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# Minnesota Multiphasic Personality Inventory of The Workers Exposed to Blast Trauma at Bomb Filling Atelier of Ammunition Factory

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**Abstract**

**Objectives:** We investigated the relationship between blast trauma and personality traits in Ammunition Factory workers by Minnesota Multiphasic Personality Inventory (MMPI).

**Methods:** Forty-four male workers exposed to blast trauma constructed the study group (Group 1). Forty-four male workers not exposed to the explosion, constructed the control group (Group 2). MMPI was given to all patients.

**Results:** MMPI subscales of the Group 1 and 2 were not different. In the study group, MMPI subscales were increased in older workers; in workers nearer to the explosion site, experienced acute tinnitus, hearing loss, sleep problems after explosion. Higher educated workers had experienced more psychological problems.

**Conclusion:** Workers exposed to blast trauma have not poorer psychological functions. In 11-year period from the explosion, psychological, physical and economic support to the workers may lessen the psychological trauma on workers.

**Key words:** Occupational diseases, noise, workers, explosive blast trauma, tinnitus, hearing loss, Ammunition Factory, Minnesota Multiphasic Personality Inventory (MMPI).

**Mühimmat Fabrikası Bomba Dolum Atelyesi'nde Patlama Travmasına Maruz Kalan İşçilerde Minnesota Çok Yönlü Kişilik Envanteri**

**Özet:**

**Amaç:** Mühimmat Fabrikası işçilerinde, Minnesota Çok Yönlü Kişilik Envanteri (Minnesota Multiphasic Personality Inventory-MMPI) kullanılarak, patlama travması ve kişilik özellikleri arasındaki ilişki araştırılmıştır.

**Metod:** Patlama travmasına maruz kalan 44 erkek işçi, çalışma grubunu (Grup 1) oluşturmuştur. Patlama travmasına maruz kalmayan 44 işçi (Grup 2), kontrol grubunu oluşturmuştur. Tüm hastalara MMPI uygulanmıştır.

**Bulgular:** MMPI alt-skalaları, Grup 1 ve 2'de farklı değildi. Çalışma grubunda, MMPI alt-skalaları yaşlı işçilerde, patlama sahasına yakın olanlarda, patlamadan sonra akut tinnitusu, işitme kaybı ve uyku bozukluğu olanlarda artmıştır. Eğitim seviyesi daha yüksek olan işçiler, daha fazla psikolojik sorunlar yaşamıştır

**Sonuç:** Patlama travmasına maruz kalan işçilerde psikolojik fonksiyonlar daha kötü değildir. Patlama sonrası geçen 11 senelik zaman, işçilere verilen psikolojik, fiziksel ve ekonomik destek, işçilerdeki psikolojik travmayı azaltmış olabilir.

**Anahtar kelimeler:** Meslek hastalıkları, gürültü, işçiler, patlama travması, kulak çınlaması, işitme kaybı, Mühimmat Fabrikası, Minnesota Çok Yönlü Kişilik Envanteri (Minnesota Multiphasic Personality Inventory-MMPI).

## Introduction

Explosions have the capability to cause multisystem, life-threatening injuries in single or multiple victims simultaneously. These types of events present complex triage, diagnostic, and management challenges for the health care provider. Explosions can produce classic injury patterns from blunt and penetrating mechanisms to several organ systems, but they can also result in unique injury patterns to specific organs including the lungs and the central nervous system.

Understanding these crucial differences is critical to managing these situations (1). The ear is the organ most susceptible to primary blast injury. Acoustic barotraumas commonly consist of TM rupture. Hemotympanum without perforation also has been reported. Ossicle fracture or dislocation may occur with very high-energy explosions [1].

Acute acoustic trauma (AAT) is relatively common after exposure to intense gunwire noise. Gunshot impulses consist of a combination of energies from acoustic and pressure waves at high intensities, resulting in rupture of the organ of Corti, its separation from the basilar membrane and fracture and displacement of hair cell stereocilia[2,3].

According to some studies, the cochlear hypoxia is considered to be one of the mechanisms for the development of AAT [2,4].

