Food choices.	**10**	3.02 ±2.96 **(30.20 %)**	5.26 ± 1.54 **(52.60 %)**	2.24 (17.37%)	- 6.87	**0.000 *****
Household energy conservation	**20**	9. 46± 5.51 **(47.30 %)**	15.28 ± 1.38 **(76.40%)**	5.82 (43.60%)	- 9.90	**0.000 *****
Transportation	**6**	4.09 ± 1.78 **(68.16 %)**	4.38 ± 1.29 **(73.00 %)**	0.29 (2.25%)	- 1.81	0.141
Waste Reduction.	**14**	5.41 ± 4.05 **(38.64 %)**	10.15 ± 1.16 **(72.50 %)**	4.74 (36.77%)	-12.17	**0.000 *****
Total	**50**	**21.98 ±7.51 (43.96 %)**	**35.07 ± 3.84 (70.14 %)**	**13.09**	- 13.77	**0.000 *****

SD = stander deviation, **T**. t test, *** very highly statistical significance at p < 0.001

Figure (4): Nursing Students' Distribution Based on their Total Low Carbon (de-carbonization) lifestyle Score levels pre and follow-up Program phases.



X^2 : 97. 262 - **The *p*-value** is < 0.000***

Table (4): Nursing Students' Carbon Footprint pre and follow-up Awareness Program Implementation (n=276)

Categories of individual carbon footprint calculator (TonCo2e)	The Awareness Program Phases		Mean difference/ % of total carbon reduction	T	P
	Preprogram Implementation	Post Program Implementation			
	Mean ± SD (Mean %)	Mean ± SD (Mean %)			
Household carbon footprint	1.389 ± 0.764 **(39.13%)**	1.140 ± 0.593 **(37.60%)**	-0.249 (48.07%)	3.070	**0.012***
Transportation carbon footprint	0.855 ± 0.290 **(24.08%)**	0.788 ± 0.323 **(25.99%)**	-0.067 (12.93%)	0.941	0.114
Secondary carbon footprint	1.306 ± 0.592 **(36.79%)**	1.104 ± 0.601 **(36.41%)**	-0.202 (38.99)	2.775	**0.026***
Total Carbon footprint	**3.550 ± 0.564**	**3.032 ± 0.401**	**0.518**	2.882	**0.015***

(*) statistical significance at p < 0.05, **T**. t test

Figure (5): Comparison of the Faculty Nursing Students' Pre- and follow-up-Awareness Program Implementation with the Global and Egyptian Averages for Carbon Footprint.

