Global Warming: Knowledge and Views of Iranian Students

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Abstract- Study of students' knowledge about global warming can help authorities to have better imagination of this critical environmental problem. This research examines high school students' ideas about greenhouse effect and the results may be useful for the respective authorities to improve cultural and educational aspects of next generation. In this cross-sectional study, a 42 question questionnaire with mix of open and closed questions was used to evaluate high school students' view about the mechanism, consequences, causes and cures of global warming. To assess students' knowledge, cognitive score was also calculated. 1035 students were randomly selected from 19 educational districts of Tehran. Sampling method was multi stage. Only 5.1% of the students could explain greenhouse effect correctly and completely. 88.8% and 71.2% respectively believed "if the greenhouse effect gets bigger the Earth will get hotter" and "incidence of more skin cancers is a consequence of global warming". 69.6% and 68.8% respectively thought "the greenhouse effect is made worse by too much carbon dioxide" and "presence of ozone holes is a cause of greenhouse effect". 68.4% believed "not using cars so much is a cure for global warming". While a student's 'cognitive score' could range from -36 to +36, Students' mean cognitive score was equal to +1.64. Mean cognitive score of male students and grade 2 & 3 students was respectively higher than female ones ($P<0.01$) and grade 1 students ($P<0.001$) but there was no statistically significant difference between students of different regions ($P>0.05$). In general, students' knowledge about global warming was not acceptable and there were some misconceptions in the students' mind, such as supposing ozone holes as a cause and more skin cancer as a consequence of global warming. The Findings of this survey indicate that, this important stratum of society have been received no sufficient and efficient education and sensitization on this matter.
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Introduction

One of the most critical environmental subjects of 21th century is Global warming (1). More lately, global warming is not only environmental danger but also social and economic threat and unfortunately some adverse consequences of it are becoming visible these days (2). Greenhouse effect which causes this phenomenon, happens because of greenhouse gases (water vapor, carbon dioxide, methane, etc) existing in the atmosphere, trapping sunrays and making earth's atmosphere warmer. Whereas some of these gases are naturally found in the atmosphere, human activity increases the amount of particular gases (3-5).

Worries about environmental impacts of energy

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consumption in Iran have been increased recently. Iran's total emission in 2006 included respectively 413.23, 2.18, 2.5, 0.75, 2.26, 0.59 and 0.32 million tons of carbon dioxide, carbon monoxide, NO_x, SO_2, residual hydrocarbons, aldehydes and dusts (6). There are some challenges in this field including peoples' lack of enough awareness about global warming.

If people's knowledge of environment generally improves, they will behave in a manner that avoids environmental degradation (7). This fact is also true about global warming phenomenon; since the people's behavior in the field of producing greenhouse gasses is a determinant factor and their action is directly dependent on the amount of knowledge about this matter, it is so important to discover what they know in this regard. There may be some misconceptions about climate change in persons' minds; therefore it is necessary to explore those misconceptions before any educational planning (8). As students are among the most trainable stratums of the society, it is essential to discover their knowledge and perception of greenhouse effect to prepare the best kind of educational program for them.

While global warming and ozone layer depletion are two totally different subjects a recent research which was carried out in Turkey showed that apparently, students mix the causes and consequences of global warming up with those of ozone layer depletion (8). The considerable point is that there are some relationship between greenhouse effect and ozone layer depletion; the greenhouse effect is responsible not only for heating the lower atmosphere (lower troposphere), but also for cooling the upper atmosphere (stratosphere). The cooling poses problems for ozone molecules, which are most unstable at low temperatures, and then unprecedented stratospheric cold is driving the extreme ozone destruction (9,10).

Another study in Sweden had indicated that students didn't completely understand what principal social changes would happen if an effective reduction in CO_2 emission occurs, but they were aware of adverse effects of ozone layer depletion on humans (11). A research on 1460 Spanish secondary students showed that, education about global warming is likely to make effective willingness in students to act for reducing greenhouse gasses (12).

This survey was conducted to assess Tehran high school students' ideas about global warming, with the aim to assist respective authorities in educational planning and improving cultural aspects of next generation.

