

## **Biological Air Pollutants, Big Threat to Baby's Health in the Flats**

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**Abstract:** People spend about 90% of their life in the indoor environments so invisible, indoor air pollution is one of the world's main environmental risks that has great effect on human health and especially babies. This study undertaken in 120 flats in different districts of Ankara City. Concentration and type of bacteria and fungi identified in the flats where the babies spend most of their time there. Also the health status of the babies and bioaerosols in the flats were evaluated. As a result, it is aimed to reveal the relationship between status of bioaerosols in flats and some health problems observed in the babies.

According to the sampling results, types of bacteria found inside the flats were, Staphylococcus, Corynebacterium, Streptococcus, Neisseria and Bacillus, gr (-) Bacillus and types of fungi were, Penicillium, Sporothrix, Aspergillus, Rhizopus, Alternaria, Stachybotrys, Acremonium, Sporothrichum and White Colony. Concentration of bacteria in the 76% of flats exceeded 500 CFU/m<sup>3</sup> and inside 50% of flats exceeded 1000 CFU/m<sup>3</sup>. Also concentration of fungi in the 11 % of flats exceeded 500 CFU/m<sup>3</sup> and inside 60% of flats exceeded 1000 CFU/m<sup>3</sup>. Moreover concentration of bacteria and fungi in the indoor environments were found respectively 5.75 and 3 times more than outdoor environments.

According to statistical results, 80% of babies living in these flats had respiratory infection, %1 of them had allergy, %15 of babies had other diseases (chronic diarrhea and constipation, fever) and %4 of babies didn't have any health problem. Obtained results states that concentration and types of bioaerosols inside the flats severely affect the baby's health. Skin irritation and allergies on the chin, cheeks and throat area, allergic reaction, itching and atopic dermatitis, allergic reactions, redness and itching on the baby's legs and arms, redness and rough patches under the armpit, eczema, itching between baby's toes, inflammation of the eyelid, yellow-brown pimples on baby's face and back have been seen in babies living in the flats with high levels of bacteria and fungi.

**Keywords:** Biological Pollutants, baby's health, Bioaerosol, indoor environments

### **INTRODUCTION**

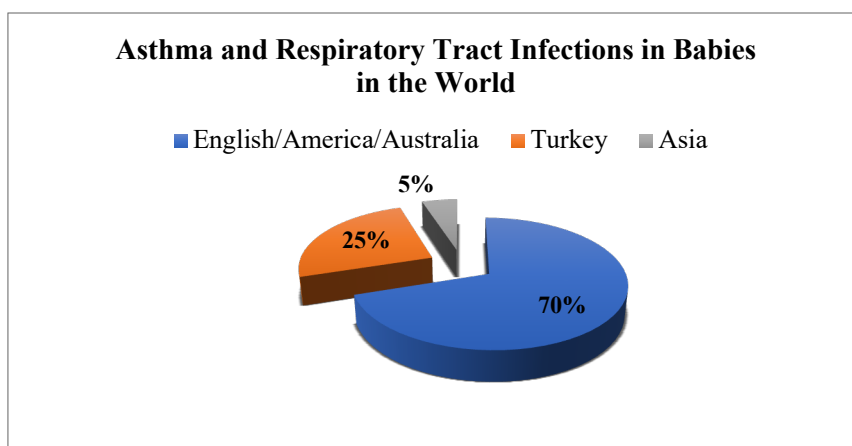
Over 90% of people live in environments where the air is unhealthy to breathe, resulting in 4.2 million deaths globally each year. Of all deaths from ambient air pollution, 38% were due to heart problems, 20% were due to stroke and 43% were due to progressive lung disease.

We spend most of our lives inside the buildings and almost half of the 8 million deaths due to poor air quality are caused by indoor pollution. People in Turkey spend about 79% of their time in the indoor environments and significantly affected by indoor air pollution. Bacterial and fungal cells and their spores are part of indoor airborne particulate matter and have been related since a long time to health issues of human beings as well as flora, and fauna. Also, the most interaction of allergenic substances, bacteria, fungi, particulate matter and harmful gases occurs in the indoor environments.

Babies are more biologically sensitive and have insufficient safety system to turn toxins into harmless substances. On the other hand, babies and children are breathing through the mouth instead of the nose where 90% of the dirty air is filtered there. So, air pollution has an especially devastating impact on children's health and has been linked to respiratory infections, adverse birth outcomes, adverse impacts on brain development and lung function, obesity, asthma, cancers and increased mortality.

