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INFRASOUND GENERATED BY HUMAN BODY

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INTRODUCTION

In many environments the high levels of natural and man-made low frequency noise, especially infrasound (IFS), has been reported. An effort has been made to discover whether such high levels of low frequency noise are significant. In general man-made sources of low frequency noise such as compressors, boilers, cars and ships appear to present a potentially greater hazard than natural sources such as wind, turbulence, storms and earthquakes. Certainly, subjective reports due to infrasonic exposure to man-made sources have indicated that nausea, disorientation and general unpleasantness as well as variety of other symtoms have been observed in our experiments. On the other hand human body has also oscillatory organes such as heart, blood vessels, digestive organes and lungs, which generates IFS in small levels. In our environments these sources, at least heart rate and respiratory frequency, affected by the high levels of infrasound and high frequency noise, may alter the oscillatory frequency and at the same time present such variety of symptom. Thus we investigated human response to IFS and high frequency noise or audible sound.

SUBJECTS AND METHOD

Vibration

Electrical vibration signal detected by the transducer placed at the the navel region were analized with a vibration level meter to obtain a power spectrum from various organes in man.

Experimental arrangement

For the measurement of physiological parameters an experimental set-up consisting of relatively small room with excerllent electrical and acoustic shielding was prepered. In this room a subject was comfortably sat. This was also equipped with an array of speaker of considerably large output and an electronic system for the monitoring of the parameters. The IFS field can be controlled up to some 100 dB at the position of the subject. The subjects were exposed to back ground sound of 1000 Hz at 80 dB in case of need. In other case back ground noise was kept below 50 dB.

Physiological parameters

Heart rate calculated from sphygmogram detected with a photoplethysmograprh placed at the finger.

Respiratory frequency detected by a impedance plethysmograph whose electrodes were placed on the chest and the back of the right side.

Exposure time, frequency and level of IFS

Exposure time was 30 minutes. Frequency was 10 or 20 Hz at the level of 80 and 100 dB for each frequency.

Subjects

Subjects were healthy 17 male and 18 female ranging from 19 to 23 in age. Total number of the subjects were 124 for all experiments.

RESULTS AND DISCUSSION

Infrasound from organes

First experiment was made on the abdomen of a subject. Various low frequency oscillations from organes were measured and analized. Power spectrum of the vibration at the nabel region almost decreased with increasing frequencies. The greater power at ca 0.33 Hz correspond to respiratory oscillation; other one at ca 1 Hz corresponded to the cardiac oscillation; the remaining ones may indicate oscillations of the organes in the abdomen and noises such as babbles of the intestine. Then these low frequency oscillation may generate IFS whose levels can be calculated by the equation for vibration-to-sound conversion.

Infrasound exposure

We investigated changes in heart rate and respiratory frequency in response to IFS. In this case we took the physiological data of the larst ten minutes out of 30 minutes of IFS exposure for analysis. When a subject sat on a chair located in the center of the shield room, heart rate or heart rate ratio (HR RATIO) decreased during 30-minute IFS exposure of 10 Hz at 80 dB (A1), 10 Hz at 100 dB (A2), 20 Hz at 80 dB (A3) and 20 Hz at 100 dB (A4) as shown in Fig. 1. Here HR RATIO denotes the heart rate exposed to IFS devided by the control heart rate. The number of the subjects were 39 (A1), 29 (A2), 30 (A3) and 30 (A4). Likewise, respiratory frequency or respiratory frequency ratio (RF RATIO) remained unchaged during 30-minute IFS exposure of 10 Hz at 80 dB (B1), 10 Hz at 100 dB (B2) and 20 Hz at 80 dB (B3) while RF RATIO decreased for the exposure of 20 Hz at 100 dB (B4) as shown in Fig. 1. Here, RF RATIO denotes the respiratory frequency exposed to IFS devided by control respiratory frequency. The number of the subjects were 39 (B1), 29 (B2), 30 (B3) and 26 (B4).

