Estimation of the Carbon Footprint, Its Contributory Factors, and Knowledge and Attitudes about Climate Change among Medical Students in Sri Lanka

PCI Wijesinghe1,*, S Mathurahan1, DS Wijesundere1, S Ranawaka1, C Arambepola2, T Chang3

1National Hospital of Sri Lanka, Colombo, Sri Lanka
2Department of Community Medicine, University of Colombo, Sri Lanka
3Department of Clinical Medicine, University of Colombo, Sri Lanka

*Corresponding author: channa8387@gmail.com

Received November 15, 2020; Revised December 20, 2020; Accepted January 03, 2021

Abstract The threat to human health from climate change through malnutrition, disease and extreme weather conditions is substantial. Instead of being advocates for a greener planet, doctors are known to possess a large carbon footprint (CFP). Whether a trend towards a higher CFP is initiated during the formative medical student years is not known. This study aimed to estimate the CFP among medical students and to assess their knowledge and attitudes towards climate change. A descriptive, cross-sectional study was conducted among 256 randomly selected medical students in Sri Lanka. The mean CFP of a medical student was 5.64 (SD=2.72) mtCO₂/year. The highest contribution to the CFP was from lifestyle factors (68.97%) followed by travel (26.41%). The CFP increased with increasing household income (p=0.001). 82% of students knew the meaning of ‘greenhouse effect’, but only 33% knew the meaning of ‘carbon footprint’; 58.3% were aware of the adverse effects of climate change while only 42.3% could name 3 or more gases that contribute to it. About a third considered their CFP to be negligible. However, 86.3% elected to change their mode of transport to minimize their CFP. Over 90% considered issues of climate change the responsibility of the government while only 7% felt that it was the responsibility of the individual. The CFP of medical students was higher than the per capita national average while knowledge about it was inadequate. Educating medical students on climate change and emphasizing the importance of individual responsibility is likely to change behavior towards a greener lifestyle.

Keywords: carbon footprint, climate, greenhouse, Sri Lanka

Cite This Article: PCI Wijesinghe, S Mathurahan, DS Wijesundere, S Ranawaka, C Arambepola, and T Chang, “Estimation of the Carbon Footprint, Its Contributory Factors, and Knowledge and Attitudes about Climate Change among Medical Students in Sri Lanka.” Journal of Environment Pollution and Human Health, vol. 9, no. 1 (2021): 1-5. doi: 10.12691/jephh-9-1-1.

1. Introduction

The carbon footprint is an estimate that can be used to measure the contribution an individual or organization makes towards the greenhouse effect. The greenhouse effect has been the main reason for the anthropogenic climate change experienced during the last century. CO₂ contributes 80% of the greenhouse effect followed by other gases such as nitrogen dioxide, ozone and chloro-flouro carbon [1]. Increase in CO₂ emissions to the atmosphere was mainly seen due to human activities that followed the industrial revolution. The carbon footprint is thus an estimate of the amount of CO₂ produced and released to the atmosphere and is defined as “a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product” [2].

The CO₂ concentration in the atmosphere exceeded more than 300 parts per million for the first time in the history of mankind in 1950 [3]. CO₂ in the atmosphere traps heat. Much of this heat is transferred to the oceans. The thermal homeostasis of the oceans is vital to maintain weather patterns. When the ocean temperature rises, weather patterns become disrupted resulting in global warming and climate change. The average global temperature has risen more than 2 degrees Fahrenheit during the last century [3]. The health impact of climate change is well established. Malnutrition and spread of infectious diseases such as malaria, cholera and tick-borne infections, respiratory illnesses and diseases due to thermal stress increase due to climate change and may occur over a prolonged period [4]. Climate change may also result in extreme weather events, which results in mortality and morbidity over a short period [9].

Healthcare professionals have been shown to possess a high carbon footprint, particularly in relation to air travel
It has been estimated that a single medical conference that attract attendees from all over the globe could generate over 20,000 metric tons of CO₂ in contrast to a mean carbon dioxide emission of 1.7 metric tons of CO₂ per average person living in India for a whole year [7]. Given the privileged duty of protecting human health, healthcare professionals need to lead by example by cutting down their carbon footprint and adapting a more sustainable lifestyle. This requires awareness and attitudinal changes inculcated within individuals from their formative years of training to be healthcare professionals. Therefore, as much as providing training on behavioral sciences important for patient care, it is important to harness social responsibility among medical trainees on global health effects leading to public health disasters. However, studies on carbon footprint of University students are scarce. In a study from Norway, medical students were found to have a carbon footprint of 9.6 metric tons of CO₂ per student in comparison to 4.2 per science student, which was attributed to the differences in the courses of study but no data of knowledge or attitudes were available [6]. Thus, this study aimed to estimate the carbon footprint and assess the knowledge and attitudes towards climate change among medical students.

