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Original Article

Carbon Footprint of High Institute of Public Health Before and During COVID-19 Pandemic

Mohamed F. Hussein ¥

Department of Occupational Health and Industrial Medicine, High Institute of Public Health, Alexandria University, Egypt

Abstract

Background: Carbon footprint is a widely used tool to measure the impact of human activities on global warming**.** The lockdowns caused by the COVID-19 pandemic have significantly changed energy consumption forms and decreased CO_2 emissions worldwide. This research is a trial to elaborate the effect of COVID-19 pandemic on the carbon footprint of the High Institute of Public Health (HIPH).

Objective(s): The present study aimed at measuring the amount of water, electricity, fuel, and paper consumption by HIPH before and during the emergence of COVID-19 and assessing the carbon footprint of the HIPH population inside the building through the same period.

Methods: A cross-sectional survey was done using a pre-designed questionnaire targeting 10 % of the HIPH population before and during the pandemic. Bills of water, electricity, paper, and fuel consumption were used to calculate the carbon footprint for one year before and one year during COVID-19.

Results: Online responses increased during COVID-19 emergence (69.2% during COVID-19 pandemic versus 44.1% before COVID-19 pandemic). Females were more than 2/3 of the respondents (70.6%). There was a significant difference in traveling outside Egypt before and during COVID-19 ($\chi2$=12.794, *p*-value=0.002). A significant reduction in the average time spent in front of the computer at HIPH was found during the emergence of COVID-19 as most of the work became from home ($\chi2$= 18.443, *p*-value= 0.001). Significant reduction in the consumption of hot drinks, cold drinks, bottled water and food inside the HIPH was noticed ($\chi2$=50.219, *p*-value<0.0001; $\chi2$=12.030, *p*-value=0.017; $\chi2$=15.945, *p*-value=0.004; $\chi2$=72.929, *p*-value<0.0001 respectively). The carbon footprint of HIPH in the period from July 2018 to June 2019 was 79.43MT of CO_2e. In the period from July 2020 to June 2021, it was 59.85MT of CO_2e with a 25% reduction in the emission.

Conclusion: The carbon footprint of HIPH was reduced during the lockdown period compared to that before the epidemic. So, efforts should be gathered to hasten the reduction of carbon footprint through encouraging online teaching and changing lifestyle.

Keywords: Carbon Footprint, COVID-19, global warming

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¥*Correspondence*:
Email:
hiph-mohamedfakhry@alexu.edu.eg

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INTRODUCTION

Global warming is "the long-term increasing of Earth's climate system due to human activities, primarily fossil fuel burning". Human activities emit heat-trapping greenhouse gases (GHG) such as Carbon Dioxide (CO_2), Methane (CH_4), Ozone (O_3), Nitrous Oxide (N_2O), Sulfur Dioxide (SO_2), and Hydrofluorocarbons (HCFCs) which trap heat within the atmosphere. [1] Climate change causes the melting of glacial masses, flooding of islands and coastal cities, hurricanes, and desertification of fertile areas which endanger animal species and lead to food shortages. It also increases the spread of diseases, emerging infectious diseases, and pandemics. [2,3]

The scientific community focuses research on CO_2 concentrations more than other greenhouse gases due to the gas abundance in the atmosphere. It is also the main contributor to climate change. [4] Carbon footprints are a widely used tool to measure the impact of human activities on global warming**.** Carbon footprint is the amount of carbon dioxide (CO_2) emissions associated with all the activities of a person or other entity such as a building, or country. It is expressed in equivalent tons of CO_2. [5]

Human activities emit an amount of CO_2 into the atmosphere nowadays more than in any previous time. Burning fossil fuels "coal, oil, and natural gas" is the main source of global CO_2 emissions. Electricity production from energy-produced plants, energy used in different industrial activities, heat production, and transportation are the major sources of global CO_2 emissions. [6]

The concentration of CO_2 in the atmosphere has increased from approximately 277 parts per million (ppm) in 1750 [7], the beginning of the industrial era,

to 412.45 ± 0.1 ppm in 2020. [8] Fossil CO_2 emissions in Egypt were about 219 million tons in 2016 which means an increase of 4.72% over the previous year. The carbon dioxide global share of Egypt was 0.61%. Carbon dioxide emissions in Egypt are equivalent to 2.32 tons per person. [9] Each individual could be responsible for increasing CO_2 emissions by consuming modern civilization products. Each person could make a drastic decrease in CO_2 emissions if he reduces his consumption of processed food, reduces traveling by his own car and reduces use of air condition. [10]

