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# SICK BUILDING SYNDROME - LIKE SYMPTOMS IN EMERGENCY PREFABRICATED ACCOMMODATION

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**The present study investigated the sources of discomfort and the symptoms reported by earthquake victims residing in temporary emergency prefabricated accommodation (prefab). The investigation was carried out by means of a questionnaire. 203 prefab occupants and 132 inhabitants of houses, who were chosen as reference population, replied in winter and 233 prefab occupants and 154 inhabitants of houses replied in summer. In both seasons more people living in prefabs identified dry air, stuffy air, stale air, dust, dampness, uncomfortable temperature and bad odours as sources of discomfort. They also complained of general symptoms (headache, irritability, insomnia, difficulty in concentration) and irritative symptoms of the eyes, upper and lower airways and skin. Multiple regression analysis identified the type of accommodation as the variable that most influenced the onset of general, ocular, upper and lower airway symptoms. Intrinsic characteristics of the prefabs (being constructed with synthetic materials, combustion sources, poor ventilation and insulation) and psychosocial factors e. losing their home, could have contributed to the onset of symptoms.**

In the past decades public opinion and scientists have concentrated on the problem of indoor air pollution (1). Although many studies have reported Building Related Illness (BRI) (i.e. bronchial asthma, allergic alveolitis, Legionella infections) and the Sick Building Syndrome (SBS) in office, hospital, library workers (2-3) little information is available on residents of, for example, house boats, summer houses and mobile homes such as caravans and campers, tents and prefabricated houses (prefabs). Mobile homes and prefabs are generally used in Italy, unlike other countries such as the USA, only for brief sojourns as holiday houses, accommodation for site workers or as pro-temp emergency housing for victims of natural disasters such as floods, earthquakes, volcano eruptions. This study investigated whether prolonged sojourns in prefabs were associated with sources of discomfort and the onset of symptoms that are indicative of BRI or SBS.

## MATERIALS AND METHODS

### *Health investigation*

The present investigation was conducted in Nocera Umbria, a village in central Italy, that was badly damaged in the 1997 earthquake. Most villagers were forced to use emergency temporary prefabricated accommodation (prefabs).

Houses and prefabs were randomly selected from the Council Register listing all prefabs in use and all houses that were still fit for human habitation. Data on the characteristics of each prefab and house were collected on a pre-designed chart. The investigation was performed in two stages: January-February 1999 (winter) and July-August 1999 (summer). Both stages included a health visit for prefab occupants and an environmental inspection of the prefabs. A total of 111 prefabs with 203 occupants completed the winter stage of the study and 49 houses with 132 occupants; 115 prefabs with 233 inhabitants completed the investigation in summer

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and 50 houses with 154 occupants.

A specialist in Occupational Medicine administered a questionnaire to everyone between 11 and 80 years of age. The questionnaire was designed to elicit personal details – age, schooling, marital status, daily habits – and information about occupation, time spent at home, activities carried out at home, respiratory diseases, allergies diagnosed before or since the earthquake, and current therapy. The second part of the questionnaire investigated accommodation-related sources of discomfort that the inhabitants perceived while at home: drafts, uncomfortable temperatures, stuffy air, dry air, unpleasant smells, environmental tobacco smoke, noise, dust and dampness. Part three of the questionnaire investigated accommodation-related symptoms, i.e. appeared on entering the house or prefab and disappeared or improved upon leaving it, and their frequency (daily, weekly, occasionally or never). Only accommodation-related symptoms with a daily or weekly frequency were analysed individually and after being grouped into categories as follow: a) lethargy, drowsiness, insomnia, headache, irritability, lack of concentration, nausea - *general symptoms*; b) dry eyes, burning eyes, lacrimation - *ocular symptoms; c)* rhinorrhea, nasal irritation, nasal obstruction, bouts of sneezing, hoarseness, dry throat - *upper airway symptoms*; d) chest tightness, dry cough, dysphnea, wheezing - *lower airway symptoms*; e) dry skin, peeling, itchiness, erythema - *cutaneous symptoms.*

*Statistical Analysis*

Statistical Package for Social Sciences programme version 9.0 (SPSS, 1990) was used for data analysis. The chi square test, Fisher's exact test, Student's test and logistic regression analysis were applied. Differences were considered significant at $p<0.05$.