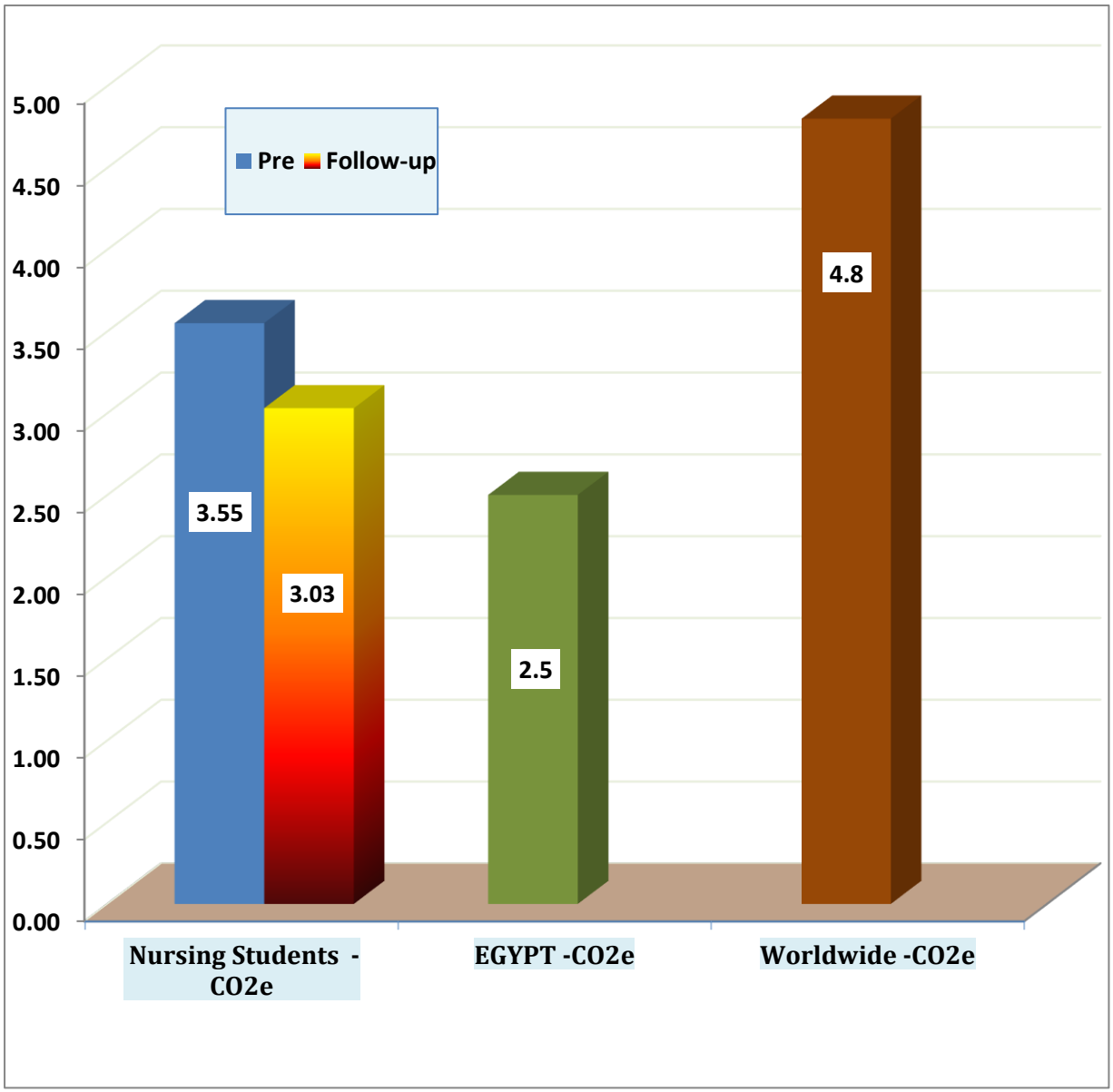


Table (5): The Correlation among Nursing Students' Total Carbon footprint with their CF awareness and Low-Carbon (De-carbonization) Lifestyle

	Total CF			
	Pre		Follow-up	
	R	P-value	R	P-value
CF Awareness	-0.120	**0.048***	-0.067	0.586
Low-Carbon Lifestyle	-0.141	**0.025***	-0.155	**0.016***

(*) statistical significance at $p < 0.05$

Table (6): The Relationships between Nursing Students' Demographic Characteristics and Their Total Carbon Footprint

Students' Demographic Characteristics		Students' Carbon Footprint			Student T test /ANOVA test	
Variables	**Level**	**mean**	**±**	**SD**	**T/F**	**P-value**
Age by year	- 18 ≤ 20 Y	3.546	±	0.566		
	- >20 Y	3.565	±	0.547	1.654	0.169
Gender	- Males	3.603	±	0.567		
	- Females	3.502		0.560	4.015	**0.033***
Nationality	- Egyptian	3.550	±	0564	-1.066	0.143
	- Nigerian	4.223	±	0.090		
Academic level	- Level one	3.550	±	0.569		
	- Level two	3.549	±	0.486		
	- Level three	3.552	±	0.610	0. 996	0.243
	- Level four	3.558		0.563		
Marital Status	- Single	3.550	±	0.564		
	- Married	3.572	±	0.553	-1.033	0.188
Working condition	- Not work	3.520	±	0.562		
	- Work	3.571	±	0.547	2.802	**0.050***
Students' GPA:	- A	3.611	±	0.395	1.726	0.173
	- B	3.555	±	0.590		
	- C	3.498	±	0.563		
	- D	3.614	±	0.343		
Residence place (Housing)	- Alone	4.201	±	0.631	40.47	**0.000***
	- With family	3.443	±	0.443		
	- With friends	3.308	±	0.389		
	- Next to relatives	3.346	±	0.379		
Transportation	- Public	3.380	±	0.482	-11.62	
	- Private	3.986	±	0.488		**0.000****
Family Monthly Income:	- 6000 : 8000	3.280	±	0.382		
	- >8000 : 10000	3.330	±	0.372	8.809	**0.000****
	- >10000	3.825	±	0.478		
Place of family residence	- Rural Status	3.521	±	0.89		
	- Urban Status	3.579	±	1.15	3.099	**0.042***

(*) statistical significance at $p < 0.05$, **(**)** highly significant if $p < 0.01$,
(***) very highly statistical significance at $p < 0.001$ **T**. t test, **F**. Anova test.

6. Discussion:

Nurses must be knowledgeable about and equipped to handle CC, and Academic education is ideally positioned to prepare the students of nursing for their professional role toward CC and environmental sustainability. Therefore, it's imperative to provide the upcoming and present generation of nurses with the relevant competencies supporting creative approaches to lower CF, where nurses act as positive models for the community [(30).]

Concerning the nursing students' characteristics, based on current study finding more than half of the participants were male, indicating a progressive increase in the percentage of male nurses and a shift in the femininity stereotype in nurses. ***Shen et al., (2022)*** [(31)] and ***Moselhy et al., (2022)*** [(23),] found the same results. Furthermore, a large proportion of nursing students live away from their families; according to the study results, around one-half of them

lived with friends, and more than one-fifth lived alone or next to relatives. Also, slightly greater half of them were of rural origin. Similarly, ***Abdel Razik et al., (2024)*** [(32),] found approximately two-thirds of the students came from rural backgrounds.