Presence of tympanic membrane (TM) rupture indicates that a high-pressure wave (at least 40 kilopascal [kPa], 6 psi) was present and may correlate with more dangerous organ injury. Theoretically, at an overpressure of 100 kPa (15 psi), the threshold for lung injury, TM routinely ruptures; however, a recent Israeli case series of 640 civilian victims of terrorist bombings contradicts traditional beliefs about a clear correlation between the presence of TM injury and coincidence organ damage. Of 137 patients initially diagnosed as having isolated eardrum perforation who were well enough to be discharged, none later developed manifestations of pulmonary or intestinal blast injury [1].

Being exposed to explosive blast trauma may cause a lot of harmful effects on humans, like hearing loss and tinnitus. It is not difficult to predict that workers who exposed to explosive blast trauma may also have some psychological problems in different degrees. In the present study, we investigated the relationship between explosive blast trauma exposure and psychological functions of the nonpsychiatric population of workers exposed to blast trauma at "Bomb Filling Atelier" of Ammunition Factory. Explosion occurred in 1997 because of unknown reasons and we investigated the current psychological status of the workers in 2008, 11 years later after explosion. By this aim, we used MMPI (Minnesota Multiphasic Personality Inventory) for assessing the personality traits. There is no comment in the literature about psychological effects of explosive blast trauma evaluated by MMPI.

**Materials and Methods**

This study was carried out in the Ear Nose Throat (ENT) and Psychiatry Departments of Kırıkkale University Faculty of Medicine.

*Subjects***:** The study was carried out in patients exposed to explosive blast trauma during their works in "Bomb Filling Atelier" of Ammunition Factory in 1997. Forty-four male workers exposed to explosive acoustic trauma in Ammunition Factory 11 years ago constructed the study group (Group 1). They were included into the study with their agreement by written informed consent to participate the study, and to give permission for the use of their all data. Their mean age was 45.27 ± 4.91 (Ranged from 34to 53). The workers were evaluated by periodic health check-up in the factory. In the factory, the noise level in the factory was measured and the noise level map of the all departments in the factory was made. Noise levels varied between 70 dB and 100 dB. There were no ototoxic chemical exposures in the factory. The workers were instructed to wear hearing protection devices (protective ear muffs or earplugs). Forty-four male workers of Ammunition Factory, who were not exposed to the explosion, were included into the control group (Group 2). Their mean age was 43.25±6.33 (Ranged from 33 to 60). Any of the patients in the study and control group had head trauma; and in the present time, any symptoms and findings of the infectious ear diseases. None of them had obstructive sleep apnea and known psychiatric diseases.

*Instrumentation*: Minnesota Multiphasic Personality Inventory (MMPI)**:** The Minnesota Multiphasic Personality Inventory is currently the most widely used and researched objective personality test. Originally performed by Hathaway and McKinley in 1940, the MMPI provides an objective means of assessing abnormal behavior. A person taking the MMPI sorts 556 statements into one of the three categories: "true", "false" or "cannot say". The person's responses to these statements are scored on 10 clinical scales [Hypochondriasis (Hs), Depression (D), Hysteria (Hy), Psychopathic deviation (Pd), Masculinity Feminity (Mf), Paranoia (Pa), Psychastenia (Pt), Schizophrenia (Sc), Hypomania (Ma), Social Introversion (Si) ] that assess major categories of abnormal behavior. In addition, 4 validity scales [Question (?), Lie (L), Frequency (F), Correction (K) ] was used to assess the person's test taking attitudes. Overall, a standard profile sheet is used for plotting the person's scores on these 14 scales. The Turkish form of the test was used (Savaşır, 1981) [5].

*Procedure:* The Turkish version of the MMPI was given individually to all workers, exposed to occupational noise. The control group was also completed the MMPI. The MMPI was chosen to assess personality, because it is a psychometric instrument that can assess a wide range of personality traits [6,7].