Materials and Methods

The present cross-sectional study was carried out by National Research Institute of Tuberculosis and Lung Disease (NRITLD) in high schools of 19 educational districts of Tehran from November 2008 to March 2009.

The instrument used in this study was the exact and reliable Persian translation version of the English questionnaire which had been prepared by Eddie Boyes and Martin Stanisstreet (2). The Turkish translation version has been used by Ahmet Kilinc and colleagues (8) to evaluate Turkish students' ideas about global warming. The process of translation (English to Persian) and back-translation of the questionnaire was conducted by two separate individuals fluent in English and Farsi who were conversant about the subject. The back translation version was confirmed by designers of the questionnaire. Cronbach's alpha (α) was calculated after the pilot study and was equal to 0.85.

The questionnaire began by explanation about the project and asking students to record their gender and grade. The first main section of the questionnaire was an open question and asked students to explain greenhouse effect. Responses to this open question were categorized into 5 groups: No response, incomplete response, complete response (this group was dedicated to responses which included at least this main point: trapping sunrays by greenhouse gases in the earth' atmosphere), wrong response (excluding misconception with ozone layer depletion) and wrong response that shows misconception with ozone layer depletion.

The second part asked students to mention what percent they have learned about greenhouse effect from any of the mass media. To evaluate the source which students had taken their information about the greenhouse effect from, we accessed average of the reported percentages to the question: How much about the greenhouse effect do you think you have learned from television, internet, school, newspapers and magazines and radio?

The rest and most important part of the questionnaire was in three sections containing items about the consequences, causes and cures of global warming and each section consisted of six scientifically right ideas and six scientifically wrong ideas about global warming (totally 36 items). The available responses to these Items were "I am sure this is right", "I think this is right", "I don't know about this", "I think this is wrong" and "I am sure this is wrong". To evaluate students' knowledge about global warming and determine a cognitive score for any student, we used students' answers to this part of

the questionnaire. For each scientific statement, a "sure right" response was given a mark of 1, "think right" 0.5, "don't know" 0, "think wrong" -0.5, and "sure wrong" -1. The scoring was reversed for statements that were scientifically wrong. The cognitive score was the sum of the any person's score for each of the 36 items.

The study population was a random sample of high school (both public and private schools) students of Tehran. The type of sampling was multi stage. To sample from all socioeconomic status levels we divided Tehran into five regions (north, south, east, west and center), then we chose two female high schools and two male high schools of any region randomly (totally 20 schools). Volunteer students of any grade level (9-11) at each school participated in the study.

Students were assured that their score would be confidential. The questionnaires were completed by students themselves and under supervision of their own teacher and questioner of the project without time restriction. 1035 persons of 1054 eligible students participated in the study (response rate: 98.2%). The data were analyzed using SPSS version 15.

The Ethics committee of the National Research Institute of Tuberculosis and Lung Disease (NRITLD) approved the study. Additionally, students participated in the study voluntary and the questionnaires were anonymous.

Results

Demographic data of the 1035 participants in the study are presented in table 1. While 34.6% of the students were in grade 1, 29.3% and 36.1% were studying in grade 2 and 3 of high school, respectively.

Table 2 shows students' responses about the mechanism of greenhouse effect according to the grade. Totally among 1035 students 610 persons didn't answer the question, 202 students made an incomplete response, 53 people gave a correct complete answer, 124 students gave wrong response but didn't mix global warming up with ozone layer depletion and 46 students confused greenhouse effect with ozone layer depletion. There were significant differences ($P<0.01$) in response to this question among grades.

In response to the question; "how much about the greenhouse effect do you think you have learned from any of mass medias?", The average reported percentage were television 24.65%, internet 14.88%, school 38.49%, newspapers and magazines 14.76% and radio 9.66%.

Table 3 summarizes students' ideas about the consequences, causes and cures of global warming. It must be emphasized that the percentages have brought later in the results, belong to students who were sure or thought that the statement was correct.

Table 1. Descriptive data of students who participated in the study.

| Sex | Grade | | | |
	1	2	3	Total
Girls	132 (34.8%)	119 (31.4%)	128 (33.8%)	379 (36.6%)
Boys	227 (34.6%)	184 (28%)	245 (37.4%)	656 (63.4%)
Total	358 (100%)	303 (100%)	374 (100%)	1035 (100%)

Distribution of girls and boys in the three grades has no statistical difference.