2. Methods

A descriptive cross-sectional study was conducted among students of the Faculty of Medicine of the University of Colombo, Sri Lanka. This University is the premier higher education institute in the country and enrolls medical students who have performed best academically in the country. From among approximately 1000 students across the five academic years of study, 256 participants were randomly selected. This sample size was based on Z value of 1.96, precision of 0.05 and expected prevalence of poor knowledge on carbon footprint of 20%. Students living in hostels were excluded.

A pre-tested, self-administered questionnaire with 3 sections was used: the first section recorded demographic data and data needed to calculate the carbon footprint on household activities, travel and lifestyle; the second section included 17 multiple choice questions to assess knowledge on carbon footprint and the greenhouse effect; and the third section included 16 questions to assess attitudes related to reducing the carbon footprint. Calculations were done using a validated online carbon footprint calculator (available at www.carbonfootprint.com). The calculator uses data on lifestyle, travel and household activities to give an estimate of the carbon footprint. Each question in the calculator was assessed for its relevance in assessing the carbon footprint in Sri Lanka, appropriateness of thewordings used, acceptability in the local context and cultural sensitivity. Further, the questionnaires on knowledge and attitudes were developed based on a literature review and expert opinion. The face, content and consensual validity of the total questionnaire was ensured in consultation with an expert panel comprising an environmentalist, environment activist, chemistry specialist and an academic, and with students representing the target group. Data were analyzed using SPSS (version 20) software package. Quantitative data were presented in mean (SD) and qualitative in proportions. Significance of the factors associated with carbon footprint was assessed using t test and chi-square test. Ethics clearance was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Colombo.

3. Results

A total of 136 males (53.1%) and 120 females (46.9%) with a mean age of 21.5 (SD=1.7) years participated in the study. The average monthly household income of the students was in the range of LKR 20,000.00 - 50,000.00 (USD 125 - 312.5).

The mean carbon footprint of a medical student was 5.64 (SD=2.72) metric tons of CO₂/year, ranging between 1.08 and 17.03. The highest contribution to the carbon footprint was from lifestyle factors (68.9%; 3.89 metric tons of CO₂/year (SD=1.86)), followed by travel (26.4%; 1.49 metric tons of CO₂/year (SD=1.74)) and household activities (4.7% 0.26 metric tons of CO₂/year (SD=0.29)).

Among the lifestyle practices contributing to the carbon footprint, not recycling, engaging in carbon intensive activities and regularly acquiring latest fashions were found to be significantly higher compared to the average carbon footprint of medical students. The carbon footprint progressively increased with increasing household income. Students of households having a monthly income of more than LKR 100,000.00 (USD 625) generated on average 7.66 metric tons of CO₂/year which was significantly higher than students with monthly incomes < LKR 100,000.00 (p=0.001) (Figure 1).

Table 1. Factors that Contribute to the Carbon Footprint of Medical Students (N=256)

| Factor                  | No. (%) | Mean CFP | SD  |
|------------------------|---------|----------|-----|
| **Household activities** |         |          |     |
| Electricity            | 256 (100.0) | 0.21     | 0.28 |
| Natural gas            | 256 (100.0) | 0.06     | 0.05 |
| Total                  | 256 (100.0) | 0.26     | 0.29 |
| **Travel**             |         |          |     |
| Bus                    | 204 (79.9)  | 0.53     | 0.59 |
| Train                  | 29 (11.3)   | 0.37     | 1.2  |
| Taxi                   | 73 (28.5)   | 0.08     | 0.13 |
| Motor bicycle          | 58 (22.7)   | 0.37     | 0.68 |
| Car                    | 111 (43.4)  | 1.49     | 1.98 |
| Total                  | 256 (100.0) | 1.49     | 1.74 |
| **Lifestyle**          |         |          |     |
| Never recycles         | 77 (30.2)   | 7.25     | 2.86 |
| Enjoys carbon intensive activities | 166 (64.8) | 6.09     | 2.47 |
| Regularly acquire the latest fashion | 10 (3.9)  | 10.05    | 2.62 |
| Total                  | 256 (100.0) | 3.89     | 1.86 |
| **Total**              | 256 (100.0) | 5.64     | 2.72 |
On testing knowledge, 210 (82%) of students knew the meaning of ‘greenhouse effect’, but only 85 (33.2%) knew the meaning of ‘carbon footprint’ (Table 2). The proportion of students who responded with correct answers to ≥3 out of 5 items on knowledge questions regarding adverse effects of climate change was 56.3%, regarding effective ways to minimize the carbon footprint was 77.4% while only 41.8% could name more than 3 gases that contribute to climate change. (Table 2)