In the respect to the impact of the awareness program for CF mitigation on the study variables, **before program implementation**; over half of the investigated nursing students had a moderate level of awareness regarding CC, global warming, factors contributing to carbon emission, and its impacts on the environment & human health. In contrast, almost all the students were completely unaware of CF and the significance of measuring CF size, confirming that calculating the CF was something new and surprisingly unexpected for the students of nursing, indicating that the CF measurement is not widely known and is therefore not well understood. Furthermore, more than two-thirds of the students, either Egyptian or Nigerian lacked awareness of SDG & Egyptian government's initiatives of CC & CF. The overall pretest results revealed that low CF awareness was documented in over half of the studied students with low mean scores; this result indicated the nursing students had only superficial opinions and very limited knowledge about CF. The dearth of formal CC &CF education in higher education could be an important factor, regardless of other nursing specializations, the community health department is the only one where environmental health is typically studied in depth in nursing courses. These results could be alarming because the absence of a basic comprehension of the problem makes it difficult to take intentional, pro-environmental action. Noteworthy, the research results showed that the internet was the major source of students' information regarding CF as it is the most extensively utilized search engine, communication, and knowledge instrument of the modern era. Unfortunately, the academic institutions were mentioned by less than one-third of the participants as the source of their CC information.

Numerous previous research studies carried out in various countries concurred with the current study's findings. ***DASH et al. (2023)*** [(27),] found in their Indian research study that many students lacked adequate CF information. Moreover, based on the Egyptian study of ***Elsharkawy et al. (2023)*** [(33),] more than one-half of the students presented with a solid understanding of the contributing factors and effects of CC, even though the large majority them unaware of the SDGs for CC, and Egyptian authority's efforts to mitigate CC. Additionally**,** a study at a medical university in Sri Lanka, ***Wijesinghe et al., (2021)*** [(4),] discovered that only one-third of students understood the concept of CF.

Conversely, findings of **the follow-up test** showed a statistically significant elevation in the high CF awareness level of the studied nursing students. The CF mitigation awareness program helped the students comprehend some of the fundamental ideas behind CF more thoroughly. ***Incesu and Yas (2023)*** [(34),] found that nursing students' awareness of CC was effectively increased by attending meetings on environmental issues. Moreover, an Egyptian study of ***Mohammed et al., (2023)*** [(35),] discovered that students' knowledge of CC significantly increased after educational intervention.

Meanwhile, **before the program implementation**, about two-thirds of students had engaged in unsustainable carbon behavior, especially in the food consumption domain, which had the lowest mean score compared to the other lifestyle categories. The majority of them preferred dairy products, meat, beef, and other meat-rich diets; additionally, daily habits of pre-packaged, ready-made meals, which have the highest carbon emissions, because they were unaware that food waste is a major cause of CF. As a result, they made several

unsustainable food choices that were linked to the highest CF. ***DASH et al., (2023)*** [(26),] verified that more than fifty percent of postgraduate students did not engaged in CF reduction.

After **program implementation**, there were statistically significant improvements in the mean score of the students' low-carbon lifestyle practices, more than three-quarters of the participants engaged in either average or high de-carbonization lifestyle. The follow-up test also revealed that household energy conservation had the highest significant mean score. As the efficiency of the awareness program, nursing students started to pay attention to their various daily life practices for household electric and water rationalization, such as cooking with pots covered, changing to more energy-efficient light bulbs, and switching off unnecessary lights and electronics. The waste reduction category showed a high significance difference between the pre-and follow-up program implementation. The students became motivated to take some actions to reduce waste, such as purchasing products with less packaging, replacing single-use plastic with reusable alternatives, and donating products for reuse. Although the connection of food choices with carbon emissions is not as widely known, moderately significant improvements were reported in the follow-up awareness program. The participants were relatively encouraged to some extent to shift from a meat-rich to a more vegetation diet, however, students' de-carbonization food choices behavior still depends on their needs, wants, taste, and satisfaction. Overall, the implemented CF awareness program directly affected students' decision-making for a de-carbonization lifestyle. The Egyptian study of ***Ghazy and Fathy (2023)*** [(36),] detected a highly significant statistical difference between pre and post-program regarding CC indoor and outdoor daily life practices.

Concerning the CF rate among students of nursing, the researcher used the validated web-based CF calculator for users to measure the CO2 emissions. **Preprogram intervention,** the result showed that the MTI University nursing students' average means CF was 3.55 t-CO2e, which was larger than the annual average CO2 emission per capita in EGYPT 2.50 t-CO2e ***(World Data Atlas, 2021)*** [(37)]. This result confirmed the high need and the significance of awareness programs for CF mitigation among students in nursing. The average CF of nursing students discovered in the present academic research was almost the same as the Philippine study of ***Abarracoso, (2022)*** [(38),] and Chinas's study by ***Li et al., (2015)*** [(39),] in which students' average annual CF was 2.55 t-CO2e and 3.84 t-CO2e respectively.