The emergence of the novel coronavirus (COVID-19) has caused dramatic shifts in the way we live and work. [4] The lockdowns caused by the COVID-19 pandemic have significantly changed energy consumption forms and decreased CO_2 emissions worldwide. [11] After rising steadily for decades, global carbon dioxide emissions fell due to decrease in economic and social activities worldwide. By the end of 2020, due to COVID-19 related reduced human activity, daily emissions of CO_2 were reduced by around 7% below 2019 levels mainly due to a sharp decline in vehicle transportation. [12]

Unfortunately, global fossil CO_2 emissions (excluding cement carbonation) in 2021 returned to their 2019 levels. This is due to the gradual return to the style of life just like that before the emergence of COVID-19 infection. [8] Every person - during his daily activity such as using electricity, driving a car, taking a bath, or buying and disposing of products - produces greenhouse gases which are subsequently responsible for an individual's carbon footprint. [13, 14]

Changes in our lifestyle and practices are needed, like changes in consumption behavior (such as avoiding airplane travel), using public transportation or sharing a car with other people instead of using private cars, using low-energy-consuming devices, and using recyclable or eco-friendly products. All these practices could reduce carbon footprint. When many people start to change their lifestyle the carbon footprint will dramatically fall. [13]

Unfortunately, persons' motivation to reduce their carbon footprint is low. To increase motivation, show people how the improvement in health will be when they use a bicycle or eat healthy food. Increasing awareness about global warming through mass media and strict implementation of regulations towards the environment could reduce the carbon footprint in the long term. [13,14]

High Institute of Public Health (HIPH) carbon footprint is the annual total amount of CO_2 emitted into the atmosphere as a result of daily campus activities and operations. This research is a trial to elaborate the effect of the COVID-19 pandemic on the carbon footprint of the HIPH focusing light on the changes in the activity and living conditions of the people to cope with this pandemic. This will clarify the importance of efforts spent to reduce carbon footprint which subsequently reduces the effects of global warming.

METHODS

Aim of the study

The current study aimed at assessing the carbon footprint of the High Institute of Public Health before and during the COVID-19 pandemic. The research had two specific objectives; the first was to measure the amount of water, electricity, fuel, and paper consumption of High Institute of Public Health before and during the emergence of COVID-19. The second specific objective was to calculate the carbon footprint of the High Institute of Public Health population before and during the pandemic of COVID-19.

Plan of the work

The study design was a cross-sectional survey. It was conducted at HIPH. Participants were eligible if they were attending HIPH for at least one year. The research was conducted between September 2019 and June 2021.

The sampling method was a non-random sampling design that was used to recruit the required sample size (convenience sampling technique). The sample size (ten percent of the HIPH population) was included in the study according to the recommendation of the Carbon Footprint Team of Alexandria University. There were about 400 staff members, demonstrators, and assistant lecturers, in addition to 100 employees and workers in the HIPH with an average of 500 students each year. So, 100 participants were needed to answer the questionnaire before the COVID-19 pandemic and the same number were needed during the pandemic lockdown. The total responses were 118 responses for the period from July 2018 to June 2019 out of 180 distributed questionnaires with a response rate of 65.6%; and 117 responses for the period from July 2020 to June 2021 out of 200 distributed questionnaires with a response rate 58.5%.

Bills of water, electricity, paper, and fuel consumption were taken for one year before and one year during COVID-19 from July 2018 to June 2019 and from July 2020 to June 2021to calculate the carbon footprint (before the emergence of COVID-19 and during the pandemic lockdown).

The first data collection tool was the pre-coded pre-designed interviewing questionnaire. It was administered face-to-face, and it was also uploaded to Google form for online responders and disseminated online via different social media platforms (Facebook, WhatsApp, and emails). Data about socio-demographic characteristics (sex, occupation,

education, and residence) were collected. The studied population was asked about the type of transportation, number of travels in the previous years (inside and outside Egypt), number of hours of using the computer, mobile, and tablet inside HIPH, paper consumption, water, drinks, and food consumption inside HIPH. All participants were allowed to fill out the form once. This questionnaire was distributed once before the pandemic and once during the lockdown period.