Table 2. Knowledge on Carbon Footprint of Medical Students (N=256)

| Question                                                                 | No. (%) |
|--------------------------------------------------------------------------|--------|
| Correct responses given on the meaning of CFP                          | 85 (33.2) |
| Correct responses given on the meaning of greenhouse effect             | 210 (82.0) |
| Correctly named gases that contribute to CFP                            |        |
| None                                                                    | 11 (4.3) |
| One                                                                     | 24 (9.3) |
| Two                                                                     | 27 (10.5) |
| Three                                                                   | 82 (32.0) |
| Four                                                                    | 92 (35.9) |
| Five                                                                    | 15 (5.9) |
| Correct answers given on adverse effects of climate change              |        |
| None                                                                    | 8 (3.1) |
| One                                                                     | 28 (10.9) |
| Two                                                                     | 67 (26.2) |
| Three                                                                   | 61 (23.8) |
| Four                                                                    | 46 (18.0) |
| Five                                                                    | 37 (14.5) |
| Correct answers given on ways to decrease your CFP                      |        |
| None                                                                    | 7 (2.7) |
| One                                                                     | 14 (5.5) |
| Two                                                                     | 27 (10.5) |
| Three                                                                   | 16 (6.3) |
| Four                                                                    | 111 (43.4) |
| Five                                                                    | 71 (27.7) |

On testing attitudes, 30.1% of students considered their carbon footprint to be negligible. However, when compared to students who did not think so, they had a significantly higher carbon footprint of 6.17 mt/CO₂/year (p<0.05). 90.6% of students felt that climate change was the responsibility of the government while only 7% felt that it was a collective responsibility of individuals (Table 3). However, 86.3% considered using a bicycle for transport to minimize their carbon footprint (Figure 2).

Table 3. Attitudes on Carbon Footprint of Medical Students (N=256)

| Attitude                                                                 | Number agreeing with the statement (%) |
|--------------------------------------------------------------------------|---------------------------------------|
| 1. My carbon footprint is negligible.                                    | 77 (30.1)                             |
| 2. The carbon footprint is not something developing countries should worry about. | 26 (10.2)                             |
| 3. I try not to think about pollution.                                  | 28 (10.9)                             |
| 4. My individual carbon footprint contributes towards climate change.   | 181 (70.7)                            |
| 5. Doctors do not have significant individual carbon footprints.        | 20 (7.8)                              |

 Modes of transportation that you would consider using to decrease your carbon footprint

| Mode                        | Number agreeing with the statement (%) |
|-----------------------------|---------------------------------------|
| 1. Bicycle                  | 221 (86.3)                            |
| 2. 100% electric car        | 178 (69.5)                            |
| 3. Petrol car               | 19 (7.4)                              |
| 4. Diesel car               | 15 (5.9)                              |
| 5. Bus                      | 113 (44.1)                            |

Addressing climate change is the responsibility of,

| Responsibility              | Number agreeing with the statement (%) |
|-----------------------------|---------------------------------------|
| 1. Governments              | 232 (90.6)                            |
| 2. Individuals              | 206 (80.5)                            |
| 3. Organizations            | 225 (87.9)                            |
| 4. Teachers                 | 211 (82.4)                            |
| 5. Doctors                  | 204 (79.7)                            |
| 6. All above                | 18 (7.0)                              |

4. Discussion

The study revealed that the mean carbon footprint of medical students of the University of Colombo, Sri Lanka was 5.64mt/CO₂/year, which was four-fold higher than the national per capita average of 1.4 mt/CO₂/year [5]. The carbon footprint has been reported to be higher among medical students when compared to students studying humanities, social sciences and law [6]. This difference
has been attributed to the inherent nature of the field of study with science-oriented programmes requiring usage of more equipment and activities that are carbon intensive [6]. However, cultural differences of students of different faculties such as eagerness to travel to conferences and a relatively higher level of affluence of medical students may contribute to the higher carbon footprint. Indeed, our data showed that even among medical students the carbon footprint was higher among students with higher household incomes. This is also reflected by the observation that major contribution to the carbon footprint among medical students was from lifestyle practices including carbon intensive recreational activities and acquiring latest fashion regularly. These same factors are attributable to the relatively higher carbon footprint of medical students compared to the national per capita average. Currently, there are no published data to compare the carbon footprint of students from other study programmes or Universities in Sri Lanka. However, compared to medical students in Sri Lanka, per capita carbon footprints were lower among students of Universities in London, United Kingdom and Cape Town, South Africa, and higher among students attending Universities in the United States of America [10]. This difference may be due to knowledge and attitudes to climate change as well as a greater dependence on air travel as a mode of transport, which is more likely to occur in the USA.