Since individual lifestyle choices and behaviors significantly impact CF, results of the current study's pre-test revealed that ***Household energy*** was the primary contributor to direct carbon emissions, closely followed by ***Secondary CF*** resulting from indirect emissions. The irrational use of water, electricity, air conditioners, appliances, and fuel combustion during cooking are some household activities that cause an increase in direct emissions of CF. Additionally, the nursing students had high product expenditures that led to raised their secondary CF, including dietary products, dining out, medications, the latest trend imported clothing, mobile phones, call costs, paper products, computers, and IT equipment, as well as activities related to education, recreation, and sports. According to the researcher's viewpoint, the academic activities in nursing studies, such as printing, exams, and digital learning, combined with lifestyle choices, could have played a role in the rise of CF among the nursing students than the average CO2 emission per capita in EGYPT. Numerous studies found that the biggest contributor to CF was housing expenditure ***(Long et al., 2023*** [(40)]***, Bera et al., 2022***[(41)]***, and Fahmy et al., 2022*** [(42)]***)***.

While ***Transportation*** was the least contributor to CF and was responsible for less than one-fourth of total direct carbon emission among students, reflected their sustainable

transportation practices, as the vast majority of students preferred to use public motor transportation, and most of them did not fly at all. Not only this, but also, about half of them lived in rental houses close to the faculty with their friends, commuted on foot or in groups, and used the university bus or other shared transportation to get around. A German study by ***Venghaus et al., (2022)*** [(43),] found that approximately one-fourth of GHG emissions come from transportation.

The **follow-up test** revealed a statistically significant CF mitigation to approximately half a ton below the average before program implementation (3.03 metric Co2 tons per capita/year). As co-benefits of the awareness program, the student's behavior shifted towards more sustainable consumption and lifestyle choices and contributed to CF mitigation. Home energy-saving measures were the most frequent behavior change among nursing students; therefore, it was the most prominent category responsible for over half of the achieved carbon emissions reductions. Moreover, CF mitigation was also noted in the secondary CF category and is accountable for more than one-third of the total CF reductions. According to the researcher's perspective, since the secondary CF category was measured by the consumer spending rate using the previously mentioned web-based carbon footprint calculator, the study findings showed a highly significant CF reduction when considering the drop in the Egyptian pound's value and also the variation in the rise in basic commodity prices from the date of the pretest to the next follow-up test. Noteworthy, CF calculation seems to have an awareness-raising effect on their individual consuming behavior and thus encourages students to modify and adopt low-carbon lifestyles. Furthermore, financial savings could be an internal motivator for enhancing personal CF reduction, especially after the flotation of Egypt's currency several times. Accordingly, the current results verified that the research hypothesis is approved. ***Watabe and Yamabe-Ledoux (2023)*** [(13),] concluded that reducing CF can be facilitated by strictly implementing lifestyle change options. ***Valls-Val and Bovea (2021)*** [(44),] illustrated that the CF measurement raises students' awareness of environmental issues. Also, ***Jimlan, (2021)*** [(45),] documented that; the CC mitigation awareness among school principals affects their CF status.

Concerning the **relationship between the study variables**, the statistical analysis showed a significant correlation between students' CF and gender, with male students having a higher mean CF than female students. This result represents the higher consumption among men for goods and services associated with higher CF and more energy-intensive 46 for their private cars, smoking, and eating out. A previous study by ***Bodinier (2023)*** [(46),] discovered that the carbon emissions were largely induced by single men. Also, ***Hernandez (2021)*** [(47),] found that GHG emissions from men are 16% higher than those from women and spend 70% of their income on automobile fuel for cars.

The study results also clarified those students of nursing who were working in addition to their academic studies had higher CF mean scores than non-working students. This may be linked to higher energy use that resulted from primary CF, such as transportation used for traveling to work, or from secondary CF, like takeaway or restaurant food. The statistical analysis also revealed a significant difference in the higher CF of nursing students who ***live alone*** versus those living with their families or friends. This is even though cohabitation allows individuals to share household energy expenses for things like cooking tools, appliances, water, waste collection, heating, and cooling expenditures, which leads to efficient resource conservation and a decrease in carbon emissions. A prior study by ***Jack and Ivanova, (2021)*** [(48),] confirmed that a major challenge to sustainability is the shrinking household, which results in less sharing and more resource usage.

The mean students' CF score increases with higher ***household income***, confirming that higher consumption is correlated with a higher economic level. This finding was reinforced by ***Belaid and Rault, (2021)*** [(49),] who found that EGYPT energy expenditure positively correlates with household-income. Additionally, ***Lévay et al., (2021)*** [(50),] found income and household CF are strongly correlated. The current results also revealed that the investigated students who commuted via public transit, had lower CF, whereas private vehicles can only contain one or two passengers at a time, public transit may hold large groups of people. According to ***Zheng and Krol (2023)*** [(51),] compared to driving a private vehicle, using public transport allows people to travel farther while producing significantly less GHG emissions.