The second data collection tool was a data collection sheet containing information about the bills of water, electricity, and paper consumption in the institute as well as the number of kilometers (Km) traveled by transportation vehicles of the institute. This data was used to calculate the carbon footprint for one year before and one year during COVID-19 pandemic (from July 2018 to June 2019 and from July 2020 to June 2021).

Equations which were used to calculate the carbon footprint of HIPH were as follows: [4]

1. Electricity:
   Input value (in Kilowatt hour (KWh)/ Yr) X 0.6102 (Emission Factor ($kgCO_2$ e/ kWh)) = Output value in (kilogram of carbon dioxide equivalent (Kg of CO2e))(1)
2. Transportation:
   Average Gasoline Vehicle: Input Value (In Km/ Yr) X 0.2131 (Emission Factor ($kgCO_2$ e/ km)) = Output value in (Kg of CO_2e)(2)
3. Transportation:
   Average Air travel: Input Value (In Km/ Yr) X (Emission Factor ($kgCO_2$ e/ passenger km)) = Output value in (Kg of CO_2e) for economy class(3)
   Emission factor for short Haul = 0.1292 for distances less than 785 km
   Emission factor for medium Haul = 0.08088 for distances range from 785 km to less than 3700 km
   Emission factor for long Haul = 0.07727 for distances 3700 km or more
4. Paper usage:
   Input value (in metric tons (MT) /Yr) X 8.9 (Emission Factor (MT CO_2 e /MT of paper)) = Output value in (MT of CO_2e)(4)
   HIPH used papers in packs. Every pack weighted 2.25 kilograms.
   Total weight = Number of packs used per year X weight of each pack
5. Water supply:
   Input value (in cubic meter (M^3) /Yr) X 0.4760 (Emission Factor (kg CO_2 e / M^3)) = Output value in (Kg of CO_2e)(5)

HIPH Carbon Footprint

It was calculated by conversion of Kg to Metric Ton (MT) by dividing results in kg by 1000, then by adding results of all equations together to get the total HIPH Carbon Footprint.

Total HIPH Carbon Footprint in (MT of CO_2) = (1 + 2 + 3 + 4 + 5)

Ethical considerations

The researcher received the approval of the Ethics Committee of the High Institute of Public Health for conducting the research. The researcher complied with the International Guidelines for Research Ethics. Verbal consent was taken from all study participants after an explanation of the purpose and benefits of the research. Anonymity and confidentiality were assured and maintained. There was no conflict of interest.

Statistical analysis

Categorical and numerical data were presented as numbers and percentages. Cross tabulation of categorical data before and during the COVID-19 pandemic with testing the association by chi-square test were applied. A p-value <0.05 was considered statistically significant for inferential analysis if applicable. Equations mentioned above were used for data conversion into MT CO_2 e.

RESULTS

As shown in Table 1, a total of 235 individuals responded to the questionnaire. A total of 118 (50.2%) responses were received before the emergence of the COVID-19 infection and 117 (49.8%) responses were received during the appearance of the epidemic. Online responses increased during the COVID-19 emergence (69.2% during the COVID-19 pandemic versus 44.1% before COVID-19 pandemic) as most of the communication became online due to lock-down and work-from-home policy.

Table 1: Type of responses of the High Institute of Public Health participants (n=235)

Type of responses	From July 2018 to June 2019 (before COVID 19 pandemic) No. (%)	From July 2020 to June 2021 (during COVID 19 pandemic) No. (%)
Interview	66 (55.9%)	36 (30.8%)
Online	52 (44.1%)	81 (69.2%)
Total	118 (100.0 %)	117 (100.0 %)

Respondents' socio-demographic characteristics and pattern of travelling are shown in Table 2. Females were more than 2/3 of the studied group (70.6%). Most of the participants were found to live inside Alexandria (93.6%). Half of them were used to go to HIPH by private car (50.3%) and about 1/4 of them were used to go by bus (24.2%). More than half of the

respondents were staff members (51.9%), assistants of staff members were 17.5%, and students were 18.3% of the studied sample. Regarding pattern of travelling, the majority of the participants reported that they did not travel outside Alexandria (80.4%). Those who traveled to other cities inside Egypt reported having used private cars, buses, or trains. Most of the respondents reported that they did not travel outside Egypt (90.6%). Those who traveled outside Egypt went to the United Arab Emirates (UAE), the United States of America (USA), Saudi Arabia, Lebanon, Tunisia, England, Qatar, France, or Kuwait.