Invisible air pollution is one of the world's main environmental risks with 8 million premature deaths annually and it is the fourth largest mortality risk on the planet.

According to EPA, human is exposed to indoor air pollution 2-5 and sometimes 100 times more than outdoor air pollution. EPA also states that air of 6 out of every 10 flats are unhealthy especially for infants and children due to indoor pollutants. Bioaerosols include bacteria, fungi and their spores, viruses, pollen and biologically derived fragments and general name of organic dusts originating from air. Scientific study in America states that, babies are exposed to 4 cigarettes damage every day because of existence of bioaerosols in indoor environments. Frequency of Asthma and Respiratory Tract Infections in Babies in the world is given in Figure 1.



**Figure 1.** Frequency of Asthma and Respiratory Tract Infections in the World

## **MATERIAL AND METHODS**

We set out to determine the pattern of bacterial and fungal diversity and concentration in indoor air on a local scale and to identify health effects behind that pattern. Bioaerosol sampling was carried out from 120 flats in different districts of Ankara City, starting from the prenatal period of pregnancy until babies reach the age of 2 years.

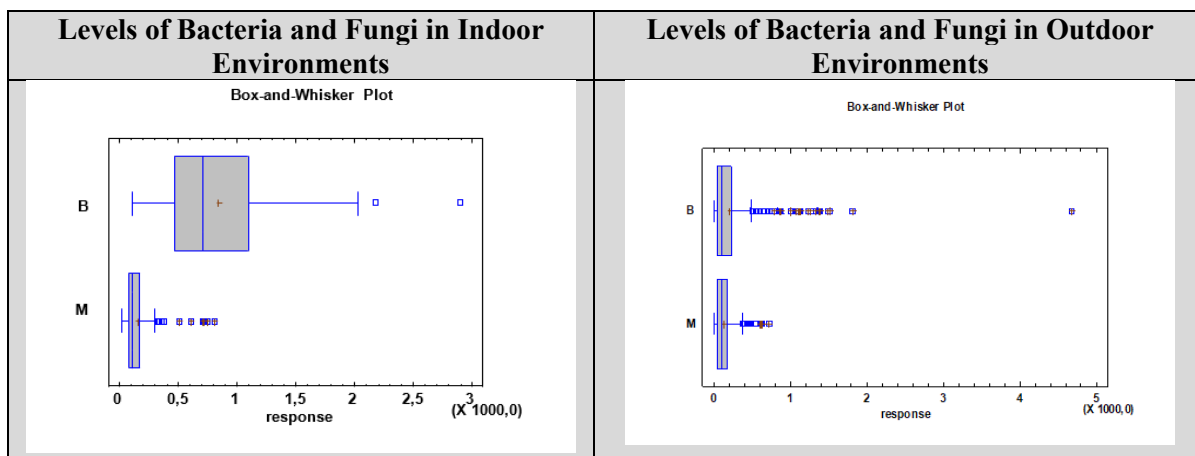
A detailed survey was conducted with 120 volunteer pregnant women who were under follow-up at Hacettepe and Etlik Zubeyde Hanım Hospitals in Ankara and were in the last 3 months of their pregnancy. Bioaerosol measurements were made in the flats of these pregnant women 4 times for two years. Samples were taken from the indoor air of their flats, before the birth of the baby, between 2-4 months, when the babies were 11,13, 24 and 30 months old. Bioaerosol sampling was carried out in accordance with the bioaerosol sampling standard NIOSH Method-0800 and with the SKC device. Air samples were taken from the indoor environments during a sampling period of 4 minutes with a vacuum pump with a constant flow rate of 28.3 L/min and placed on Plate, Bloody and Sabouraud-Antibiotic agars. Bacteria were incubated at 37 °C for 48 hours and fungi at 25 °C for approximately 7 days. In order to determine the fungal and bacterial counts, after keeping the Plate Count agars at 37 °C for 24 hours, the colony counting processing was performed on the semi-automatic colony counter device under fluorescent light. Simultaneously, the health status of the babies living in these flats was recorded. The frequency of lower respiratory tract infections, allergies, bronchitis, asthma, skin irritation, eczema, atopic dermatitis in babies were recorded for two years. As a result, it is aimed to reveal the relationship between status of bioaerosols in flats and some health problems observed in the babies.