## RESULTS

Prefabs usually housed a mean of 2 people. They ranged in size from 12 $m^2$ for singles (small hall, kitchen-dinner, bathroom and bedroom) to 36 $m^2$ for families (small hall, sitting-room with kitchen area, bathroom, 2 bedrooms). External walls and roofs were made of 8-12 cm thick sandwich panels that were painted on the outside and aluminium, steel or laminate panels on the inside. Polystyrene or polyurethane foam was inserted between panels. Floors were made of hardwood or multi-layer plywood and covered with linoleum or fitted carpet. All furnishings were made of synthetic materials. Prefabs were equipped with electric heating, air conditioning and humidifier systems. Cookers were electric. The number of silicone sealed doors and windows, with aluminium frames, ranged from 4 to 6 in each prefab. Wood stoves had been installed in 22.

Houses were inhabited by a mean of 3 people and were situated on the outskirts of the village in an area of medium to low traffic flow. Most were detached houses although a few apartments were included in the study. Methane or liquid propane gas central heating systems were usually controlled individually. No house was equipped with a humidifier or air conditioning system. Cooking was done by gas or, occasionally, electricity. Wood stoves were found in 18 houses.

No significant differences emerged in the occupants of prefabs and houses as far as regards distribution of sex, marital status, schooling, daily habits, occupations, smoking habit, respiratory and allergic diseases. The mean age of all subjects was 45 years (SD 19) with occupants of houses being slightly younger than prefab occupants (41 vs 48 years). The frequency of reported sources of discomfort and symptoms overlapped in houses and prefabs of all sizes, independently of whether or not they were equipped with wood stoves (data not shown). In both seasons (Tab. I) prefab occupants complained significantly ($p=0.000$) more of dust, dampness, uncomfortable temperatures, noise, stuffy air, unpleasant smells, drafts, dry air. Complaints about environmental tobacco smoke overlapped in both groups.

Tab. II shows the distribution of individual symptoms. Prefab occupants always complained significantly more of most symptoms. When symptoms were grouped into the general, ocular, upper and lower airway and cutaneous categories (Tab. III), significantly higher percentages of prefab occupants complained of all groups of symptoms. Multiple logistic regression analysis (Tab. IV) showed accommodation (prefab) was the variable that most strongly influenced the onset of general, ocular, upper ($p=0.000$) and lower airway ($p=0.002$) symptoms but not cutaneous symptoms. Hours spent at home influenced the onset of general ($p=0.008$) and ocular ($p=0.028$) symptoms. Older age had a moderate influence on the onset of

**Tab. I.**

*Sources of discomfort in people living in emergency prefabricated accommodations (prefabs) and in houses in winter and in summer*

| | Winter | | | Summer | | |
|---|---|---|---|---|---|---|
| Sources of discomfort | Prefabs % | Houses % | p | Prefabs % | Houses % | p |
| Dust | 84.2 | 18.2 | 0.000 | 82.0 | 3.4 | 0.000 |
| Dampness | 80.2 | 5.3 | 0.000 | 40.8 | 0.0 | 0.000 |
| Uncomfortable temperature | 69.3 | 9.1 | 0.000 | 95.7 | 24.5 | 0.000 |
| Noise | 51.5 | 6.1 | 0.000 | 64.4 | 11.6 | 0.000 |
| Stuffy air | 46.5 | 2.3 | 0.000 | 41.2 | 0.0 | 0.000 |
| Unpleasant smells | 44.6 | 10.6 | 0.000 | 38.2 | 3.4 | 0.000 |
| Drafts | 35.6 | 8.3 | 0.000 | 15.0 | 1.4 | 0.000 |
| Dry air | 26.2 | 1.5 | 0.000 | 47.6 | 0.7 | 0.000 |
| Environmental tobacco smoke | 25.2 | 0.0 | N.S. | 35.6 | 25.9 | N.S. |