Comparison of some socio-demographic characteristics and pattern of travelling among participants are illustrated in Table 3. Although the percentage of people who went to HIPH by public transportation (bus) was reduced during the epidemic, the difference is statistically insignificant ($\chi2 = 7.844$, *p*-value= 0.097). According to working status, the responses of the staff members increased significantly during COVID-19 and the responses of students decreased ($\chi2=37.4029$, *p*-value <0.00001).

Regarding traveling inside Egypt, the number of persons traveling inside Egypt in the studied sample was reduced during COVID-19 pandemic, but the difference was statistically insignificant ($\chi2=7.4996$, *p*-value =0.112). There was a significant difference in traveling outside Egypt before and during COVID-19 pandemic ($\chi2=12.794$, *p*-value=0.002) as shown in table 3.

Lifestyle inside HIPH before and during the COVID-19 pandemic is shown in Table 4. Regarding average time spent in front of the computer at HIPH, a significant reduction was found during the emergence of COVID-19 ($\chi2= 18.443$, *p*-value= 0.001). No significant difference in the time spent on mobile or tablet at HIPH was noticed ($\chi2=5.4293$, *p*-value=0.246). No significant difference was observed in the number of paper consumption (bought by persons, not from HIPH) before and during the pandemic ($\chi2=2.608$, *p*-value=0.625). Significant reductions in the consumption of hot drinks, cold drinks and bottled water inside the HIPH were noticed ($\chi2= 50.219$, *p*-value<0.0001; $\chi2= 12.030$, *p*-value= 0.017; $\chi2= 15.945$, *p*-value= 0.004 respectively). Concerning food consumption inside HIPH, a significant reduction in food consumption was observed during the pandemic ($\chi2= 72.929$, *p*-value<0.0001).

HIPH consumption of electricity, water, paper, and fuel consumption is shown in table 5. According to electricity consumption by HIPH, there was a reduction by 1/5 during COVID-19 emergence (72162 KWh/Yr in the period from July 2020 to June 2021 versus 91452 KWh/Yr in the period from July 2018 to June 2019). Water consumption was reduced by 43% during the emergence of COVID-19 infection (from 1665 M^3/Yr in the period from July 2018 to June 2019 to become 950 M^3/Yr in the period from July 2020 to June 2021).

Table 2: Socio-demographic characteristics and travelling pattern of the High Institute of Public Health participants, 2021

Socio-demographic characteristics & travelling pattern	Participants (n=235) No. (%)
Gender	
Male	69 (29.4)
Female	166 (70.6)
Residence	
Inside Alexandria	220 (93.6)
Outside Alexandria	15 (6.4)
Transportation to HIPH:	
Private car	118 (50.3)
Bus	57 (24.2)
Taxi	40 (17.0)
On foot	15 (6.4)
Train	5 (2.1)
Working status	
Staff member	122 (51.9)
Assistant of a staff member	41 (17.5)
Student	43 (18.3)
Worker or clerk at HIPH	29 (12.3)
Number of travels inside Egypt/year	
No	189 (80.4)
Once	24 (10.2)
Twice	10 (4.3)
Three times	7 (3.0)
Four times or more	5 (2.1)
Number of travels outside Egypt/year	
No	213 (90.6)
Once	17 (7.3)
More than once	5 (2.1)

Paper usage inside HIPH was reduced by 19% in the closing period (1.24 MT/Yr in the period from July 2018 to June 2019, and 1.01 MT/Yr in the period from July 2020 to June 2021).

Surprisingly, gasoline consumption for vehicles increased in the closing period of COVID-19 (1500 Liters in the period from July 2018 to June 2019, and became 1630 Liters in the period from July 2020 to June 2021). About 8.7% increase in gasoline consumption during COVID-19 emergence was noted.

Concerning air travel, there was a sharp decrease in air travel during the emergence of the pandemic (more than 70% reduction) from 104581 Km in the period from July 2018 to June 2019 to 30798 Km in the period from July 2020 to June 2021.

HIPH carbon footprint is illustrated in Table 6. After conversion of each item of that mentioned in the previous part to equivalent Kg of CO_2, then converting Kg to metric ton (MT), and adding them together, the carbon footprint of HIPH in the period from July 2018 to June 2019 (before the pandemic) was 79.43MT of CO_2e. In the period from July 2020 to June 2021 (during the lockdown), it was 59.85 MT of CO_2e with a 25% reduction in the CO_2 emission. There was no significant difference between the two years carbon footprint (Mann-Whitney test "U" = 27.5, *p*=0.67).

