Sister-chromatid Exchange Frequency in Women Who Exposed to Biomass in a Village of Central Anatolia

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Abstract

Objective: Biomass fuels are used by most of the people living in the rural areas (wood, agricultural waste and dung are used by about half of the world population) as a major, and most of the time as the only source of domestic energy for cooking and heating. Sister-Chromatid Exchange (SCE) values are analyzed in our study, to determine the mutagenic effects of exposure to biomass fuels.

Design and Patients: Sister-chromatid exchange analysis has been performed on peripheral lymphocytes by conventional sitogenetics method. In this study, two groups as 20 non-smoker subjects who are healthy women between 25 and 70 years of age, and have exposed to biomass for ten years, 3-5 hours per day, and 20 healthy women at the same age who did not exposed to biomass fuels were evaluated.

Measurements and Results: The mean SCE frequency was increased significantly in the study group in contrast to the control group in statistical evaluation, which is applied by the Man-Whitney *U*- test ($p<0.05$).

Conclusion: We suggest that, our findings support a transient increase in SCE after exposure to biomass fuels and there are constant and harmful effects of biomass fuels on increased SCE frequency.

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Key words: *Biomass, organic and inorganic fuels, SCE (sister - chromatid - exchange).*
Abbreviations: *SCE: Sister chromatide exchange, BrdU: 5-Bromo-2`-deoxyuridine*

Introduction

Biomass fuels (wood, agricultural waste, and dung) are used by about half of the world's population as a major, often as the only source of domestic energy for cooking and heating. The smoke emissions from these fuels are an important source of indoor air pollution, especially in rural communities in developing countries. These emissions contain important pollutants that adversely affect health, such as suspended particulate matter and polycyclic organic matter which includes a number of known carcinogenes, such as benzopyrene, as well as gaseous pollutants like carbon monoxide and formaldehyde. The persons most frequently affected are women who do the cooking for households in rural villages; they suffer from impaired health due to prolonged and repeated contact with these harmful pollutants. In the developing countries, exposure to biomass fuel emissions is probably one of the most important occupa-

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tional health hazards for women. A conservatively estimated 300-400 million people worldwide, mostly in the rural areas of the devoloping countries, are affected by these problems (1). The exposure to biomass produced a significant amount of respiratory morbidity (1-3). Sister-chromatid exchange (SCE) is known to be originated from reciprocal DNA interchange in homologous loci of sister chromatids in the replication process. Although it occurs spontaneously at certain rates in all the cells, some chemicals on physical agents causing DNA damage may lead to an increase in SCE frequency (4). It was reported that DNA demethylating agents are known to affect the SCE frequency in mammalian cells *in vitro* and *in vivo* (5-7). Therefore, in the present study, we planned to find out whether it is mutagenic or not by evaluating SCE frequencies in women who are using biomass excessively and continually in their daily life.

Materials and Methods

This research was done in a village of Sivas city, in Central Anatolia. 20 non-smoker healthy women, using biomass for cooking bread and heating for a long period of time, between 25 and 70 years of age (mean age is 44.80±14.80 years) were examined as the study group. On the other hand, the same age group and 20 non-smoker healthy women not being exposed to biomass were considered as the control group. Biomass use in the study group was 4 hours per day on the average for at least 10 years. They had neither coughing, expectoration, shortness of breath, metabolic, endocrine, malignity nor any other diseases. It is significant to see that they didn't have any radio- or chemotherapy for any reasons for the last 3 months.

The patients gave their informed consent for SCE analysis and then lymphocytes were cultured (8). 0.1 ml., from the 5-bromo-2`-deoxyuridine (BrdU) preservation solution was added. The preparations were stored for the required period of time and the SCE banding method was applied (9). If there was only one break at the tip of chromatid which was painted dark and light to determine SCE, it was evaluated as mono break SCE. A change in the middle of the chromatid was considered as double. The mean CSE frequency of in total of 20 metaphases for each case was evaluated and compared to the control group statistically by the Mann-Withney *U*-test.

Results

Mono (4.20±0.28) and double breaks (0.83±0.07) of SCE values in the study group; mono break (2.32 ±0.97), and double break (0.20±0.03) in the control group were found statistically significant at the end of the cytogenetic evaluation ($p<0.05$) (Table I).

