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Human Activity And Biological Pollutants İn The Homes

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***ABSTRACT*:** *Indoor air pollution sources are divided into two groups as biological resources and non-biological resources.Bacteria, fungi, mold, viruses, pollen and their fragments have been identified as biological resources.Non-biological resources are determined by different type of gases, particulate matter anddust generated by smoking, heating and cooling systems, building materials and cooking.Presentstudy undertaken in different indoor environments of Ankara to identifing the effects of human activity on indoor airpollutantsinside the flats during 2 years. Concentration of bacteria and fungi identified inside of 119 flats in Ankara city. Also different types of human activities that affect concentration of bacteria and fungi in indoor environments of flats were aimed. Concentration ofbioaerosols was measured by NIOSH Method-0800. According to the obtained results, different human activities such as; number of individuals living at home, ventilation status andnumber of people smoking insideflats severely affect the concentration of bacteria and fungi in an indoor environment. As a result, statistical relationship between concentration of bacteria and fungi and human activity were found in indoor environments.*

***Keywords*:** *Human Activity, Indoor Air Pollution,Bacteria, Fungi, Indoor environments*

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I. INTRODUCTION

Bioaerosols are the generic name for all organic dusts of biological origin, including bacteria, fungi spores, viruses, pollen and their fragments [16].Biological contaminants include bacteria, viruses, animal dander and cat saliva, house dust, mites, cockroaches, pollens and their fragments. Among them bacteria and fungi are the most common bioaerosols.The most important and medically important types of fungiand bacteria in an indoor environments are; Penicillium spp., Aspergillus spp.,Alternaria, Staphilicoccus, Corynobacteria and Streptococcus [29].Existence of high levels of microorganisms in indoor environments causesdifferent types of diseases such as; shortness of breath, asthma and allergic rhinitis and sick building syndrome [20, 21, 23].Bacteria can adhere to organic particles and inorganic powders [26, 27, 28].Some types of fungi also produce mycotoxins or microbial volatile organic compounds (MUOB) which are poisonous. Side products such as endotoxins and exotoxins produced by bioaerosols and their endotoxin, mycotoxin and volatile organic compounds (UOB) such as microbial metabolites show infection and toxin effects in the human body [2,3]. Bioaerosolsare transferred to indoor environments fromventilationsystems, heating and cooling systems, cracks indoors and windows (especially during spring and summer), pipes or people's shoes and clothes[18].Bioaerosols are transferred to indoor environments bydegradation of organic matter, people's different activities and from atmosphere Fig[18].

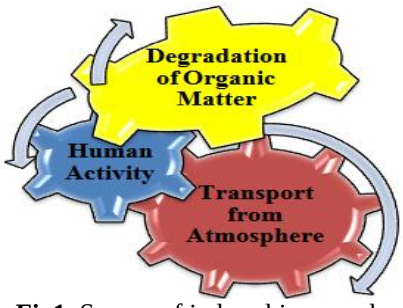


Fig1. Source of indoor bioaerosols

1.1. HumanActivity andAir Pollution

Source of bioaerosolsin indoor environments are both man-made and natural sources. However the reports specified humans continue to negatively impact their environments and contribute to air pollution more than natural sources[4].This represents a direct impact of human activities on air pollution. Man-made air pollution sources include industrial activities, agricultural soil management and vehicle exhaust. Human activity differs between midweek and weekend, between one season and anotherand between one part of one's lifetime and another[5].Human behavior inside the flats such as: number of individuals living at homes, ventilation status and number of smokingpeople at home severely affect the concentration of bacteria and fungi in an indoor environment.

II. MATERİAL AND METHODS

Type of human behavior determines how human activity affects indoor air[6, 9]. Therefore in this study questions were asked about the activities of the family members living in the flats and detailed questionnaires were made.Then air samples were taken from indoor air of 119 flatsin 15 different districts of Ankaracity and concentration of bioaerosols was carried outin autumn-winter and spring-summer seasons for 2 years.Plate, Blood and Sabouraud-Antibiotic agars were used to determine the total number and type of bacteria and fungi for 4 minutes with the device for measuring bioaerosol in indoor environments. Also some socio-demographic characteristics of families, lifestyles,ventilation frequency, smoking in the indoor environment,cleaning frequency, number of people living at home and their activities were recorded through questionnaires. For sampling and analysis of bioaerosolsin indoor environmentsNIOSH Manual of Analytical Method-0800 which is the indoor bioaerosol sampling standard method and SKC device were used. This sampling system consists of anBiyoimpactor and a vacuum pump that collects the bioaerosols on the agars inside the impulse. Vacuum pump was carried out with constant flow rate of 28.3 L/min for 4 minutes and flow rate was checked with the DC-Lite Calibrator before each sampling.At the end of the sampling, agars were taken to the laboratory and placed in the incubator of microbiology laboratory. Bacteria were incubated for 48 hours at 37 ºC and Sabouraud-antibiotic agars were incubated for about 7 days at 25 ºC.