Notably, the average total CF of ***urban dwellers*** nursing students is higher than that of rural dwellers as shown by the study findings, this could be related to the urban lifestyle where higher consumption of electricity, higher expenditure of different products, and elevated socioeconomic status. Also, transportation and mobile phone connectivity are indispensable services in urban areas. According to the study of ***Long et al., (2023)*** [(40)] and ***Bera et al., (2022)*** [(41),] the urban area's CF is significantly larger than that of rural areas. Conversely, the outcome went against the findings of ***Pang et al., (2020)*** [(52),] and ***Ottelin et al., (2019)*** [(53),] who found that urban households in Switzerland and Europe have lower direct emissions than rural households. These discrepancies are related to the developing and developed nations' economic standing and the demographic distribution of the population in rural and urban areas.

The results detected a significant negative correlation between students' average CF and their CF awareness levels preprogram implementation. Also, the mean ***CF*** tended to be reduced with the nursing students' practice of de-carbonization lifestyle pre and follow-up CF awareness program implementation. The nursing students under the study investigation felt well-informed and motivated to make a difference and mitigate their personal CF when they were empowered by adequate CF knowledge and practices. According to ***Crow et al. (2023)*** [(54)], modifications in behavior to lower energy usage can aid in de-carbonization. Also, ***Brandenstein et al., (2023)*** [(55),] confirmed that consistently, perceived behavioral control and modification showed an effect on carbon emissions. Moreover, ***(Venghaus et al., 2022)*** [(43),] mentioned that raising people's awareness of CC can directly affect change by influencing their behavior to make more sustainable consumption choices. Consequently, the researcher provided evidence for and supported the research hypothesis.

7. Conclusion and Implication:

In light of the study findings, the designed CF mitigation awareness program significantly helped to improve students' awareness level and encourage the adoption of low-carbon Lifestyle and behavior choices, ultimately resulting in a half-ton reduction in the students' CF rates.

8. The Study Recommendations:

Integrating climate change related issues into universities' nursing curriculum and courses with a more in-depth and comprehensive emphasis on nurses' roles in CF mitigation strategies, to raise environmental awareness among all university nursing students, irrespective of their academic study nursing specialty. This will help to enhance students' readiness for assuming future roles as a nurse leader in society will encourage them to live a de-carbonized lifestyle that will lower their CF and provide a positive example for others.

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Conflict of Interest:

None

10. References:

1. **WHO.** Climate change [**Internet**]. **2023;** https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health. Accessed 12 December 2023.
2. **Smoot G. 4** Main Reasons Why Reducing Your Carbon Footprint Is Important. [**Internet**] **2023;** Available at: https://impactful.ninja/why-reducing-your-carbon-footprint-is-important. Accessed: 08 March 2023.
3. **Nabipour A.H., Ahmed J., Mobin S.B., Khairuddin N. and Hassan A.** A comprehensive review on carbon footprint of regular diet and ways to improve lowered emissions, Elsevier B.V 2023; 18 (1): 101054. https://doi.org/10.1016/j.rineng.2023.101054.
4. **Wijesinghe S., Mathurahan D.S., Wijesundere S., Ranawaka C., Arambepola T**. **C.** Estimation of carbon footprint, contributory factors, knowledge & attitudes about climate change among medical students in Sri Lanka. JEPHH, 2021; 9(1):1-5. https://doi:10.12691/jephh-9-1-1.
5. **Nullis C.** Global temperatures set to reach new records in next five years. [**Internet**]. 2023; Available from: https://wmo.int/news/media-centre/global-temperatures-set-reach-new-records-next-five-years. Accessed 15 Nov 2023.
6. **Climate Change Performance Index, CCPI.** [**Internet**] **2024;** https://ccpi.org/country/egy/. Accessed 15 Nov 2023.
7. **Awad S.F.A, and Ebrahim M.A.M.** Study of effects of climatic changes on the Nile River Basin (African Countries) and Egyptian water. IJSRSD. 2023;6(3),78-95. https://doi:10.21608/ijsrsd.2023.315557.
8. **Ali H.A., El-Ayouti A., and Mohieldin M.** Climate actions in Egypt, challenges and opportunities. [**Internet**] **2023;** Available from: https://www.brookings.edu/articles/climate-action-in-egypt-challenges-and-opportunities/. Accessed 15 Nov 2023.
9. **Diallo T., Berube A., Roberge M., Audate P., Larente-Marcotte S. et al.** Nurses' perceptions of climate change; protocol for a scoping review, JMIR Res Protoc. 2023; 12(11), e42516. https://doi:10.2196/42516**.**
10. **Masoud A. A.** Spatio-temporal patterns and trends of the air pollution integrating MERRA-2 and in situ air quality data over Egypt (2013-2021). *Air quality, atmosphere, & health*, Advance online publication. 2023; 16 (1), 1543–1570. https://doi.org/10.1007/s11869-023-01357-6.
11. **Moneim D. A.** Egypt Ranks 2nd in North Africa On Climate Change Index. [**Internet**]. **2023;** The JACA, Egypt. businessmonthlyeg. Available at: https://businessmonthlyeg.com/egypt-ranks-2nd-in-north-africa-on-climate-change-index/. Accessed 15 Nov 2023.
12. **Selin N. E. Carbon footprint. Ecology and conservation.** [**Internet**]. **2023;** Available at: https://www.britannica.com/science/carbon-footprint. Accessed 01 Jaun. 2024.
13. **Watabe A., and Yamabe-Ledoux A.M**. Low-Carbon Lifestyles beyond Decarbonisation: Toward a More Creative Use of the Carbon Footprinting Method. *Sustainability*. MDPI Journals 2023;15(5):4681. https://doi.org/10.3390/su15054681,
14. **Ebrahim E., S., Samir D. S., & Mohamed S., W.** The Effectiveness of Educational Interventions about Sustainability Development among Nursing Students. EJHC, 2022;*13*(1), 294-310. https://doi: 10.21608/ejhc.2022.216641.
15. **Ratwatte P., Wehling H., Phalkey R., & Weston D.** Prioritizing Climate Change Mitigation Behaviours and Exploring Public Health Co-Benefits; A Delphi Study. IJERPH, 2023;*20*(6), 5094. https://doi.org/10.3390/ijerph20065094.
16. **Haines A.** How governments and decision makers can capitalize on the health benefits of climate action. The OECD Forum Network**.** [**Internet**]. **2023;** https://www.oecd-forum.org/posts/how-governments-and-decision-makers-can-capitalise-on-the-health-benefits-of-climate-action. Accessed 01 Jau. 2024.