Grade 1: first year of high school/ Grade 2: second year of high school/ Grade 3: third year of high school

Table 2. Students' responses to the question" Do you know about the greenhouse effect? Can you explain it? "

| Responses | Grade | | | |
	1	2	3	Total
No response	60.9%	51.8%	63%	59%
Incomplete response	19%	22.8%	17.4%	19.5%
Complete response	7.5%	5.3%	2.7%	5.1%
Wrong response	10.1%	14.5%	11.8%	12%
Misconception with ozone layer depletion	2.5%	5.6%	5.1%	4.4%

$P<0.01$. Grade 1: first year of high school, Grade 2: second year of high school, Grade 3: third year of high school

Table 3. Student's ideas about consequences, causes and cures of global warming.

Responses	Sure right	Think right	Don't know	Think wrong	Sure wrong
Consequences of greenhouse effect:					
Misconceptions					
More skin cancer	42.3%	28.9%	18.6%	5.5%	3.3%
More food poisoning	23.2%	35.5%	30.1%	7.1%	2.6%
Unsafe tap water	20.1%	35.6%	30.7%	8%	3.4%
More poisonings of fish	32%	33.9%	21.1%	6.9%	3.6%
More heart attacks	28.5%	29.4%	28.1%	7.3%	4%
More earthquakes	18.4%	19.6%	40.8%	12.3%	8.1%
Scientifically acceptable ideas					
More bugs and pests	24.3%	32.5%	31%	7.4%	3.8%
More flooding	19.8%	16.3%	35%	15.1%	9.9%
More deserts	29.7%	30.3%	26.3%	7.4%	5.2%
Earth will get hotter	66.8%	22%	7.7%	1.9%	1.1%
Polar ice will melt	53.2%	23%	17.1%	3.2%	2.1%
Weather Changes	55.7%	25.8%	12.9%	2.4%	1.3%
Causes of greenhouse effect:					
Misconceptions					
Ozone holes	38.2%	30.6%	21.3%	4.8%	3.3%
Too many rays	32.6%	33.4%	21.6%	7.1%	3.8%
Radioactivity	29.6%	30.4%	27.9%	6.1%	3.5%
Street litter	17%	27%	31.9%	13.5%	7.6%
Acid rain	26.9%	32.3%	24.8%	9.6%	4.1%
Rubbish in rivers	20.8%	30.3%	31.4%	10%	6.4%
Scientifically acceptable ideas					
Ground ozone	19.1%	27.8%	30.6%	12.4%	6.4%
Artificial fertilizers	27.4%	34.5%	28.5%	5.4%	2.3%
Trapped rays	35.2%	29%	22.2%	7%	4.7%
Rotting waste	24.3%	31.5%	28.9%	8.6%	2.8%
CFCs	41.1%	25.5%	22.9%	4.8%	2.4%
Carbon dioxide	34.8%	34.8%	21.6%	4.3%	1.5%
Cures for greenhouse effect:					
Misconceptions					
Fewer nuclear bombs	28.2%	25.7%	30.6%	6.6%	4.8%
Use unleaded petrol	37.3%	30%	21.8%	5.1%	2.3%
Clean beaches	26.7%	29.8%	28%	7.7%	4.1%
Protect rare species	27.1%	23.4%	28.9%	9.7%	7.1%
Healthy foods	26.2%	26.7%	26.4%	11.4%	7.2%
Reduce starvation	18.8%	20.1%	33.7%	13.4%	10.2%
Scientifically acceptable ideas					
Save electricity	21..4%	22.6%	36.1%	10%	6%
Use nuclear power	32%	31.7%	26.6%	3.2%	3.1%
Use renewable power	35.3%	22.6%	30%	5.8%	2.5%
Use cars less	44.1%	24.3%	19.6%	5.1%	4.4%
Recycle paper	28.3%	27.3%	29.5%	7.1%	3.6%
Plant more trees	45.8%	22.3%	17%	6.4%	4.3%

In the field of scientifically acceptable consequences of the greenhouse effect, the most common idea was "if the greenhouse effect gets bigger the Earth will get hotter" (88.8%), while 81.5% were sure or thought that "if the greenhouse effect gets bigger there will be changes in the world's weather" and 76.2% believed that "some of the ice at the Poles will melt as a consequence of global warming". After these three most popular ideas about the consequences of the global warming, "more deserts" (60%), "more bugs and pests" (56.8%) and finally "more flooding" (36.1%) were in the next ranks, sequentially.