*Scoring*: K-corrected raw scores were obtained for the 14 MMPI scales (4 validity, 10 clinical scales) and converted to T scores as described in Savaşır (1981) [5] and Erol's (1982) [8] manual. Validity scales included: Question (?), Lie (L), Frequency (F), Correction (K). Clinical scales included: Hypochondriasis (Hs), Depression (D), Hysteria (Hy), Psychopathic deviate (Pd), Masculinity Feminity (Mf), Paranoia (Pa),

Psychastenia (Pt), Schizophrenia (Sc), Hypomania (Ma), Social Introversion (Si).

All steps of the study were planned and continued according to the principles outlined in the Declaration of Helsinki [9]. Permission for the study were taken from Rectorship of Kırıkkale University and Directorate General of Ammunition Factory.

*Statistical analysis***:** Statistical packet for SPSS (Version 8.0) was used for statistical analysis. "Student t test" was done for assessment of the difference between MMPI's of the patients exposed to explosive blast trauma and the control group. For the study group, effects of each of age, education, acute tinnitus during and just after explosion, chronic tinnitus still going on, hearing loss after explosion, sleep disorders after explosion, distance from the explosion site on each of the MMPI subscales were analyzed by "Linear Regression Analysis". "p value < 0.05" was considered statistically significant.

**Results**

The results of the MMPI are seen in Table 1. In Figure 1, MMPI profiles of the study (Explosion exposed group-Group 1) and the control groups (Non-explosion exposed group-Group 2) were shown respectively."Student t test" is done for the comparison of the MMPI's of the Group 1 and 2. No significant difference was present (p value >0.05) (Table I).

For the study group, effects of each of Age, education, acute tinnitus during and just after explosion, chronic tinnitus still going on, hearing loss after explosion, sleep disorders after explosion, distance from the explosion site on each of the MMPI subscales were analyzed by "Linear Regression Analysis" (Table II). The results of "Linear Regression Analysis" were listed below:As the workers get older, Hs, D, Hy, Mf, Pa, Pt, Sc, Si values increased.

As the worker's education levels increased; except Pa, all of the MMPI subscales increased. As the workers' education level increased, they had experienced more psychological problems and they realized that the explosion is very important accident and may have caused more harmful effects on their life.

As acute tinnitus during and just after explosion occurred; except Hs and Sc, all of the MMPI subscales increased. When the worker were experienced acute tinnitus during and just after explosion, their psychological problems and response were much more than acute tinnitus non-experienced group As the workers' chronic tinnitus is still going on after explosion to nowadays; Hs, Hy, Pd, Mf, Pa, Ma increased; and D, Pt, Sc, Si decreased. We conclude that, effects of acute tinnitus on workers psychological construction is more important. But, when it becomes chronic tinnitus, workers used to live with tinnitus; and depression and social introversion due to tinnitus did not affect worker any more.As hearing loss after explosion occurred; Pt and Si increased.As sleep disorders after explosion were present; except Ma, all of the MMPI subscales increased.As distance from the explosion site gets nearer; except Pd and Ma, all of the MMPI subscales increased.

**Discussion**

The extent and pattern of injuries produced by an explosion are a direct result of several factors including the amount and composition of the explosive material (egg, the presence of shrapnel or loose material that can be propelled, radiological or biological contamination), the surrounding environment (egg, the presence of intervening protective barriers), the distance between the victim and the blast, the delivery method if a bomb is involved, and any other environmental hazards. No two events are identical, and the spectrum and extent of injuries produced varies widely [1].

A primary blast injury is caused solely by the direct effect of blast overpressure on tissue. Air is easily compressible, unlike water. As a result, a primary blast injury almost always affects air-filled structures such as the lung, ear, and gastrointestinal (GI) tract. A secondary blast injury is caused by flying objects that strike people. A tertiary blast injury is a feature of high-energy explosions. This type of injury occurs when people fly through the air and strike other objects. A patient may be injured by more than one of these mechanisms[1]