Table 3: Comparison of some socio-demographic and travel2ling characteristics among the High Institute of Public Health participants, 2021 (n=235)

		Before COVID-19 pandemic (n= 118) No. (%)	During COVID-19 pandemic (n=117) No. (%)	P
Transportation to HIPH	Private car	58 (49.2)	60 (51.3)	**=0.097**
	Bus	36 (30.5)	21 (17.9)	
	Taxi	18 (15.3)	22 (18.9)	
	On foot	5 (4.2)	10 (8.5)	
	Train	1 (0.8)	4 (3.4)	
Working status	Staff member	49 (41.5)	73 (62.4)	**<0.001***
	Assistant of a staff member	21 (17.8)	20 (17.1)	
	Student	39 (33.1)	4 (3.4)	
	Worker or clerical at HIPH	9 (7.6)	20 (17.1)	
Number of travels inside Egypt/year	No	88 (74.6)	101 (86.3)	**=0.112**
	Once	16 (13.6)	8 (6.9)	
	Twice	8 (6.8)	2 (1.7)	
	Three times	3 (2.5)	4 (3.4)	
	Four times or more	3 (2.5)	2 (1.7)	
Number of travels outside Egypt/year	No	99 (83.9)	114 (97.4)	**=0.002***
	Once	15 (12.7)	2 (1.7)	
	More than once	4 (3.4)	1 (0.9)	

* *p*-value is significant as it is less than 0.05

Table 4: Lifestyle inside HIPH before and during the COVID-19 pandemic, High Institute of Public Health, 2021 (n=235)

		Before COVID-19 pandemic (n= 118) No. (%)	During COVID-19 pandemic (n=117) No. (%)	P
Average of computer usage in HIPH (hours/day)	No	25 (21.2)	40 (34.2)	**=0.001***
	1	31 (26.3)	21 (17.9)	
	2	12 (10.2)	25 (21.4)	
	3	9 (7.6)	12 (10.3)	
	4	16 (13.5)	11 (9.4)	
	5 or more	25 (21.2)	8 (6.8)	
Average of mobile or tablet usage in HIPH (hours/day)	No	22 (18.6)	29 (24.7)	**=0.25**
	1	50 (42.4)	35 (29.9)	
	2	15 (12.7)	12 (10.3)	
	3	8 (6.8)	12 (10.3)	
	4	8 (6.8)	17 (14.5)	
	5 or more	15 (12.7)	12 (10.3)	
Average of printed paper (packs/year)	No	51 (43.3)	56 (47.9)	**=0.63**
	1	26 (22.0)	31 (26.5)	
	2	16 (13.5)	10 (8.5)	
	3	10 (8.5)	8 (6.8)	
	4	4 (3.4)	5 (4.3)	
	5 or more	11 (9.3)	7 (6.0)	
Average of hot drinks consumption (unit/day)	No	16 (13.5)	53 (45.3)	**<0.001***
	1	30 (25.4)	43 (36.8)	
	2	33 (28.0)	10 (8.5)	
	3	27 (22.9)	7 (6.0)	
	4	8 (6.8)	2 (1.7)	
	5 or more	4 (3.4)	2 (1.7)	
Average of cold drinks consumption (unit/day)	No	56 (47.5)	78 (66.7)	**=0.017***
	1	41(34.7)	25 (21.4)	
	2	12 (10.2)	11 (9.4)	
	3	2 (1.7)	2 (1.7)	
	4 or more	7 (5.9)	1 (0.8)	
Average bottled water consumption (bottle/day)	No	38 (32.2)	57 (48.7)	**=0.004***
	1	44 (37.3)	45 (38.3)	
	2	23 (19.5)	5 (4.3)	
	3	8 (6.8)	7 (6.0)	
	4 or more	5 (4.2)	3 (2.7)	
Type of food consumption inside HIPH	No	26 (22.0)	91 (77.8)	**<0.001***
	From home	77 (65.3)	25 (21.4)	
	HIPH café	12 (10.2)	1 (0.8)	
	Delivery	3 (2.5)	0 (0.0)	

* *p*-value is significant as it is less than 0.05

Table 5: The High Institute of Public Health yearly consumption of electricity, water, paper and fuel, and Kilometers of air travels