2.1. Survey Studies

In this study different questions were asked about the activities of the family members living in the flats and detailed questionnaires were made. Some parameters examined in the flats are number of persons living at homes, state of windows during sampling and number of persons smoking inside the flats. Three peoplelive %47 of sampled flats and more than three peoplelive in %53 offlats.In this study, 57% of the windows in the flats we sampled were open and 43% were close during sampling perriods. Also, in 50% of the flats nobody smokes and in 50% of the sample flats at least one person smokes inside the flats. (Table 1).

Table 1. Parameters examined in sampled flats

Number of People Living in Flats	Three People	%47
	More than Three People	%53
State of Windows During Sampling	Open	%57
	Close	%43
Number of People SmokeInside the Flats	Nobody Smokes	%50
	At Least One Person Smokes	%50

2.2. Sampling and Analysis Method

On sampling days, two separate units were sampled daily in 4 flats and each sampling period was completed in approximately 2.5-3 months. Bioaerosolsampling was carried out in the middle of the rooms and 50 cm above the ground, in accordance with NIOSH Method-0800, a bioaerosol sampling standard. Air samples were collected on the agarsinside the impactor from the indoor environmentsduring 4 minutes with 28.3 L/min constant flow rate with vacuum pump[10,18].

SKC Biyoimpactor	Air Pump
	

Fig 2. SKC biyoimpactor and air pump

2.3.CFU Calculation

The number of colonies counted on the agars are the total number of living and non-living colonies. In order to analysis oflivingcolonies,concentration of bioaerosols is calculated in CFU/m³ (Colony Forming Unit).Air was filtered from the inside of each flatswith constant flow rate (28.3 L/min) and duting 4 minutes.The Statgraphics XV.Istatistical package program was used to examine the differences in the evaluation of all sampling results, to examine the difference between the measured value and the expected value and to examine the differences between two factors.The assessment of the data was generally made at a 95% confidence interval.Box whiskers, spearman rank correlation, ANOVAand correlation analyses were used in Statgraphics program.

III. RESULTS AND DISCUSSION

In this part of the study, statistical relationship between the bacterial and fungal concentration measured in the indoor environments and human activities was examined[7, 8].According to the results; socio-demographic conditions of families, lifestyle habits and human activities severely affect concentrations of bacteria and fungi measured in the indoor environments of the sampled flats.Factors affecting bacterial and fungal levels in indoor environment are, number of individuals living at homes, number of smokers inside the flatsand stateof Windows (ventilation frequency) during sampling.One-Way ANOVA Test, Kruskal-Wallis Test (KWT), Mood's Median Test (MMT) and Variance Check Test (VCT) were applied between the concentration of bacteria and fungi in the indoor environments and the questionnaire studies. The results were determined in 95 confidence intervals($p<0.05$).

3.1. Influence of Number of Individuals Living at Homes on Concentration of Bacteria and Fungi

Human beings have been identified as a very important source of indoor air pollution.Human activity, movement, human skin and even just touching the material in the indoor environmentscause alot of particulate matter, bacteria and fungi to be scattered [11].In this study, as a result of questionnaire studies inside the 47% of the flats 3 people live and inside the53% of flats more than 3 people live.According to one way ANOVA tests, Variance Check and Anova Table tests; there was a statistically significant relationship between the concentrationofbacteria and fungi and the number of individuals living inside theflats during autumn-winterand spring-summer periods.The results of the tests and P values are shown in Table 2.The flats with 3 individuals are shown in number 1 and the flats with more than 3 individuals are shown in number 2 on the Box-and-Whisker Plot.During spring-summer period, concentration of fungiinside the flats with more than 3 individuals was found morethan other flats. In autumn-winter period,concentration ofbacteriainside the flats with more than 3 individuals was found about 2 times more then other flats.In the spring-summer period, in 61% of flats with bacterial concentration more than 1000 CFU/m³ and inside the 60% of flats with fungal concentration more than 500 CFU/m³ more than three people live.In a study conducted, bioaerosol concentration was measured in crowded placesand where there are no human beings.According to the results of this study; human being has been identified as the most important source of bacteria, fungi and dusts in the indoor environments[1,11].In2005, bioaerosol measurements were made in apartments in Athens.As a result of these measurements, it was determined that human being is the most important parameter increasing the level of bioaerosol both inside and outside.In another study, concentration of bacteria and fungi were measuredinside the schools when the class were fullof students and when the classes were empty.When the classes were full of students, concentration of bacteria and fungi were found about 10 times more [3]. According to some studies, the number of individuals who live in the flats affects the amount of pollutants in the indoor environments [17].Many investigations show that human