## **RESULTS AND CONCLUSION**

The health status of the babies was examined for four periods by obtaining continuous health information from their mothers. Also, the bioaerosol concentration inside the flats of sick babies were examined simultaneously. Statgraphics XV.I statistical package program was used in the evaluation of all sampling results. Evaluation of the data was generally made with a 95% confidence interval.

### **Distribution of Bacteria and Fungi in the Indoor and Outdoor Environments**

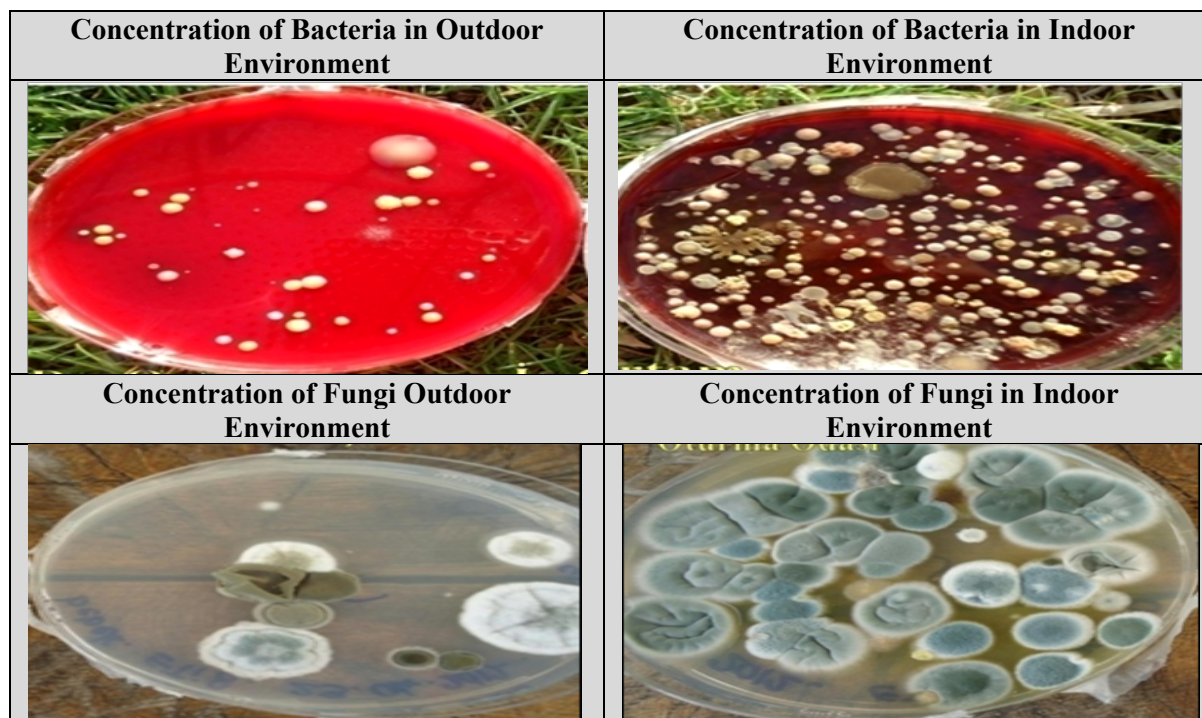
According to the results of bacterial and fungal sampling in indoor and outdoor environments; bacterial concentration in the indoor environment was found to be higher than outdoor environment. Box-whisker plot of bacterial and fungal concentrations in indoor and outdoor environments are shown in Figure 2.



B: Bacteria - M: Fungi

**Figure 2.** Box Whisker Plot of Concentrations of Bacteria and Fungi in Indoor and Outdoor Environments

As a result, obtained from the measurement of bacteria and fungi concentration in the flats was found 5.75 times higher than outdoor environment. High bacterial concentration indicates a source of intense bacterial growth in indoor environments. It has been determined that indoor environment is more suitable for the reproduction and growth of bacteria. Due to the high humidity and temperature level of the indoor environments, concentration of fungi in the flats was measured 3 times higher than outdoor environments. In Figures 3, concentration of bacteria and fungi are seen in indoor and outdoor environments of a station we sampled.