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**Table 1:** Age and MMPI findings of the groups

| | **Groups** | | | | | | | | P* |
|---|---|---|---|---|---|---|---|---|---|
| | Group 1(n=44) Explosion exposed group | | | | Group 2(n=44) Non-explosion exposed group | | | | |
| | Mean | St.Dev - | Minimum | Maksimum | Mean | St.Dev - | Minimum | Maksimum | |
| Age | 45.27 | 4.91 | 34.00 | 53.00 | 43.25 | 6.33 | 33.00 | 60.00 | 0.098 |
| MMPI Validity scales | | | | | | | | | |
| L | 5.81 | 2.40 | 1.00 | 11.00 | 6.38 | 2.37 | 2.00 | 12.00 | 0. 268 |
| F | 9.27 | 5.15 | 2.00 | 26.00 | 9.61 | 6.57 | 2.00 | 29.00 | 0.787 |
| K | 12.29 | 4.38 | 3.00 | 23.00 | 12.20 | 3.84 | 3.00 | 21.00 | 0.918 |
| Clinical scales | | | | | | | | | |
| Hs | 16.36 | 4.90 | 9.00 | 31.00 | 15.80 | 4.86 | 8.00 | 25.00 | 0.587 |
| D | 21.29 | 4.80 | 12.00 | 34.00 | 22.25 | 4.04 | 15.00 | 35.00 | 0.316 |
| Hy | 21.50 | 5.94 | 10.00 | 37.00 | 20.59 | 5.72 | 11.00 | 35.00 | 0.467 |
| Pd | 20.95 | 3.89 | 14.00 | 32.00 | 21.77 | 4.49 | 14.00 | 35.00 | 0.364 |
| Mf | 20.38 | 3.34 | 14.00 | 28.00 | 20.25 | 4.08 | 10.00 | 28.00 | 0.864 |
| Pa | 10.22 | 3.22 | 5.00 | 19.00 | 11.54 | 4.43 | 5.00 | 28.00 | 0.114 |
| Pt | 28.15 | 6.36 | 16.00 | 45.00 | 30.09 | 6.37 | 21.00 | 48.00 | 0.158 |
| Sc | 27.59 | 8.39 | 13.00 | 61.00 | 29.72 | 8.45 | 17.00 | 52.00 | 0.238 |
| Ma | 18.97 | 4.09 | 11.00 | 27.00 | 19.43 | 4.78 | 10.00 | 30.00 | 0.633 |
| Si | 28.20 | 7.21 | 14.00 | 42.00 | 30.81 | 6.97 | 11.00 | 47.00 | 0.088 |

p* values shows the results of the "Student t test".

**Table 2:** In the study group (Exposed to explosive blast trauma), Linear Regression Analysis of MMPI Results

| | MMPI Subscales* | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hs | | D | | Hy | | Pd | | Mf | | Pa | | Pt | | Sc | | Ma | | Si | |
| | Beta | p | Beta | p | Beta | p | Beta | p | Beta | p | Beta | p | Beta | p | Beta | p | Beta | p | Beta | p |
| Age | 0.235 | 0.154 | 0.343 | 0.034 | 0.114 | 0.484 | -0.060 | 0.725 | 0.469 | 0.004 | 0.012 | 0.946 | 0.321 | 0.052 | 0.161 | 0.339 | -0.088 | 0.615 | 0.200 | 0.219 |
| Education | 0.106 | 0.496 | 0.168 | 0.264 | 0.082 | 0.595 | 0.032 | 0.845 | 0.226 | 0.131 | -0.099 | 0.539 | 0.078 | 0.612 | 0.053 | 0.738 | 0.052 | 0.755 | 0.108 | 0.483 |
| Acute tinnitus during and just after explosion | -0.083 | 0.624 | 0.125 | 0.442 | 0.071 | 0.673 | 0.109 | 0.536 | 0.188 | 0.246 | 0.033 | 0.852 | 0.157 | 0.352 | -0.022 | 0.898 | 0.088 | 0.628 | 0.065 | 0.699 |
| Chronic tinnitus still going on | 0.074 | 0.649 | -0.188 | 0.231 | 0.063 | 0.697 | 0.164 | 0.336 | 0.046 | 0.765 | 0.047 | 0.778 | -0.222 | 0.172 | -0.109 | 0.515 | 0.159 | 0.364 | -0.123 | 0.446 |
| Hearing loss after explosion | -0.143 | 0.395 | -0.013 | 0.934 | -0.079 | 0.637 | -0.021 | 0.902 | -0.206 | 0.199 | -0.036 | 0.836 | 0.055 | 0.739 | -0.151 | 0.383 | -0.166 | 0.358 | 0.155 | 0.351 |
| Sleep disorders after explosion | 0.362 | 0.040 | 0.368 | 0.030 | 0.429 | 0.016 | 0.268 | 0.139 | 0.092 | 0.571 | 0.379 | 0.038 | 0.286 | 0.097 | 0.392 | 0.032 | -0.104 | 0.575 | 0.345 | 0.047 |
| Distance from the explosion site | 0.025 | 0.886 | 0.116 | 0.491 | 0.357 | 0.047 | -0.067 | 0.715 | 0.074 | 0.657 | 0.084 | 0.644 | 0.107 | 0.539 | 0.110 | 0.545 | -0.186 | 0.327 | 0.030 | 0.861 |