17. **Kreslake J. M., Sarfaty M., Roser-Renouf C., Leiserowitz A. A., & Maibach E. W.** The critical roles of health professionals in climate change prevention and preparedness. AJPH, 2018;*108*(S2), S68–S69. https://doi.org/10.2105/AJPH.2017.304044.
18. **Álvarez-Nieto C., Richardson J., Navarro-Perán M.Á., et al.** Nursing students' attitudes towards climate change and sustainability; A cross-sectional multisite study. *Nurse Educ Today*. 2022;108(3), 105185. https://doi.org/10.1016/j.nedt.2021.105185.
19. **Fletcher L.** The Intersection of Nursing and Environmental Health - A Call to Action for Sustainable Practices. JAPN, 2023; 8(6), 1-2. https://www.hilarispublisher.com/open-access/**.**
20. **Firth S. (2023)**: Nurses Step Up to Bat on Educating Patients About Climate Change. **Medpage Today**. https://www.medpagetoday.com/nursing/nursing/106466. Accessed 02 March 2024.
21. **Anåker A., Spante M., & lf M.** Nursing students' perception of climate change and sustainability actions – A mismatched discourse: A qualitative, descriptive exploratory study, Nurse Education Today, 105 2021; 105028, 0260-6917. https://doi.org/10.1016/j.nedt.2021.105028.
22. **Kiehle J., Kopsakangas-Savolainen M., Hilli M., & Pongrácz, E.** Carbon footprint at institutions of higher education: The case of the University of Oulu. *Journal of environmental management*, 2023;*329*, (1) 117056. https://doi.org/10.1016/j.jenvman.2022.117056.
23. **Moselhy, M., Ghareeb, D., AbdelElrahman, E.** Carbon footprint knowledge and calculation among nursing students. EJNHS, 2022; 3(1): 20-44. doi: 10.21608/ejnhs.2022.251410,
24. **Tuna, I., Tunç T., Pınar M., B. & Yildirim K. A.** Determination of nursing students' awareness of the health effects of climate change. IJCS, 2022;15(2)1149.
25. **Carbon footprint calculator.** Available from: https://www.carbonfootprint.com/calculator.aspx. Accessed: 11 February 2023.
26. **Dash D. S., Pradhan, P., & Kumar R.** Awareness and Practices of Carbon Footprint Reduction: A Survey among Postgraduate Students. *Current Res. J. Soc. Sci. & Human.* 2023; 6 (1), 122-131. http://dx.doi.org/10.12944/CRJSSH.6.1.10.
27. **Madkour K.** The carbon footprint of Alexandria governorate, Egypt and its contribution to climate change. Bulletin de la Société de Géographied' Egypte. 2019; 92(1), 90-103. https://doi.org/10.21608/bsge.2019.90378.
28. **Dancey C.P., Reidy J**. Statistics without Mathematics for psychology; 5th ed. Prentice Hall; London: 2011; p. 175.
29. **Lee, J., Yim, M. H., & Kim, J. Y.** Test-retest reliability of the questionnaire in the Sasang constitutional analysis tool (SCAT). *Integrative Medicine Research*, 2018; *7*(2), 136-140. https://doi.org/10.1016/j.imr.2018.02.001.
30. **Esringü A., Toy S.** The Effect of Climate Change Education on the Knowledge and Awareness Levels of Atatürk University Student, *Kent Akademisi. Dergisi*, 2022; *15*(2), 595-610. https://doi.org/10.35674/kent.1041157**.**
31. **Shen J, Guo Y, Chen X., Tong L., Lei G., and Zhang X.** Male nurses' work performance; A cross sectional study, Medicine (Baltimore). 2022; 101(31): e29977. https://doi.org/10.1097/MD.0000000000029977.
32. **Abdel Razik,.M.G., Barakat H.A., Morsy M.A.F. & EL-ayari S.M. O**. Effect of COVID-19 Pandemic on Psychological Wellbeing among Faculty of Nursing Students. EJHC, 2024; 15(1): 977-990. https://doi.org/10.21608/ejhc.2024.343204.
33. **Elsharkawy S.A. Elsheikh A.A. and Refaat L.A. R.** Knowledge, perception, and practices regarding climate change among students of Al-Azhar University for Girls in Cairo, Egypt. JPH, [**Internet**]. **2023;** https://doi:10.1007/s10389-023-01901-9.
34. **İncesu O. & Yas M.** The relationship between nursing students' environmental literacy and awareness of Global Climate Change. Public Health Nursing. 2023; 41(1)67-76. https://doi.org/10.1111/phn.13255.
35. **Mohammed A. W., Mohamed H. A. B., & Elsaid H. D.** Empowering nursing students to face climate changes and its effects on health. EJNHS, 2023; *4*(4), 49-64. https://doi.org/10.21608/ejnhs.2023.327636.
36. **Ghazy H.K., & Fathy, D.M.** Effect of Awareness Program Regarding Climate Change on Knowledge, Attitudes and Practices of the University Students. IEJNSR, 2023; *3*(2), 186-203. https://doi.org/10.21608/ejnsr.2023.277896.
37. **World Data Atlas Egypt Environment**. [**Internet**]. **2023;** Available from: https://knoema.com/atlas/Egypt/CO2-emissions. Accessed: 14 January 2024.
38. **Abarracoso L.W.M.A.** Analysis of the students' carbon footprint in higher education institutions amidst pandemic. J. Bio. Env. Sci. 2022; 21(5), 35-40, https://innspub.net/analysis-of-students-carbon-footprint-in-higher-education-institutions-amidst-pandemic.
39. **Li X., Tan H and Rackes A.** Carbon footprint analysis of student behavior for a sustainable university campus in China, J. Clean. Prod. 2015; 106 (1), 97-108. https://doi.org/10.1016/j.jclepro.2014.11.084.