*p= prefab vs house occupants*

**Tab. II.**

*Symptoms in people living in emergency prefabricated accommodations (prefabs) and in houses in winter and in summer*

| | Winter | | | Summer | | |
|---|---|---|---|---|---|---|
| Symptoms | Prefabs % | Houses % | p | Prefabs % | Houses % | p |
| Lethargy | 23.1 | 6.8 | 0.000 | 18.5 | 0.6 | 0.000 |
| Drowsiness | 13.8 | 0.8 | 0.000 | 13.3 | 0 | 0.000 |
| Insomnia | 12.7 | 5.3 | 0.027 | 9.9 | 0.6 | 0.000 |
| Headache | 16.5 | 3.8 | 0.000 | 15.1 | 0.6 | 0.000 |
| Irritability | 30.3 | 22 | N.S. | 29.6 | 1.9 | 0.000 |
| Lack of concentration | 14.9 | 0.8 | 0.000 | 9.9 | 0.6 | 0.000 |
| Dry eyes | 3.9 | 0 | N.S. | 4.3 | 0 | 0.007 |
| Burning eyes | 12.4 | 0.8 | 0.000 | 12.9 | 0.6 | 0.000 |
| Nasal obstruction | 9 | 0 | 0.000 | 11.6 | 0 | 0.000 |
| Sneezes | 10.4 | 0.8 | 0.000 | 13.3 | 0 | 0.000 |
| Hoarseness | 5 | 0 | 0.007 | 1.7 | 0 | 0.000 |
| Dry throat | 19.8 | 0 | 0.000 | 16.7 | 0 | 0.000 |
| Dry cough | 6.5 | 0.8 | 0.01 | 5.6 | 0 | 0.002 |
| Dysphnea | 3.5 | 0.8 | N.S. | 2.6 | 0 | N.S. |
| Peeling skin | 3.4 | 0 | 0.045 | 3.4 | 0 | 0.02 |
| Dry skin | 2 | 0 | N.S. | 0.4 | 0 | N.S. |

*p= prefab vs house occupants*

**Tab. III.** *Groups of symptoms in people living in emergency prefabricated accommodations (prefabs) and in houses in winter and in summer.*

| | Winter | | | Summer | | |
|---|---|---|---|---|---|---|
| Group of symptoms | Prefabs % | Houses % | p | Prefabs % | Houses % | p |
| General | 42.2 | 25.8 | 0.002 | 38.6 | 4.5 | 0.000 |
| Ocular | 13.3 | 0.8 | 0.000 | 14.2 | 0.6 | 0.000 |
| Upper airways | 30.0 | 0.8 | 0.000 | 29.2 | 0.6 | 0.000 |
| Lower airways | 9.4 | 1.5 | 0.004 | 6.4 | 0 | 0.001 |
| Cutaneous | 8.4 | 0 | 0.001 | 5.6 | 0 | 0.003 |

*p= prefab vs house occupants*

**Tab. IV.** *Logistic regression analysis (symptoms vs season, age, gender, smoking habit, hours at home, type of accommodation).*

| | General | | | Ocular | | | Upper airways | | | Lower airways | | | Cutaneous | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | OR | p | B | OR | p | B | OR | p | B | OR | p | B | OR | p |
| Season | -0.619 | 0.538 | 0.000 | -0.090 | 1.094 | 0.749 | 0.003 | 1.003 | 0.987 | -0.463 | 0.630 | 0.196 | -0.428 | 0.652 | 0.266 |
| Age | 0.000 | 1.000 | 0.936 | 0.017 | 1.017 | 0.049 | 0.006 | 1.006 | 0.292 | 0.024 | 1.025 | 0.031 | 0.006 | 1.006 | 0.622 |
| Gender | -0.404 | 0.668 | 0.037 | -0.472 | 0.624 | 0.152 | -0.120 | 0.887 | 0.606 | -0.047 | 0.954 | 0.908 | -0.536 | 0.585 | 0.228 |
| Environmental tobacco smoke | 0.300 | 1.349 | 0.135 | 0.250 | 1.284 | 0.455 | -0.051 | 0.950 | 0.839 | -1.131 | 0.323 | 0.069 | -0.100 | 0.904 | 0.834 |
| Hours at home | 0.072 | 1.075 | 0.008 | 0.099 | 1.104 | 0.028 | 0.044 | 1.044 | 0.196 | 0.064 | 1.066 | 0.276 | 0.042 | 1.043 | 0.490 |
| Accommodation | 1.480 | 4.391 | 0.000 | 3.110 | 22.415 | 0.000 | 4.071 | 58.609 | 0.000 | 2.314 | 10.113 | 0.002 | 8.554 | 5185.504 | 0.589 |

*Code: Season: winter= 0; summer= 1; Gender: female= 0; male= 1; Smoking: no= 0; yes= 1; Accommodation: house= 0; prefab= 1*

ocular (p=0.049) and lower airway (p=0.031) symptoms; female gender and winter season influenced the onset of general symptoms (p=0.037 and p=0.000 respectively). Smoking did not influence the onset of symptoms.