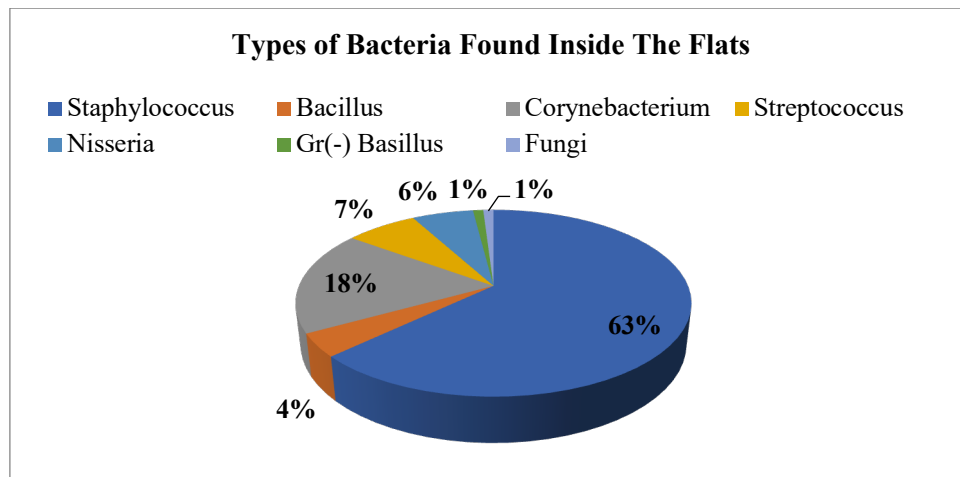
**Figure 3.** Concentrations of Bacteria and Fungi in Indoor and Outdoor Environments

### Types of Bacteria

Types of bacteria found in the flats are respectively, Staphylococcus (%63), Corynebacterium (%18), Streptococcus (%7), Neisseria (%6), Bacillus (%4), gr (-) Bacillus (% 1) and fungi (% 1). These bacterial species are the most isolated species in indoor environments and are cause of various diseases and allergies in human body. In this study, Staphylococcus bacteria was found to be the most common bacterial species with a rate of 63% among the 7 bacterial species that are medically important.

According to literatures Staphylococcus causes 25%-30% lower respiratory tract infections, skin diseases, allergies and asthma in human. Other important diseases caused by this bacteria are, folliculitis, skin irritation, eczema and urinary tract infection. Corynebacterium and Streptococcus are the second and third most common types of bacteria and cause lower respiratory tract infection, skin diseases, allergies and asthma, infection in the genital organs following birth, red spots all over the body and especially in the tongue, face, armpits and groin area, high fever, swelling, inflammation and redness of the tonsils, nausea, vomiting.

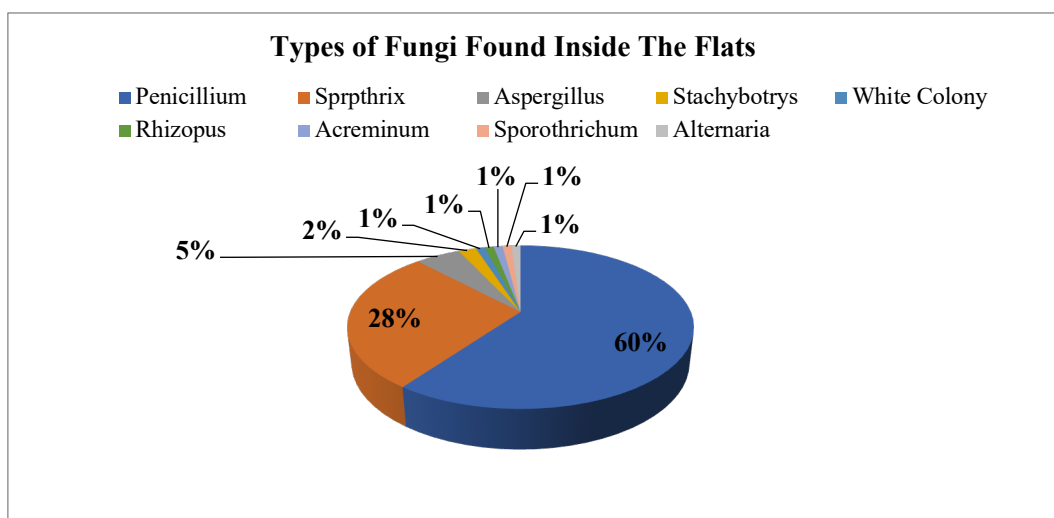
These kinds of bacteria are responsible for more than half of the deaths from meningitis globally and they cause other severe diseases like sepsis and pneumonia. Species of bacteria found inside the flats during the sampling periods are shown in Figure 4.