Table 4. Comparison of Cognitive Score between students based on sex, grade and living region.

		Mean	S.D	*P*-value
Sex				
	Girl	1.21	3.32	-
	Boy	1.89	4.10	<0.01
Grade				
	1	0.94	3.42	-
	2	2.24	4.21	-
	3	1.83	3.83	<0.001
Region				
	North	1.84	4.11	-
	South	1.76	4.02	-
	Center	1.58	3.71	-
	East	1.41	3.13	-
	West	1.45	3.88	>0.05

Misconceptions about the consequences of global warming, in the descending order according to the prevalence, were "more skin cancer" (71.2%), "more poisoning of the fish" (65.9%), "more food poisoning" (58.7%), "more heart attacks" (57.9%), "unsafe tap water" (55.7%) and "more earthquakes" (38%).

Investigation of the acceptable ideas about the causes of global warming showed that 69.6% believed "the greenhouse effect is made worse by too much carbon dioxide in the air". Meanwhile, 66.6% accepted chlorofluorocarbons as a cause of global warming, 64.2% "trapped rays", 61.9% "gas from artificial fertilizers", 55.8% "gas from rotting waste" and 46.9% "too much ground ozone".

On the other hand, prevalence of the students' misconceptions about the causes of the global warming for "ozone holes", "too many sun's rays", "radioactive waste", "acid rain", "rubbish in rivers", % and "too much street litter" were 68.8%, 66%, 60%, 59.2%, 51.1 and 44% respectively.

Assessment of students' concepts about methods of improving global warming, indicated that the percentage of the student's ideas in this regard were 68.4% for "not using cars so much", 68.1% for "planting more trees", 63.7% for "more nuclear power stations", 57.9% for "using renewable power", 55.6% for "more recycled paper" and 44% for "not wasting electricity".

Prevalence of students' misconceptions about cures for global warming were for "using unleaded petrol" 67.3%, "clean beaches" 56.5%, "reducing nuclear bombs" 53.9%, "healthy foods" 52.9%, "protecting rare species" 50.5% and "reducing starvation" 38.9%.

While a student's 'cognitive score' could range from -36 to +36, Students' mean cognitive score was equal to +1.64 (SD=3.85). The levels of cognitive scores according to gender, grade and region of the students' school have been brought in table 4. There was statistically significant difference between cognitive scores for genders and grades; totally cognitive score of male students and grade 2 and 3 students was respectively higher than female ones (*P*<0.01) and grade 1 students (*P*<0.001) but there was no statistically significant difference between students of different regions (*P*>0.05).

Discussion

The findings of this survey totally indicated that students of Tehran are not well informed about the global warming phenomenon. According to the findings only about 5% of the students were able to explain the greenhouse effect correctly and completely, while more than half of the students didn't answer to this question at all. There were also misconceptions in their minds such as mixing global warming with ozone layer depletion.

In current project the students mentioned their most common source of information on the greenhouse effect as school, television, internet, newspapers & magazines and radio. Considering this and the fact that students' knowledge was not acceptable, it seems necessary to increase our educational planning, especially via school and television.

The study showed high percentages of the students believed that if the greenhouse effect gets bigger "the Earth will get hotter", "there will be changes in the world's weather" and "polar ice will melt". These findings together with students' low level cognitive scores and the fact that students were not able to

describe greenhouse effect correctly and completely indicate that students know some points about global warming but their knowledge is not deep-seated.

71.2% of the students believed "more skin cancer" is a consequence of global warming phenomenon, 68.8% appreciated that "the greenhouse effect is made worse by holes in the ozone layer" and 4.4% of the students had described the mechanism of ozone layer depletion instead of the global warming in response to the open question of the questionnaire. These beliefs show that students have confused global warming with the ozone layer depletion.