40. **Long Y, Feng J, Sun A, Wang R, Wang Y.** Structural Characteristics of the Household Carbon Footprint in an Aging Society. *Sustainability*. 2023; 15(17):12825. https://doi.org/10.3390/su151712825.
41. **Bera M., Bose P., and Nag P.K.** Household Carbon Footprint: Rural and Urban Community. JENR, 2022; 6 (2), 000278. https://doi.org/10.23880/jenr-16000278.
42. **Fahmy M., Elwy I.M., Elshelfa H., Abdelkhalik M., Abdelalim, S. M.:** Energy efficiency and de-carbonization improvements using court-yarded clustered housing with compressed earth blocks' envelope, Energy Reports, 2022; V(3); p 365-371, ISSN 2352-4847, https://doi.org/10.1016/j.egyr.2022.01.051.
43. **Venghaus, S., Henseleit, M. and Belka M.** The impact of climate change awareness on behavioral changes in Germany: Changing minds or changing behavior?. *Energ Sustain Soc* 2022; **12** (8) (2022). https://doi.org/10.1186/s13705-022-00334-8.
44. **Valls-Val, K., & Bovea, M. D.** Carbon footprint in higher education institutions: A literature review and prospects for future research. *Clean technologies and environmental policy*, 2021; *23*(9), 2523–2542. https://doi.org/10.1007/s10098-021-02180-2.
45. **Jimlan Ju-Im T.** Carbon footprint status, climate change mitigation awareness & education for sustainable development perceptions of school principals in the Island of Panay; Bases for an eco-school toolkit." JWEEP, 2021; 3 (1), 23-52. https://doi.org/10.32996/jweep.2021.3.1.3.
46. **Bodinier J.** Scientists have found which gender is likely to have the biggest carbon footprint. [**Internet**]. **2023;** https://www.euronews.com/green/2023/03/27/single-men-have-higher-carbon-footprints-than-women-in-sweden. Accessed: 11 December 2023.
47. **Hernandez J.** Men's spending habits result in more carbon emissions than women's, Environment. Capital public Radio. [**Internet**]. **2021;** https://www.capradio.org/news/npr/story?storyid=1018796496**.** Accessed: 11 December 2023.
48. **Jack T., and Ivanova D.** Small is beautiful. Stories of carbon footprints, socio-demographic trends and small households in Denmark, ERSS, 2021; 78(1), 102130. https://doi.org/10.1016/j.erss.2021.102130.
49. **Belaid F. and Rault C.** Energy Expenditure in Egypt: Empirical Evidence Based on a Quantile Regression Approach. IZA – Institute of Labor Economics. Germany. 2021; 26 (4), 511-528. https://erf.org.eg/app/uploads/2020/12/1608636659_260_892947_1446.pdf**.**
50. **Levay P. & Vanhille J. & Goedemé T. & Verbist G.** The association between the carbon footprint and the socio-economic characteristics of Belgian households. Ecological Economics. 2021; 186. 107065. http://dx.doi.org/10.1016/j.ecolecon.2021.107065.
51. **Zheng S. and Krol A.** Public transportation. Climate Portal. [**Internet**] **2023;** https://climate.mit.edu/explainers/public-transportation. Accessed: 11 Nov.2023.
52. **Pang M., Meirelles J., Moreau V. and Binder C.** Urban carbon footprints; A consumption-based approach for Swiss households. **[Internet].** *Environ. Res. Commun. 2020;* 2 (1): 011003. https://doi.org/10.1088/2515-7620/ab59c5.
53. **Ottelin J., Heinonen J., Nässén J. et al**. Household carbon footprint patterns by the degree of urbanisation in Europe. **[Internet].** Environ. Res. Lett. 2019; 14 (11) 4016. Available from: https://doi.org/10.1088/1748-9326/ab443d.
54. **Crow D., Staas L. and Triunfo N.** Behavioural Changes. International Energy Agency. [**Internet**] **2023.** Available from: https://www.iea.org/energy-system/energy-efficiency-and-demand.
55. **Brandenstein, N., Ackermann, K., Aeschbach,** N. *et al.* The key determinants of individual greenhouse gas emissions in Germany are mostly domain-specific. *Commun Earth Environ* 2923; 4, 422. https://doi.org/10.1038/s43247-023-01092-x.