**Figure 4.** Types of Bacteria Inside the Flats

### Types of Fungi

Fungal diseases have not been taken seriously in public health agendas as well as research priorities, despite of globally causing an estimated two million deaths every. There are close to 6 million estimated fungal species on earth, out of which, nearly 600 fungal species can cause human disease. Types of fungi found inside the flats are respectively, Penicillium (%60), Sporothrix (%28), Aspergillus (%5), Rhizopus (%2), Alternaria (%1), Stachybotrys (%1), Acremonium (%1), Sporothrichum (%1) and White Colony (%1). Penicillium, the most common type of fungi found inside the flats, causes skin, lung inhalation, digestive system anthrax, respiratory tract, nose and sinus problems, eye and skin irritations, nervous system complications and headache diseases in human. Species of Fungi found inside the flats are shown in Figure 5.



**Figure 5.**Types of Fungi inside the Flats

According to the sampling results of the four periods, on average, inside 86% of the flats bacterial concentration exceeded 500 CFU/m<sup>3</sup> (Colony Forming Unit) and inside 60% of the flats exceeded 1000 CFU/m<sup>3</sup>. Also, inside 21% of the flats fungal concentration exceeded 500 CFU/m<sup>3</sup> and inside the 10% of them fungal concentration exceeded 1000CFU/m<sup>3</sup>.

Sporothrix and Aspergillus are the second and third most common types of fungi. Some types of these fungi are pathogenic and may be invasive in human and animals and cause osteoarthritis, meningitis, lung infection, brain, sinus and bone infection, respiratory tract, eye and ear infections, fever, cough, chest pain or serious illnesses, including shortness of breath.

Results obtained from this study state, respiratory tract infections are seen in 80%, allergy in 3% and other diseases in 15% (diarrhoea, fever, constipation and other diseases) of babies living at these flats. The rate of children with no disease was 2%. Skin irritation under the chin, cheeks and throat area, allergic reaction, itching and atopic dermatitis, allergic reactions, redness and itching on the baby's legs and arms, red and rough patches under the armpit, skin irritation and eczema, redness, itching between baby's toes, inflammation of the eyelid, yellow-brown pimples on baby's face and back have been seen in babies living in the flats with high levels of bacteria and fungi. There are some examples of flats where concentrations of bioaerosols were measured higher than standard level and baby's health in these flats. The flats we sampled during 2 years were named according to their districts.

### **Flats with High Concentration of Bioaerosol and Baby'Diseases**

#### **KEC38**

In a flat that we sampled in the Keçioren district (KEC38) of Ankara City, concentrations of bacteria and fungi have been measured 2540 CFU/m<sup>3</sup> (2.5 times higher than standard level) and 627 CFU/m<sup>3</sup>. The most common types of bacteria found in this flat are Staphylococcus, Streptococcus and Corynebacterium and the most common types of fungi are Penicillium, Sporothrix, Aspergillus, White Colony, Alternaria and Stachybotrys. Skin irritation under the chin, cheek and throat area, allergic reaction, itching and atopic dermatitis have been seen on 3-month-old baby living in this flat. In the fourth sampling period, when the baby was 2 years old, sever mouth fungus and sores have been seen in baby's mouth and tongue. The baby in the flat with code KEC38 is shown in Figure 6.



**Figure 6.** Baby in KEC38 Flat

### **GOL1**

Inside a flat in the Golbası district (GOL1) of Ankara City, concentrations of bacteria and fungi have been measured 2528 CFU/m<sup>3</sup> (2.5 times higher than standard level) and 580 CFU/m<sup>3</sup>. The most common types of bacteria found in this flat are Staphylococcus, Streptococcus, Bacillus, Corynebacterium and Neisseria and the most common types of fungi are Penicillium, Sporothrix, Aspergillus, Rhizopus and Alternaria. Skin irritation and severe allergies, itchy, red and rough spots which are sometimes reduced and sometimes very prominent have been seen on the arms and legs of baby living in this flat have been seen. Concentration of Staphylococcus in this flat was determined as 1766 CFU/m<sup>3</sup>. According to research, medically important staphylococcus bacteria can cause these kinds of allergies in human body. The baby in the flat with code GOL1 is shown in Figure 7.



