PRELIMINARY INVESTIGATIONS ON B.M.R. AND BODY FAT ESTIMATIONS OF SUBJECTS EXPOSED TO HIGH INTENSITY SOUND*

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Abstract

The Basal Metabolic Rates of field service mechanics working on jet aircraft in the age group 30 to 50 are determined; and the average value is found to be much lower than that of normal individuals of the same age group. The percentage body fat of the jet mechanics is found out by the skinfold technique using a pair of constant pressure calipers, the average percentage being 4.7, while the mechanics working on propeller aircraft of the same age and economic group have an average percentage of 9.2. Probable explanations for these observations are given.

Introduction

Considerable amount of work by various investigators [2,5,7] has been done on the auditory effects of the noise usually present in industrial centres. In general it has been found to cause permanent hearing loss, the impairment starting at a frequency of about 4,000 cps and gradually extending towards other frequencies. Auditory effects of noise on mechanics and maintenance personnel, showing progressive hearing loss, have been observed by P. Souvras.[11]

Souvras et al [8] subjected animals to high intensity sounds, giving long exposures, and their results showed no change in general condition and weight, though the animals became deaf. By studying the histological changes in such animals, they showed that the colloid substance of the thyroid had shrunk and had become pale.

Adrenal glands revealed evidence of great activity, with lipoid excess in the fasicular zone. Exposure to jet engine noise showed an increase in the blood sugar content.

*Paper read at the Indian Science Congress held a Roorkee in January 1961.

Prolonged exposure to noise, however, induced no hyperactivity in the endocrine glands and this is attributed to adaptation to noise. Haematological changes[8,9,10] in animals under noise exposure, showed a 20% decrease in the number of erythrocytes, when the exposure time is short; leucocytosis was also induced.

No attempts have been made to determine either the B. M. R., or the percentage of body fat of people, who have been exposed to high intensity noise for many years. It was noticed during certain other investigations on maintenance personnel in aircraft hangers, that these individuals were invariably thin and complained of losing weight. This observation prompted the investigation.

Method

Basal Metabolic Rates of twelve mechanics, in the age group 30 to 50, servicing jet engines were estimated, by the standard closed circuit method, employing a Kendrick apparatus. For purposes of comparison the B. M. R. of normal healthy individuals of the same age group were also determined.

Body fat was determined by using the skinfold technique suggested by Brozek and Keys[3], using a pair of constant pressure calipers loaded to 10 gm/ sq. mm. Skinfold measurements were made choosing the standard sites prescribed by Brozek[2], viz., (1) abdomen, on the right of umblicus (2) chest, above the right nipple (3) back, below the scapula (4) right arm, over the triceps at a level half way between the acromial process and the tip of olecranon with the skinfold parallel to the long axis; and taking all precautions suggested by him. Skinfold measurements were made by two investigators and the average value taken.

It was noted that there was consistency in the readings of both the investigators and the readings seldom differed by more than 1 mm. Using the regression equations of Brozek and Keys[3], for the different sites, the specific gravity of the human body was determined. The value of average body specific gravity thus obtained is employed to find out the percentage of body fat using the formula,

$$\text{percentage body fat} = \frac{100\,(5.548 - 5.044)}{\text{sp. gravity}}$$, put forward by Rathbun and Pace[6].

Employing the above method, the fat percentage was determined for twelve mechanics in jet engine service (Vampire) in the age group 30 to 50, and also for twelve mechanics in piston engine service (Dakota) of the same age group. All these mechanics have been in the respective services for more than three years. The number had to be restricted to twelve, because of non-availability of personnel with sufficiently long service. It may be noted that the economic status of both the groups are the same, and they hail from the same geographical region (S.India). In addition to these, the average percentage body fat of twelve normal healthy individuals of the same age group was also determined.

Audiometric check-up of the jet mechanics had also been carried out using an Amplivox audiometer; pure tone audiometry for different frequencies were done on both the ears.

Results

The Basal Metabolic Rate for jet workers is found to have an average value—19.2% taking 39.5 Cals/hour/sq.metre of surface area as the standard, whilst for the normal group, it is much higher being—9.3%; standard deviations being 6.1 and 4.5 respectively. Standard error of difference between the means is 2.19.