beings are the most important source of bioaerosols in the indoor environments[15,18,19].In some studies, cooking and smoking, human beings and their activity were found the greatest sources of indoor air pollution.Bacteria, fungi and particulate matter are scattered around from the skin of a person as well as during speech, coughing and sneezing [2,24,25].Bacterial concentration was measured in the living room and kitchen of the houses in Hong Kong in 2001 and simultaneously in the outdoor environments and a statistical relationship was established between the average bacterial concentration and the number of people living at homes[59].Bacterial species caused by human presence in indoor environments are: Staphylococcus, Propionibacteria, Corynebacterrum and EntericBacteria [2].Box-and-Whisker Plot of the number of individuals living in the flats andbacteria and fungal concentration are shown in Figure 2.

Table 2. Number of persons living at home andconcentration of bacteria and fungi

Period	Biyoaerosol	Factor	Average CFU/m³	Test	P-Value
Spring-Summer	Fungi	3 People	158	Varianc e Check	0.04
		More than 3 People	180		
Autumn-Winter	Bacteria	3 People	580	ANOV A Table	0.03
		More than 3 People	900	Varianc e Check	0.00

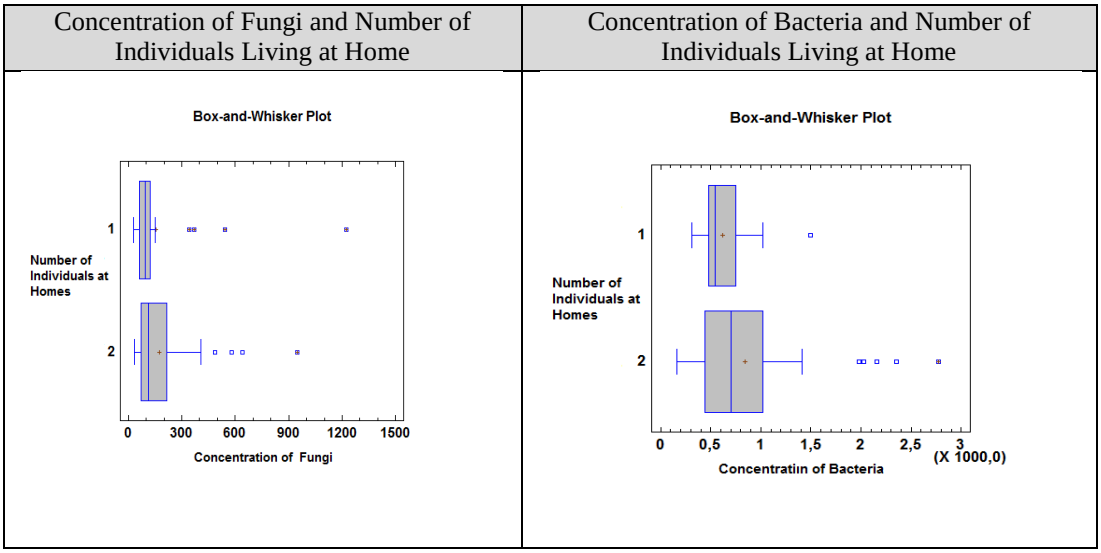


Fig2. Box-and-Whisker plot of number of individuals living at home andbacteria and fungal concentration

1:3 people live in the sampled flats
2: More than 3 people live in the sampled flats

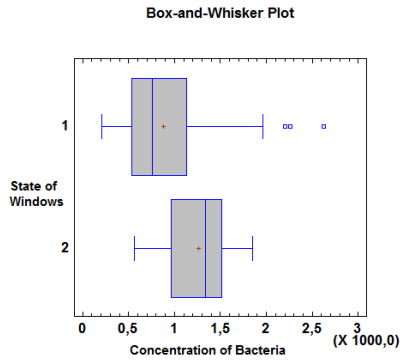
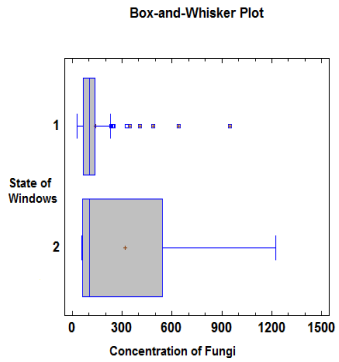
3.2. Stateof WindowsDuring Sampling and Concentrarion of Bacteria and Fungi