**Figure 7.** Baby in GOL1 Flat

### **KEC19**

Concentrations of bacteria and fungi were measured 2827 CFU/m<sup>3</sup> (more than 2.5 times higher than standard level) and 729 CFU/m<sup>3</sup> in another flat in Keciogren district of Ankara (KEC19). The types of bacteria found in this flat are Staphylococcus, Corynebacterium, Streptococcus, Bacillus and Neisseria. Also types of fungi found in the flats are Penicillium, Aspergillus, Sporothrix, Rhizopus and White Colony. The baby living in this flat had skin irritation and eczema on his back. Concentration of Streptococcus was measured 1907 CFU/m<sup>3</sup> (almost 2.5 times higher than standard level). According to literature one type of streptococcus bacteria causes red and itchy spots on the skin. The baby in the flat with code KEC19 is shown in Figure 8.



**Figure 8.** Baby in KEC19 Flat

### **MAM8**

Concentrations of bacteria and fungi were measured 2916 CFU/m<sup>3</sup> (almost 3 times higher than standard level) and 815 CFU/m<sup>3</sup> inside a flat in Mamak district of Ankara City (MAM8). The types of bacteria found in this flat are *Corynebacterium*, *Staphylococcus*, *Streptococcus* and *Bacillus* and types of fungi are *Penicillium*, *Sporothrix*, *Aspergillus*, *Rhizopus* and *Alternaria*. Concentration of *Corynebacterium* was measured 1020 CFU/m<sup>3</sup> and it is estimated that it can cause inflammation and wounds and pink itchy blisters on legs of the baby living in this flat. The baby in the flat with code MAM8 is shown in Figure 9.



**Figure 9.** Baby in MAM8 Flat

### **ETL2**

In a flat in the Etlik district (ETL2), concentrations of bacteria and fungi have been measured 2986 CFU/m<sup>3</sup> (almost 3 times higher than standard level) and 1104 CFU/m<sup>3</sup>. The most common types of bacteria found in this flat are *Staphylococcus*, *Corynebacterium*, *Streptococcus*, *Neisseria* and *Bacillus* and types of fungi are *Streptococcus*, *Sporothrix* and *Alternaria*. The baby living in this flat had red spots, severe irritation and eczema on the armpits, groin area, legs and arms. These symptoms can be due to the presence of high concentrations of *Staphylococcus* and *Streptococcus* inside the flats. The baby in the flat with code ETL2 is shown in Figure 10.



**Figure 10.** Baby in ETL2 Flat

### **SIN2**

Concentrations of bacteria and fungi were measured 2779 CFU/m<sup>3</sup> (almost 3 times higher than standard level) and 871 CFU/m<sup>3</sup> in a flat in Sincan district of Ankara City (SIN2). The types of bacteria found in this flat are *Staphylococcus*, *Neisseria*, *Streptococcus*, *Corynebacterium* and *Bacillus* and types of fungi are *Penicillium*, *Sporothrix*, *Aspergillus*, *Stachybotrys* and *Alternaria*. Redness, itching, red rashes and scaling were observed on the face of the baby living in this flat. The baby in the flat with code SIN2 is shown in Figure 11.



**Figure 11.** Baby in SIN2 Flat

### **KEC20**

Concentrations of bacteria and fungi were measured 3666 CFU/m<sup>3</sup> (almost 4 times higher than standard level) and 629 CFU/m<sup>3</sup> in a flat in Keciogren district of Ankara City (KEC20). The types of bacteria found in this flat are Staphylococcus, Corynebacterium, Neisseria, Streptococcus and Bacillus and types of fungi are Penicillium, Sporothrix, Aspergillus, Alternaria and Rhizopus. Redness, itching and eczema were observed between the 11-month-old baby's toes. The baby in the flat with code KEC20 is shown in Figure 12.