The knowledge of carbon footprint and climate change was inadequate among medical students in Sri Lanka. Despite being the cream of intelligence and the future guardians of public health, only a third of medical students knew the meaning of carbon footprint or the gases that contributed to climate change while only about half of them were aware of the threat to human health from climate change. This may partly be due to the lack of formal teaching-learning of climate change in school and University and partly due to the lack of prioritization in the country’s national policies. Recycling in Sri Lanka has only recently begun and is yet in a primitive state; promotion of use of solar energy and electrical transport by reducing taxation has not yet occurred; and prosecution of violating environmental regulations are inconsistent and negligible. School and medical curricula are subject- or system-based and thus, do not have effective input to evoke individual responsibility towards protecting the climate through realization of the harm of climate change. Even though the knowledge was inadequate, most students possessed a positive attitude in wanting to change lifestyle activities to reduce their carbon footprint. The underestimation of their individual carbon footprint and the lack of individual responsibility in their attitudes probably emanates from the lack of knowledge rather than a negative attitude.

This study has a few limitations. The study only included students of the medical faculty from a single University situated in the capital of the country. Medical students are likely to be culturally different to students of other study programmes. The carbon footprint was measured using an online tool. Thus, the result is not precise, but is a reasonable estimate and could be improved upon in future studies. Currently, there are no published data of per capita carbon footprint measurements of University students in Sri Lanka.

5. Conclusions & Recommendations

This is the first-ever estimate of per capita carbon footprint of medical students in Sri Lanka, which was found to be four-fold higher than the national per capita average. This study identified lifestyle activities as the major contributor to the carbon footprint. Lack of knowledge regarding climate change and carbon footprint precludes students from taking effective measures to reduce their carbon footprint and that of others as part of the responsibility of future health care professionals. Introducing concepts such as ‘individual responsibility to climate change’ and ‘carbon footprint’ in the university curriculum would empower medical students to advocate a greener planet as future health leaders of society while curtailing their personal carbon footprint.

Acknowledgements

The Community Stream of the Faculty of Medicine, University of Colombo for guidance on the research project.

Availability of Data and Material

All data generated or analyzed during this study are included in this published article. The questionnaires used in this study are provided as supplementary material.

Conflict of Interest

The authors declare that they have no competing interests.

Authors’ Contributions

All authors were involved in conceptualizing and designing the study. PCIW, SM, DSW and SR collected the data and did the statistical analyses. PCIW wrote the first draft of the paper. CA supervised the statistical analysis. CA and TC critically appraised, revised and wrote the final draft of the paper.

References

[1] Lashof DA, Ahuja DR. 1990. Relative contributions of greenhouse gas emissions to global warming. Nature 344:529-531.
[2] Minx J, Wiedmann T. 2008. A Definition of ‘Carbon footprint’. In: Pertsova CC (ed.). Ecological Economics Research Trends. New York: Nova Science Publishers. p 1-11.
[3] Global Climate Change: vital signs of the planet. Climate change: How do we know? NASA’s Jet Propulsion Laboratory: California Institute of Technology; [accessed 2019 Dec 10]. https://www.nasa.gov/earth/university-students-climate-change-related-issues/
[4] McMichael AJ, Haines A. 1997. Global climate change: The potential effects on health. BMJ. 315(7111):805-9.

[5] Edgar G Hertwich, Peters GP. 2009. Carbon footprint of nations: a global, trade-linked analysis. Environ. Sci. Technol. 43(16): 6414-6420.

[6] Larsen HN, Pettersen J, Solli C, Hertwich EG. 2013. Investigating the Carbon Footprint of a University - The case of NTNU. J. Clean. Prod. 48: 39-47.

[7] Nathans J, Sterling P. 2016. How scientists can reduce their carbon footprint. eLife. 5: e15928.

[8] Roberts I, Godlee F. 2007. Reducing the carbon footprint of medical conferences. BMJ. 334(7589):324-325.

[9] World Health Organization. 2009. Protecting Health from climate change; connecting science, policy and people. Geneva: WHO.

[10] Letete TCM, Mungwe NW, Guma M, Marquard A. 2011. Carbon footprint of the University of Cape Town. J. Energy South. Afr. 22(2):2-12.

© The Author(s) 2021. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).