*Hypochondriasis (Hs), Depression (D), Hysteria (Hy), Psychopathic deviation (Pd), Masculinity Feminity (Mf), Paranoia (Pa), Psychastenia (Pt), Schizophrenia (Sc), Hypomania (Ma), Social Introversion (Si)

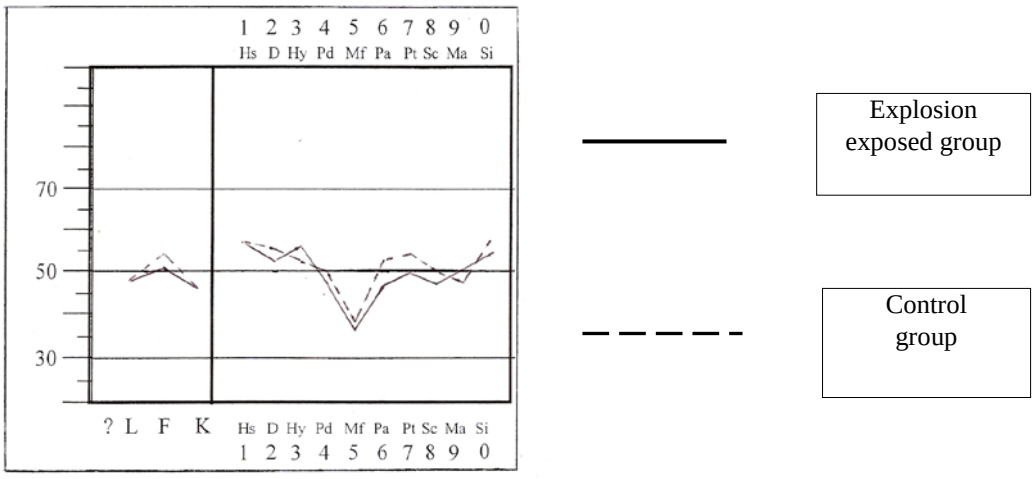


**Figure 1.** MMPI profile of the study and control groups

One of the first cochlear components to suffer after an intense noise exposure is the outer hair cell (OHC) system of the organ of Corti. PTS involves losses of both inner and OHCs and auditory neurons, whereas TTS involves an uncoupling of the OHCs' stereocilia from the tectorial membrane [10].

Noise-induced hearing loss (HL) is extremely variable across subjects, with some developing a temporary threshold shift (TTS) and others a permanent threshold shift (PTS) after a similar acoustic exposure. Furthermore, tinnitus is associated in more than 90% of cases of acute acoustic traumas (AAT) in the initial stages [11] and is often one of the most disabling functional after effects [12]. It was reported that immediately after the AAT. 46.7% of conscripts had hearing impairment and 94.2% tinnitus. Hearing loss, tinnitus or both were experienced by 45% of conscripts at the last follow-up [13]. In another study investigating the incidence of vestibular and audiologic injury related to blast injury; 24% of patients reported symptoms of vertigo or oscillopsia following blast trauma, and 51% reported subjective hearing loss [14].