These results suggested that heart rate decreased during 30-minute IFS exposure of 10 or 20 Hz at 80 or 100 dB for each frequency and that respiratory frequency decreased during 30 minute IFS exposure of 20 Hz at 100 dB. These results were physiologically reasonable because it

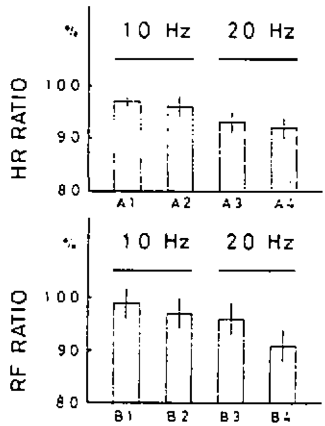

Fig. 1 HR RATIO exposed to IFS of 10 Hz at 80 dB (A1), 10 Hz at 100 dB (A2), 20 Hz at 80 dB (A3) and 20 Hz at 100 dB (A4), and RF RATIO exposed to IFS of 10 Hz at 80 dB (B1), 10 Hz at 100 dB (B2), 20 Hz at 80 dB (B3) and 20 Hz at 100 dB (B4) during 30-minute period

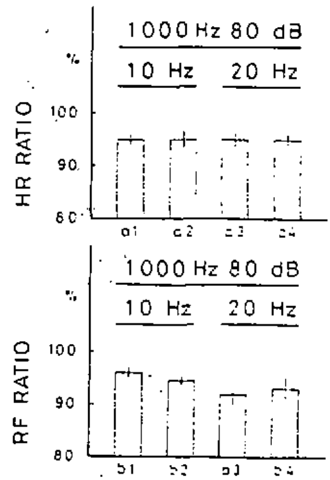

Fig. 2 HR RATIO exposed to IFS of 10 Hz at 80 dB (a1), 10 Hz at 100 dB (a2), 20 Hz at 80 dB (a3) and 20 Hz at 100 dB (a4), and RF RATIO exposed to IFS of 10 Hz at 80 dB (b1), 10 Hz at 100 dB (b2), 20 Hz at 80 dB (b3) and 20 Hz at 100 dB (b4) during 30-min period in the back ground sound 1000 Hz at 80 dB

is reported elsewhere [1] that both heart rate and respiratory frequency were decreased during one minute IFS exposure while both were increased during one hour IFS exposure of 16 Hz above 100 dB.

Infrasound plus audible sound

We investigated changes in heart rate and respiratory frequency in response to 30-minute IFS exposure in the background sound of 1000 Hz at 80 dB. Under the condition heart rate ratio decreased for IFS exposure of 10 Hz at 80 dB (a1), 10 Hz at 100 dB (a2), 20 Hz at 80 dB (a3) and 20 Hz at 100 dB (a4), and the same results yielded in the respiratory frequency for IFS exposure of 10 Hz at 80 dB (b1), 10 Hz at 100 dB (b2), 20 Hz at 80 dB (b3) and 20 Hz at 100 dB (b4) as shown in Fig. 2.

These results suggested that in the background sound of 1000 Hz at 80 dB the threshold for respiratory frequency may be lowered and then the response of respiratory frequency may be observed to the IFS exposure i.e., high frequency sound may enhance the effect of IFS on the human body.

CONCLUSION

We investigated physiological changes in heart rate and respiratory frequency in response to infrasound and audible sound. Heart rate decreased during 30-minute infrasound exposure of 10 or 20 Hz at 80 or 100 dB for each frequency. Respiratory frequency decreased during 30-minute infrasound exposure of 20 Hz at 100 dB. In the background sound of 1000 Hz at 80 dB heart rate and respiratory frequency decreased during 30-minute infrasound exposure of 10 or 20 Hz at 80 or 100 dB for each frequency.

REFERENCE

[1] O. Okai, M. Taki, A. Mochizuki, M. saito, N. Nishiwaki, T. Mori and N. Fujio, "Physiological parameters in human response to infrasound", Proceeding of the conference on low frequency noise and hearing 7-9 May 1980 in Aalborg, Denmark pp 121-129.