الملخص العربـــي

أثر برنامج توعوي للتخفيف من البصمة الكربونية لدى طلاب التمريض .خطوة نحو الاستدامة.

الخلفية: ينبغي إجراء برنامج توعية لتخفيف البصمة الكربونية لطلاب التمريض لإعدادهم لدورهم المستقبلي الحاسم نحو مكافحة أزمة المناخ وتعزيز صحة المجتمع والاستدامة البيئية، من خلال تبنى سلوك نمط حياة منخفض الكربون وبالتالي خفض البصمة الكربونية كخطوه أساسية نحو تحقيق أهداف اتفاق باريس المتمثلة في خفض صافي الكربون والوصول خفض الانبعاثات الكربونية بنسبة 45٪ بحلول عام 2030 إلى صافي انبعاثات صفري بحلول عام 2050.

الهدف: تقييم تأثير برنامج التوعية لتخفيف البصمة الكربونية بين طلاب التمريض كخطوة نحو الاستدامة.

التصميم: تم اختيار 276 طالباً من طلاب كلية التمريض في الجامعة الحديثة للتكنولوجيا والمعلومات فى عينة عشوائية طبقية بسيطة باستخدام التصميم شبه التجريبي .تم تطبيق ثلاث أدوات: **(1)** استبيان لطلاب التمريض والذي يتضمن قسمين لتقييم الخصائص الشخصية للطلاب بالإضافة إلى تقييم مستوى وعى الطلاب تجاه البصمة الكربونية والتدابير اللازمة لمكافحة التغير المناخي. **(2)** مقياس سلوك نمط الحياة منخفض الكربون لدى طلاب التمريض **(3)** حاسبة البصمة الكربونية عبرالإنترنت.

النتائج: وجد تحسن ملحوظ ذو دلالة إحصائية بين متوسط الدرجات لمعلومات ومستوى وعي الطلاب بالبصمة الكربونية، وسلوكيات نمط الحياة منخفض الكربون قبل وبعد تنفيذ البرنامج التدريبى (P <0.000 **). بالإضافة إلى ذلك، تم تخفيض متوسط درجة معدل البصمة الكربونية للطلاب بشكل ملحوظ من 3.550 ± 0.564 طن من مكافئ ثاني أكسيد الكربون، قبل تنفيذ البرنامج إلى 3.032 ± 0.401 طن من مكافئ ثاني أكسيد الكربون بعد البرنامج مع وجود دلالة إحصائية (P <0.015*).

الخلاصة والتوصيات: يعمل برنامج التوعية بتخفيض البصمة الكربونية الذي تم تطويره على تحسين معارف طلاب التمريض بشكل كبير، ويشجع على تبني سلوكيات إزالة الكربون مما أدى إلى تقليل بصمتهم الكربونية بمقدار نصف طن تقريبًا. لذلك يجب دمج القضايا المتعلقة بتغير المناخ في مناهج التمريض بالجامعات مع التركيز بشكل أكبر على أدوار التمريض تجاه الاستراتيجيات المبتكرة لتخفيف البصمة الكربونية، ورفع الوعي البيئي بين جميع طلاب التمريض بالجامعات، كإعداد أفضل لقادة الصحة المستقبليين للاستدامة البيئية مع اتباع نمط حياه منخفض الكربون كنموذج مثالي يجب ان يحتذى به.

الكلمات المفتاحية: طلاب التمريض، برنامج التوعية، تخفيف البصمة الكربونية، التغيير المناخي