		From July 2018 to June 2019	From July 2020 to June 2021
Electricity (in KWh/Yr)		91452	72162
Water consumption (M^3)/Yr)		1665	950
Paper used (MT/Yr)		1.24	1.01
Vehicle Transportation (In Km/Yr)		17027	18500
Transportation "Air travel" (In Km/Yr)	Short	675	675
	Medium	21125	15213
	Long	82781	14910
	Total	104581	30798

Table 6: The High Institute of Public Health carbon footprint

Carbon footprint		From July 2018 to June 2019	From July 2020 to June 2021
Electricity (MT of CO_2e)		55.8	44.03
Water consumption (MT of CO_2e)		0.79	0.45
Paper use in packs (MT of CO_2e)		11.01	8.95
Gasoline Vehicle Transportation (MT of CO_2e)		3.63	3.95
Transportation "Air travel" (MT of CO_2e)	Short	0.09	0.09
	Medium	1.79	1.23
	Long	6.4	1.15
Total (MT of CO_2e)	Total	79.43	59.85

DISCUSSION

The present study demonstrated a reduction in bus transportation and an increase in individual transportation as private cars and taxis during the pandemic due to the fear of crowding and COVID-19 transmission. Similarly, Dingil et al found a considerable growth (26%) in private transportation modes in the same period. [15] The responses of the staff members elevated significantly during the pandemic and the responses of students decreased indicating that staff members were aware enough of the importance of the research in this area, especially during the pandemic. Students' reduction in the response may be due to unwillingness to answer the questions especially as there was no personal contact between the researcher and students due to distant learning mode applied in all universities during the pandemic.

As regards traveling inside Egypt, the present research documented that the number of persons traveling inside Egypt was reduced during the emergence of COVID-19. The insignificant result indicated that people continued to go to many places and met many persons so that no social isolation or social distancing was applied. This could show a reduction in the awareness of people about the importance of social distancing and other precautions to lower the spread of the infection. This finding was similar to a study carried out in the USA which stated that the number of trips inside the USA reduced significantly especially those by public transport during this period. [16] There was a significant reduction in traveling outside Egypt during COVID-19 in the current study as most of the countries closed their airports and other entrances during the pandemic. Bielecki et al in a narrative review demonstrated a reduction of 43% in flights during COVID-19 compared to 2019. [17]

Concerning the average time spent in front of the computer at HIPH, a significant reduction was found during the emergence of COVID-19 as most of the work became from home. A Spanish study found the daily duration of use of electronic devices increased with an average of 3.1 ± 2.2 h/d during the lockdown, with computer use increasing the most. [18] Salinas-Toro et al. found that total hours spend in front of screens increased from 7.4 (*SD* 3.3) to 9.5 (*SD* 3.3) ($p < 0.001$). [19] All the previous research counted the total hours spent in front of electronic devices inside and outside homes and our research calculated the time spent outside the home only which was reduced during the lockdown. No significant difference in time spent on mobile or tablet was observed in the present study as people become attached to these devices by habit even before the pandemic.

In the present research, the consumption of hot drinks, cold drinks, and bottled water significantly decreased during the occurrence of the pandemic as people consumed fewer drinks outside their homes due to fear of infection ($\chi2= 50.219$, p-value<0.0001; $\chi2= 12.030$, p-value= 0.017; $\chi2= 15.945$, p-value= 0.004 respectively). These results were similar to a study carried out in New York City that found a reduction in bottled water, soda, and beverage consumption during the pandemic. [20] Kim et al. observed a reduction in the consumption of drinking sweet drinks in the 2020 group than in the 2019 group ($p < 0.001$). [21]

Food consumption inside HIPH significantly decreased during the pandemic as people lower their consumption of any food outside their homes and the cafeteria inside HIPH was closed. If people consumed any food, they took the food from their homes ($\chi2= 72.929$, p-value<0.0001). Radwan et al. found a similar result as they stated that students during the COVID-19 pandemic ate home-cooked foods and avoided ordering food from outside and this shift in eating habits was significantly different from the period before the pandemic ($p < 0.001$). There was a significant increase in the participants' reporting fear about food safety outside the home from 20.8% before COVID-19 to 72.9% during the COVID-19 period ($p < 0.001$). [22] Korean adolescents consumed less fast

food in the 2020 group than in the 2019 group ($p < 0.001$). [21]

HIPH's carbon footprint in the period from July 2018 to June 2019 was 79.43MT of CO_2e. In the period from July 2020 to June 2021, it was 59.85MT of CO_2e with a 25% reduction in the emission. Electricity accounted for 73.5% of the total carbon footprint and transportation was responsible for 10.7%.