Despite of assuming "holes in the ozone layer" as a cause of greenhouse effect by most of the students, near the same percentage of the students were aware of the fact that too much carbon dioxide and chlorofluorocarbons are causes of global warming. These data show the students' superficial awareness about the causes of the greenhouse effect. While more than two third of the students knew "not using cars so much" and "planting more trees" are cures for global warming, about the same percentage of the students accepted this wrong idea that "using unleaded petrol is a way to reduce greenhouse effect", therefore students' knowledge about cures for greenhouse effect is not reliable too.

There are some themes about greenhouse effect in Iranian students' high school books, but according to the results certainly this way is not enough to educate students. Taber and Taylor have shown that after a period of eight weeks specific educational program in this field, students had a better understanding of the science of the global warming and increase in awareness was accompanied by increased level of concern and belief of ability to impact (13). Therefore it seems necessary that respective authorities plan specific educational program in this field for the students and it is better these programs begin in lower ages.

Students in grade 2 and 3 were more knowledgeable about greenhouse effect than those in grade one, that seems to be because of some themes about global warming in the chemistry book of first grade of high school.

A similar project with the same questionnaire had been carried out in two secondary schools of Turkey before (8). The sequence of prevalence of ideas in any field (consequences, causes and cures) was not exactly the same but it was almost similar to our study conducted in Iran. For example more skin cancer as a consequence and also ozone holes as a cause of global warming were the most common misconceptions in both

countries. But totally Turkish students were more informed about the greenhouse effect. In response to the open question about the mechanism of the greenhouse effect 28% of Turkish students gave a scientifically acceptable answer but only about 5% of Iranian students did the same.

A more recent study that has been performed by Kilinc *et al.* in Turkey indicated that the idea of "planting more trees will reduce global warming" was the most popular idea (14) which this situation was similar to their previous study (8). On the other hand, the most common suggestion for reducing global warming in this research was "not using cars so much" and followed by "planting more trees". It seems considering less usage of cars as a priority by Iranian students is due to special character of Tehran which contains a lot of automobiles more than its actual capacity.

Kerr and Walz have shown that 17% of the students believed global warming has caused by the ozone holes, 40% assumed global warming has caused ozone layer depletion and only 33% understood the correct relationship between greenhouse effect and ozone layer destruction (15). These misconceptions are comparable with Iranian misunderstandings about the global warming.

Mistaking global warming for ozone layer depletion is not specific for students. Both students and the general population have lots of misunderstandings about these two subjects (16): A study in 1994 showed that even highly educated people tend to mix stratospheric ozone depletion up with the greenhouse effect. Increased skin cancer was also considered as an effect of climate change (17).

Apart from misconceptions, according to cognitive score, Iranian students didn't have acceptable knowledge about global warming and need to receive more practical education, since global warming is one of the most important issues of environmental difficulties these days.

Students of different regions of Tehran didn't show significant difference in cognitive scores. We can say then, as conclusion socioeconomic aspects didn't affect students' knowledge level about global warming.

In current project awareness of male students about greenhouse effect was higher than female students (cognitive score 1.89 vs. 1.21), a research on 768 students in India showed that there were no significant difference between responses of male and female students to the questions about usefulness of actions to reduce global warming (18). Male students' higher

knowledge in Iran is an appropriate subject for further assessment in the future.

The questionnaire of current research was the exact and reliable translation of the one had been prepared by Liverpool University scientists and used in a study in Turkey study (8). However it is necessary that future studies will carry out with more developed questionnaires according to specific situation and culture of Iran. Also, it is recommended that such studied be performed in other age groups and people with different levels of education.

This research is the first study in Iran about such an important and effective subject. Considering type of sampling that students were included into the study from any region of Tehran, it is possible to generalize the results of the study to all students of such a big city like Tehran. In conclusion, considering importance of the global warming phenomenon and dependence of human life to this subject and findings of this research which showed students' knowledge in this field is not sufficient, it seems necessary that respective authorities plan specific educational programs in this field for the students.

Acknowledgment

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