**Figure 12.** Baby in KEC20 Flat

### **KEC16**

Concentrations of bacteria and fungi were measured 3732 CFU/m<sup>3</sup> (almost 4 times higher than standard level) and 120 CFU/m<sup>3</sup> in a flat in Keciogren district of Ankara City (KEC16). The types of bacteria found in this flat are Staphylococcus, Streptococcus, Corynebacterium, Bacillus and Neisseria and types of fungi are Penicillium, Sporothrix, Aspergillus, Alternaria and Stachybotrys.

Concentration of Staphylococcus was measured 2854 CFU/m<sup>3</sup> (almost 3 times higher than standard level). Inflammation of the eyelid (stye disease) was observed in the baby living in this flat. Among the bacterial species, Staphylococcus bacteria are the type of bacteria that causes stye disease. The baby in the flat with code KEC16 is shown in Figure 13.



**Figure 13.** Baby in KEC20 Flat



#### **KEC34**

In a flat in the Keciogren district (KEC34), concentrations of bacteria and fungi have been measured 2163 CFU/m<sup>3</sup> and 684 CFU/m<sup>3</sup>. The most common types of bacteria in this flat were Staphylococcus, Streptococcus, Bacillus, Corynebacterium and types of fungi found in this flat are Penicillium, Sporothrix, Alternaria, Aspergillus and Stachybotrys. The baby living in this station has yellow-brown pimples on her face. The most common bacterial species found in this house are Bacillus and Streptococcus. The most important disease caused by Bacillus bacteria is Impetigo disease. This disease is especially seen in babies and occurs in the form of yellow-brown pimples and skin inflammation on the face and spreads to the whole body.

#### **ALT8**

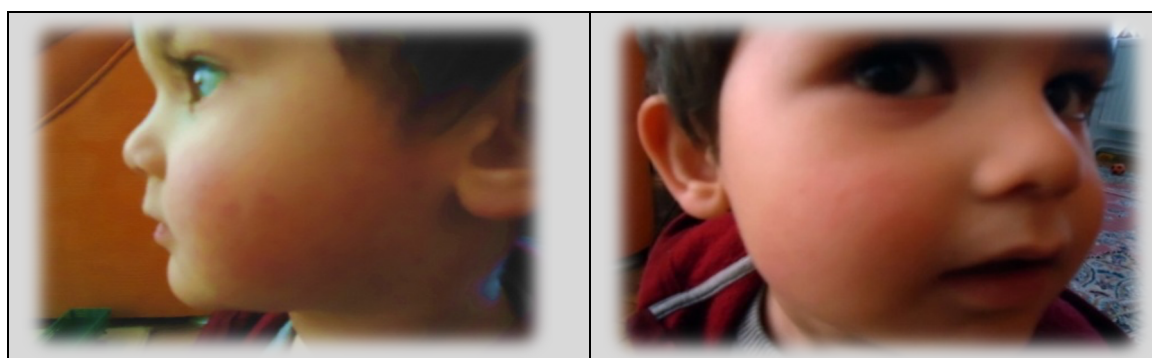
In a flat in the Altındag district (ALT8), concentrations of bacteria and fungi have been measured respectively 2323 CFU/m<sup>3</sup> and 9788 CFU/m<sup>3</sup>. The most common type of bacteria found in this flat are Staphylococcus, Streptococcus, Corynebacterium, Bacillus and Neisseria and types of fungi are Penicillium, White Colony, Aspergillus and Stachybotry. Staphylococcus (1089 CFU/m<sup>3</sup>) and Streptococcus (530 CFU/m<sup>3</sup>) bacteria are detected the most common bacterial species in this flat. Itchy red spots were seen on the cheek of the baby living in this house. The baby in the flat with code ALT8 is shown in Figure 14.



**Figure 14.** Baby in ALT8 Flat

#### **YMH 9**

Concentrations of bacteria and fungi were measured 2532 CFU/m<sup>3</sup> (2.5 times higher than standard level) and 751 CFU/m<sup>3</sup> in a flat in the YeniMahalle district of Ankara City (YMH9). The most common types of bacteria found in this flat are Staphylococcus, Streptococcus, Corynebacterium, Bacillus and Neisseria and types of fungi are Penicillium, Sporothrix, Rhizopus and Aspergillus. The child living in the station had red dots on her cheeks, allergies and eczema. The baby in the flat with code YMH9 is shown in Figure 15.



**Figure 15.** Baby in YMH9 Flat

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