Akhtar MR, et al [15] investigated the trauma to the auditory system in a bomb blast in a bus. The otological manifestation of blast trauma was hearing loss, tinnitus, ear discharge and pain. Vertigo was not a symptom of blast trauma. Perforation of tympanic membrane was a common sign in blast trauma. Sensorineural hearing loss was also one feature of bomb blast injury. Typical noise induced deafness was found in 36 % of total ears tested on PTA. The 256 Hz tuning fork was more sensitive in detecting conductive deafness as compared to 512 Hz tuning fork in Rinne test. The results of the study call for the necessity of early ENT observation of all the patients who are subjected to explosive trauma because the ear is particularly susceptible to damage.

In the present study, we investigated the relationship between explosive blast trauma exposure and psychological functions of the nonpsychiatric population of workers exposed to blast trauma at "Bomb Filling Atelier"of Ammunition Factory. By this aim, we used MMPI (Minnesota Multiphasic Personality Inventory) for assessing the personality traits. Analysis of MMPI showed that MMPI subscales of the Group 1 and 2 were not different (p value >0.05). This may be related to the relaxing precautions taken by the Management of the Factory for workplace safety. These measures are: 1. Bomb storages are localized at underground places. 2. Workers exposed to blast trauma are given salaried permission for 3 months. 3. Individual interviews and group meetings are organized by Factory Management. 4. Fire and fog alarm system was modernized, therefore as fire exists, automatic fire deflation system can deaden fire immediately. 5. Psychological support was given the workers.

In the study group, MMPI subscales were found as increased in older workers; in workers experienced acute tinnitus and hearing loss during and just after explosion. After the AAT, the emotional state of the patient is very important. The anxiety is quite high during the first 24 hours, especially as patients experience tinnitus for the first time [16]. Stress responses were not simply related to the noise exposure level, although consistent positive relations could be demonstrated between symptoms of stress and noise annoyance. Various findings led to the conclusion that noise exposure together with stressful mental activities may lead to disturbed concentration, irritation and annoyance [17].

Workers with sleep problems after explosion and who were nearer to the explosion site, MMPI subscales also increased. In workers whose chronic tinnitus is still going on after explosion to nowadays, depression and social introversion due to tinnitus did not affect workers any more and these subscales were found as decreased. Higher educated workers had experienced more psychological problems and realized that the explosion was very important accident and may have caused more harmful effects on their life; therefore their MMPI subscales were found as increased.

Intensity of an explosion pressure wave declines with the cubed root of the distance from the explosion. A person 3 m (10 ft) from an explosion experiences 9 times more overpressure than a person 6 m (20 ft) away. Proximity of the person to the explosion is an important factor in a primary blast injury. Blast waves are reflected by solid surfaces; thus, a person standing next to a wall may suffer increased primary blast injury [1].

The aim in the treatment of AAT should be the correction of impaired microcirculation and tissue oxygenation in the cochlea. For this purpose, in our study we selected the combination of steroids and piracetam for the treatment of AAT. The protective effect of steroids against acoustic injury has already been demonstrated in the animal experiments [2, 18, 19]. As vestibular and audiologic injury was seen after blast trauma, Thorough screening by audiologists and physical therapists can facilitate appropriate diagnosis and management for blast-injured patients [14]. In our study, none of the workers wore ear muffs or earplugs during explosion. The workers should be educated for the hazardous effects of the noise and preventive measures such as ear muffs or earplugs.

It is concluded that workers exposed to blast trauma have not poorer psychological functions compared with workers non-exposed to blast trauma. It may be due to explosion was occurred 11 years ago. In acute period, more psychological response may be present. In 11-year period from the explosion, psychological, physical and economic support to the workers may lessen the psychological trauma on workers. In these workers, individual interview; and group and family therapies should be recommended to decrease the negative effects of explosive blast trauma. Without taking a multidimensional approach to preventing work-related disease, a healthy work life cannot be achieved.

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