## DISCUSSION

This study shows that a prolonged sojourn in emergency prefabricated accommodation is associated with sources of discomfort and general and irritative symptoms in a high percentage of occupants. As all our subjects had experienced the trauma of an earthquake one might hypothesize that many of their general symptoms were due to the post-trauma stress syndrome (PTSS) which has often been described in victims of catastrophes (4-7). PTSS like symptoms that we found include irritability, lack of concentration and disturbed sleep patterns. However PTSS can be discounted as having had a major influence on our results because both the prefab occupants and the individuals making up the reference population

had had the experience of an earthquake and almost all symptoms, not only the general, were reported more frequently by prefab occupants.

Interestingly the pattern of the symptoms we observed in many prefab occupants followed the pattern of SBS outbreaks in modern buildings (2-3;8-9). The SBS is characterized by mucous membrane, skin and eye irritation, chest tightness, fatigue, headache, lethargy and lack of concentration, such as we observed. Several studies (10-15) suggest SBS symptoms are caused by many interacting factors including the physical (temperature, relative humidity, dampness, ventilation rate, artificial light, noise and vibration), the chemical (environmental tobacco smoke, formaldehyde, VOCS, pesticides, odorous compounds, CO, $CO_2$, $NO_2$, $O_3$), the biological (fungi, bacteria, dust mites) and the psychological (job dissatisfaction, difficult social and working relationships, etc.). It is worth noting the vast majority of prefab occupants identified the most frequent sources of discomfort as uncomfortable temperature, dampness, dust, stuffy air and unpleasant smells, all of which may be linked to the restricted space and low ventilation in the prefabs. Indeed, the normal activities of family life and hobbies may lead to the accumulation of pollutants, bad odours, stuffy air and dampness. Even though prefabs were equipped with heating, air conditioning and humidifying systems many occupants complained of drafts and excessive rises or drops in temperature when doors or windows were opened. Furthermore logistic regression analysis showed the onset of the most frequently reported symptoms was strongly influenced by the type of accommodation (prefabs). Results of the relatively few studies on mobile home occupants confirm our observations (16-20). Olsen and Dossing (18) showed a higher prevalence of mucosal irritation, headache and fatigue in 70 people working in mobile units as compared with 34 workers in traditional offices. In 1991 Liu et al. (17) correlated irritative symptoms in the eyes, skin and upper airways in 1,000 people living in mobile homes with formaldehyde exposure.

Another factor which plays a major role in SBS symptoms described in working populations is the psycho-social loads eg. job dissatisfaction, difficult social and working relationships, personal vulnerability. The impact of these factors in our population of prefab occupants seems negligible. As the study investigated housing and not the working environment, the influence of job related factors can be excluded. Personal vulnerability did not apparently play a major role because as several factors - age, schooling, marital status, life-style, etc.- were evenly distributed in both prefab and reference populations, there is no reason to suppose personal vulnerability was not.

However, one crucial difference in the two groups was that the occupants of the prefab had lost their homes and it must be borne in mind that one of the principal ambition of all Italians is to own their own homes. Hence the loss was probably strongly felt. Added to this is the disruption of daily routine in a completely different, smaller and more uncomfortable living environment. These factors could well have played a role in the onset of symptoms, particularly the general.

## CONCLUSION

Significantly higher prevalences of sources of discomfort and general and irritative symptoms were observed in a population housed for a prolonged period of time in prefabricated accommodation. The pattern of symptoms was similar to what has often been reported in outbreaks of SBS. Accommodation-related factors as well as the psychological impact of losing the home seem to be the main determinants of symptoms.

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