Ventilation of the flats is very important to reduce concentration of bacteria, fungi and harmful microorganism levels in an indoor environments, to prevent the oxygen decreasing, to reduce carbon dioxide gas, body odors and cigarette smoke, moisture increasing and to remove moisture[12, 13].Windows are the basic ways of natural ventilation and the basic forces that make up the aeration are wind power and thermal forces[14]. In this study, 57% of the windows in the flats we sampled were open and 43% were close during sampling perriods. According to the Variance Check, Mood's Median, Kruskal Wallis and ANOVA Table from one way ANOVA tests, statistically significant relationship was determined between the concentration ofbacteria and fungi and the state of the windows during sampling in spring-summer and autumn-winter periods in the indoor environment.The results of the tests and P values are shown in Table 3. The flats with open windows during sampling are shown in number 2 and the flats with close windows during sampling hours are shown in number 1 on the Box-and-Whisker Plot. In the spring-summer period, concentration of bacteria in flats with close windows measured 880 CFU/m³ and it was measured 1366 CFU/m³ (1.5 times more) in flats with open windows during sampling hours.In this period concentration of fungi was measured as 143 CFU/m³ in flats with closewindows and 319 CFU/m³ (2 times more) in flats with open windows.During the spring-summer period, windows and doors are open for a longer time than other

seasons so in this period the concentration of bacteria and fungi were measured about 2 times more than other seasons.In the spring-summer period the outdoor air influences the air of indoor environment strongly.In the same way in the fall-winter period concentration of fungi in indoor environments were measured 184 CFU/m³ in flats with close windows and it was measured 360 CFU/m³ (about 2 times more) in flats with open windows.The highest concentration of bacteria and fungi were found in the flatswith open windows during the sampling period in both periods.In all sampling periods, thelevelof bacteria was found 952 CFU/m³ inflats with close windows during sampling and it was measured 2005 CFU/m³ (2 timesmore) in flats with open windows.When the windows are open,it is possible to assume that, the air circulationfrom outdoor into indoor environment causes airborne bacteria and fungus movement into indoor environments. Box-and-Whisker Plotand concentration of bacteria and fungi and state of the windows during sampling are shown in Fig 9.

Table 3. State of windows and concentrarion of bacteriaand fungi

Period	Biyoaerosol	Factor	Average CFU/m³	Test	P-Value
Spring- Summer	Bacteria	Close	880	ANOVA Table	0.02
		Open	1366	Kruskal-Wallis	0.00
				Mood's Median	0.02
	Fungi	Close	143	ANOVA Table	0.00
		Open	319	Variance Check	0.00
Autumn -Winter	Fungi	Close	184	ANOVA Table	0.00
				Variance Check	0.03
		Open	360	Kruskal-Wallis	0.00
				Mood's Median	0.01
All Samples	Bacteria	Close	952	Variance Check	0.05
		Open	2005	ANOVA Table	0.00

State ofWindows and Concentrarion of Bacteria in Spring-Summer	State of Windows and Concentrarion of Fungi in Spring-Summer
	
State of Windows and Concentrarion of Fungi in Autumn-Winter	

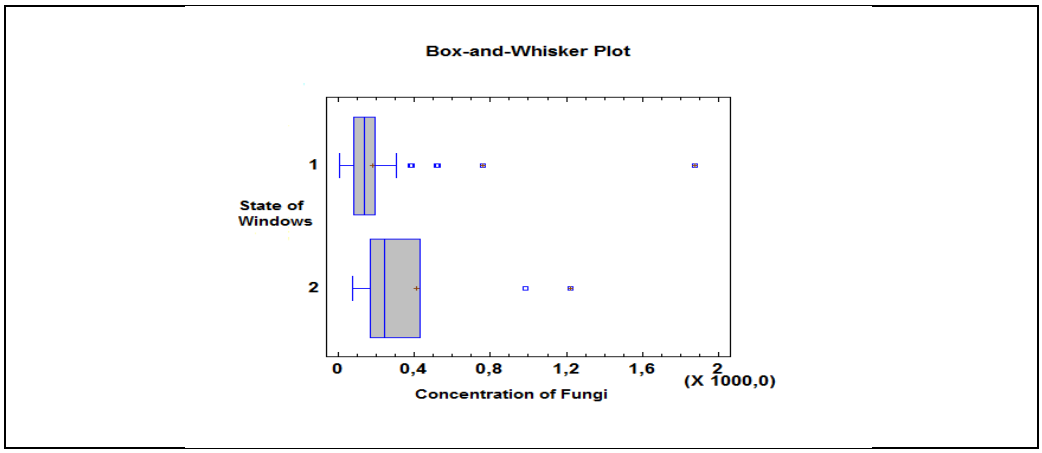


Fig3.Box-and-Whisker plot of state of windows during sampling and concentrarion ofbacteria and fungi

1: Windows were close during sampling.
2: Windows were open during sampling.