The percentages of body fat of the two groups of mechanics are given in table I. The average percentages of body fat for the jet and the Dakota mechanics have values 4.7 and 9.2 respectively, with standard deviations 1.5 and 4.2. Standard error of difference between the means is 1.29. The value for Dakota mechanics compares well with the value 9.7% obtained for normal individuals of the A. F. School of Aviation Medicine.

As physiological factors like percentage body fat and B. M. R. usually have wide individual variations, the standard deviations are also comparatively large. The observed difference between means in B. M. R. is 4.5 times the standard error and that in the case of body fat is 3.5.

TABLE I

Jet Mechanics				Dakota Mechanics				Subjects from A.F. School of Aviation Medicine		
Sub-ject	Age	Service in years	% of body fat	Sub-ject	Age	Service in years	% of body fat	Sub-ject	Age	% of body fat
1	49	4	4.5	1	31	8	13.9	1	33	12.4
2	31	5	2.1	2	39	10	14.0	2	30	16.7
3	33	3	4.9	3	47	17	15.6	3	30	5.5
4	31	3	3.3	4	38	11	11.5	4	30	7.2
5	32	4	1.6	5	35	12	3.9	5	30	9.5
6	42	3	4.0	6	46	10	5.3	6	31	11.0
7	35	3	6.2	7	39	10	7.0	7	45	13.3
8	35	4	3.3	8	33	6	4.4	8	34	2.5
9	34	5	3.3	9	35	3	13.8	9	34	11.8
10	45	4	5.7	10	35	8	3.9	10	31	3.4
11	35	9	4.9	11	32	12	8.7	11	35	14.0
12	39	7	4.3	12	40	17	8.6	12	31	8.9
Average percentage of body fat 4.7				Average percentage of body fat 9.2				Average percentage of body fat 9.7		

Audiograms of jet workers showed an average loss of 27 db at 6,000 cps, and 14 db at lower frequencies, taking 0 db as the normal for all frequencies. These hearing losses are permanent as the individuals were subjected to audiometry at punch-in-time.

Discussion

The low metabolic rate observed in jet mechanics may be explained as due to high intensity sound waves supplying extra heat to the body, so much so, that the body need produce only correspondingly smaller quantity of heat and hence the oxygen consumption falls.

An aircraft noise of 130 db is equivalent to one milliwatt/cm^2 of energy and the human body has an absorption coefficient about 0.01 to 0.1 and even as high as 0.25 according to Von Gierke et al[9] and Franke.[4] As such it can be expected that human body absorbs heat energy of the order of 5 to 10% of the energy produced by metabolism. As the body gradually acquires the tendency to respond to this, a corresponding reduction in B. M. R. can be expected.

Since the B. M. R. is closely related to thyroid activity, histological and biochemical changes are expected. Investigations along these lines are yet to be carried out.

The percentage of body fat of jet workers is considerably low compared with the normal individuals and the Dakota mechanics. A low B. M. R. together with a low percentage of body fat is seen only when the individual is underfed. However, as the economic status of the jet workers is apparently the same as that of the Dakota mechanics, whose average percentage of body fat is the same as that of normal individuals, it may be concluded that the low percentage of body fat in jet workers is probably not the effect of malnutrition. It may be that a high skin temperature, produced as a result of the sound energy, acting through the hypothalmus depresses the anterior pituitary, which in turn causes a reduction of all hormones including the growth hormone; this latter has a synergistic action with insulin for the deposition of body fat. However, in order to obtain further conclusive evidence, it is intended that further studies be pursued on the following lines:

a) Work load on jet and Dakota workers.

b) Calorie intake of both group of workers.

c) Record of skin and body temperatures of both group of workers along with ambient temperature.

d) Estimation of protein bound iodine and the metabolic rate under actual working conditions.

Acknowledgement

We acknowledge with thanks the helpful suggestions given by Wg. Cdr. J. H. F. Manekshaw and Sqn. Ldr. B. Bhatia. The technical assistance rendered by Cpl. B. R. Chopra is acknowledged.

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