The American University in Cairo (AUC) measured the carbon footprint before and during the lockdown. The main contributor to the carbon footprint was electricity followed by transportation. Heating, Ventilation, and Air Conditioning (HVAC) system and lighting were responsible for 62% of the carbon footprint. Transportation accounted for 25%. [4] Carbon footprint of the electricity of HIPH was reduced by 21% during the lockdown (44 MT CO_2e in 2020 and 55.8 MT CO_2e in 2019) while AUC's carbon footprint was reduced by 16% (the carbon footprint of the electricity was 15637 MT CO_2e in the academic year 2020 and 18637 MT CO_2e in the academic year 2019). [4]

The carbon footprint of the transportation by car and bus of HIPH increased slightly from 3.6 MT CO_2e before the lockdown to 3.9 MT CO_2e during the lockdown. During the closing period, there were many meetings for the staff members with the local authorities to contain the spread of the infection and the staff members trying to spread awareness about the pandemic, so the increase in gasoline consumption might be due to these reasons. In contrary to our results, AUC carbon footprint of the transportation by car and bus decreased from 10131 MT CO_2e in the academic year 2019 to 7243 MTCO_2e in the academic year 2020. [4]

Air travel of HIPH accounted for 8.2 MT CO_2e before the lockdown and reduced to 2.5 MT CO_2e during the lockdown due to the closing of borders and airports of different countries to contain the spread of infection. Air travel of AUC accounted for 1217 MT CO_2e in the academic year 2019 and was reduced to 965 MT CO_2e in the academic year 2020. [4] The carbon footprint of the paper consumption of HIPH was 11.01 MT CO_2e before the lockdown and decreased to 8.95 MT CO_2e during the lockdown. On the other hand, the carbon footprint of the paper consumption of AUC was 1175 MT CO_2e in the academic year 2019 and increased to 1313 MT CO_2e in the academic year 2020. [4] Water supply of HIPH was responsible for 0.79 MT CO_2e before the lockdown and was lowered to 0.45 MT CO_2e during the lockdown. The water supply of AUC was responsible for 603 MT CO_2e in the academic year 2019 and was lowered to 561 MT CO_2e in the academic year 2020. [4]

The Faculty of Engineering in Hasanuddin, Indonesia produced 2030 MT CO_2/Year. Electricity consumption was the main contributor to carbon footprint as it was responsible for 1315 MT CO_2/Year. Transportation produced 743.57 kg CO_2/Year and paper produced 49.39 kg CO_2/Year. [23] Bournemouth University (BU) is a mid-sized public institution of higher education in Bournemouth and Poole, Dorset, UK. The carbon footprint of the Bournemouth University decreased by 30% during the lockdown, which was similar to our research results. [24]

CONCLUSION AND RECOMMENDATIONS

Online responses to the questionnaire used to collect data for the study increased during COVID-19 emergence. There was a significant reduction in traveling outside Egypt during COVID-19 pandemic. A significant reduction was found in the time spent in front of the computer at HIPH during the emergence of COVID-19 as most of the work became from home. Significant reductions in the intake of hot drinks, cold drinks, bottled water, and food inside the HIPH were observed as people consumed fewer drinks and food outside their homes due to fear of infection.

Electricity consumption by HIPH was reduced by 1/5 during COVID-19 emergence. Water consumption was reduced by 43% during the emergence of COVID-19 infection. Paper usage inside HIPH was reduced in the closing period by 19%. Gasoline consumption for vehicles increased by 8.7% in the closing period of COVID-19. Concerning air travel, there was a sharp decrease in air travel during the COVID-19 pandemic with more than 70% reduction. There was 25% reduction in the total carbon footprint o the HIPH during the lockdown compared to that before the pandemic.

In general, the reduction in the carbon footprint of HIPH during the lockdown period should be encouraged through improving online learning technologies. Efforts should be gathered to reduce carbon footprint not only for the HIPH population but for the general population by increasing awareness about the effects of carbon production on climate change and how to lower our consumption of energy, food, and water.

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