4.3. Number of Smoking People at Home andConcentration of Bacteria and Mushroom Quantity

Cigarettes are in the category of tobacco products.It is quite harmful for pregnant women and babies and causing birth defects of babies, lung diseases and cancer primarily [60].In 2002, 42 patients who were diagnosed with ARI (Acute Respiratory Tract Infection) from 0-24 months of age, living in Altındağ district of Ankara were selected and a questionnaire was applied to determine their environment, family health, home characteristics and socio-demographic conditions they lived [30]. The incidence of nasal discharge in the family of this patient group was found to be 2.82 times and the incidence of ARI in children smoking in their homes were 3.28 times more than others[30].

In this study, in 50% of the flats noone smokes and in50% of flats at least one person smokes inside the house.According to Variannce Check and Mood's Median tests, there was a statistically significant relationship between bacterial and fungal concentrations and number of smokers in the indoor environment during the summer and winterperiods.The results of the tests and P values are shown in Table 4.Flats with no smoker are shown in number 1 and flats with at leas one smoker are shown in number 2 on Box-and-Whisker Plot.During fall-winter period, concentration of bacteriawasmeasured 800 CFU/m³ in flas with no smoker and 1055 CFU/m³ (1.4 times more) in flats with at least one smoker inside the flats.Also concentration of fungi was measured148 CFU/m³ in in flas with no smoker and 200 CFU/m³ in flats with at least one smoker inside the flats.Otherwise, in 53.5% of flats wihth bacerial concentration more than 1000 CFU/m³ and in 62% of flats with fungal concentration more than 500 CFU/m³at least one person smokes inside the flats.As a result of average of all sampling periods, the concentration of bacteria was measured 102 CFU/m³ in flats with no smoker and it was measured 356 CFU/m³ (3.5 times more than other flats) inside the flats with at least one smokers.The Box-and-Whisker Plot of concentration of bacteria-fungi and number of People smokinginside the flatsare shown in Figure 4.

Table 4. Bacteria and fungal concentration and number of smokers at homes

Period	Biyoaerosol	Factor	Average CFU/m³	Test	P-Value
Autumn-Winter	Bacteria	No one smokes	800	Mood's Median	0.05
		At least one person smokes	1055		
	Fungi	No one smokes	148	Variance Check	0.00
		At least one person smokes	200		
All samples	Bacteria	No one smokes	102	Variance Check	0.03
		At least one person smokes	356		

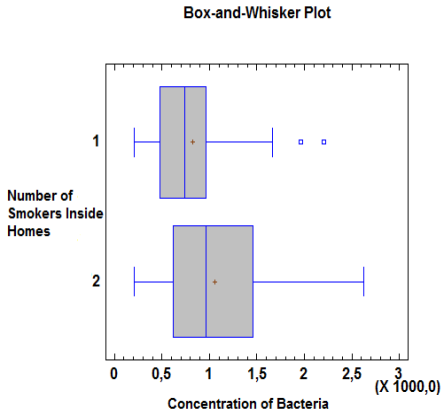
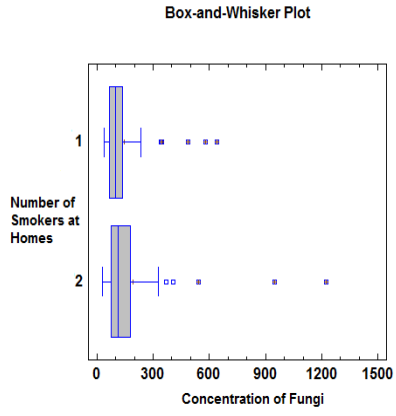
Number of Persons Smoking at Homesand Bacterial Concentration	Number of Persons Smoking at Homes and Fungal Concentration
	

Fig4.Box-and-Whisker plot of concentration of bacteria-fungi and number of people smoking at home

1: No one is smoking inside homes
2:At least one person is smoking inside homes

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