Table 1. Comparison of the median SCE frequencies in the study and control groups

Groups	Mono break	Double break
Control group (n=20)	2.32±0.97	0.20±0.03
Study group (n=20)	4.20±0.28	0.83±0.07
	Z= 4.32 P= 0. 000 P= <0.05	Z= 4.65 P= 0.000 P= <0.05

Moreover, some facts which cannot be seen in the control group were observed in the study group such as, (60%) triple breaks in 12 individuals, quartet exchanges (5%) in one chromosome of one case (Figure 1).

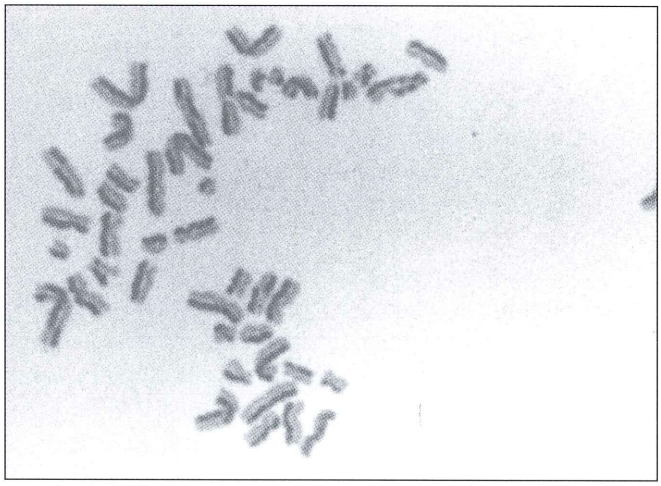

Figure 1: *The metaphase plate belongs to the study group, shows increased SCE frequency in long, short or both arms of different chromosomes. →: indicates quartet sister-chromatid exchanges in short and long arms of one chromosome.*

Discussion

The principal biomass fuels are wood, croop residues or agricultural waste, and manure, the last one is mainly obtained from domesticated animals such as cows. These fuels are composed of complex organic matter – vegetable proteins and carbonhydrates – incorporating carbon, nitrogen, oxygen, hydrogen, and certain other elements in trace amounts. Their combustion often produces substances harmful to human health, such as a range of polycyclic hydrocarbons not found in the fuels themselves. Biomass fuel emissions present a health hazard effects of which vary in type and severity depending on the local situation, the type of fuel used, and the population at risk (1). In our country, biomass fuels are used mostly by women in cooking stoves with open combustion without any combustion chamber. So, women seem to be the principal sufferers from such smoke in our country because of their role as the family cook as is the usual practice in most of the other countries.

There are few systematic studies that have been directly addressed to the effects of biomass combustion products on health, in spite of the large population at risk. The most of these studies are about the respiratory effects of the biomass exposure on the epidemiological data. Thus, it is clear that exposure to biomass combustion products may well play an important role in the etiology of both chronic and acute respiratory diseases (1-3,10-14). Recently, a study from Turkey showed that there was a significant increase in lipid peroxidation activity and a significant decrease in antioxidant enzyme activity in females who exposed to biomass (15).

Long term and excessive exposure to biomass smoke causes significant health problems in the same degree as those who are exposed to cigarette smoke and active cigarette smokers (16). There are more than 4000 active, mutagenic, carcinogenic, pharmacological substances in cigarette or tobacco (17). In contrasting experiments, it was observed that there are more structural chromosomal aberrations and changes in SCE frequencies in those who have been smoking cigarettes one packet a day for 10 years in contrast to passive cigarette smokers (18,19).

In the accessible literature, we could not find any other similar research in this respect. This study is most possibly the first and pivotal research for the other studies to be carried out on the subject in the future. However, the increase in SCE frequency which we have determined, confirms the idea that individuals are under serious threat in respect to their health.

In conclusion, the problem of adverse effects on health due to biomass exposure is complex and widespeard. Therefore, it is required that the use of these kinds of fuels are to be banned, or if this can not be accomplished, it is necessary to provide the people the correct information for burning and ventilating the biomass.

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