Occupational health assessment and risks in automotive and wood manufacturing industries: A retrospective study

Sultan Pinar Cetintepe

Gazi University, Faculty of Medicine, Department of Public Health, Division of Occupational Diseases, Ankara, Türkiye

Abstract

Aim: This study examines workers' health status and occupational risks in the automotive manufacturing and wood manufacturing sectors based on medical examinations conducted between January 2019 and January 2020.

Materials and Methods: It involves 27 individuals with an average age of 36.26. Younger workers, especially those aged 20 to 35, show a higher propensity for workplace accidents due to their engagement in hazardous tasks and limited experience. The research emphasizes prevalent health issues such as metabolic syndrome, diabetes, obesity, and cardiovascular diseases among these workers, influenced by sedentary work routines and inadequate physical activity. Workers employed for 1-10 years exhibit the highest incidence of workplace accidents, warranting careful monitoring in this demographic.

Key factors observed include tobacco consumption, blood cell counts, hemoglobin, glucose, liver function indicators, and exposure to hazardous substances. The study highlights prevalent hearing impairment and lung abnormalities in these workers, aligning with global trends in occupational health.

Results: Our study recommends regular health screenings, lung film examinations during initial employment, and periodic check-ups for early detection and treatment. While acknowledging limitations, such as study specificity and resource constraints, it underscores the role of such studies in shaping policies, guiding preventive measures, and enhancing worker health and safety in high-risk industries.

Conclusion: This study underscores the need for proactive health monitoring and regular screenings to safeguard workers' health, even in industries where symptoms might not be evident.

Introduction

The well-being and safety of workers play a crucial role in fostering economic progress and societal health, constituting a pivotal facet of development [1]. Situated within the manufacturing sector, the automotive industry is one of its cornerstone segments, a vital pillar supporting the global economy. Approximately 5% of the worldwide workforce is directly or indirectly involved in this industry [2]. The automotive industry's utilization of substantial machinery, coupled with its diverse operational landscape and governing policies about production rates, workforce scale, scheduling protocols, and more, has consistently drawn attention to the frequency of work-related accidents and illnesses within the sector [3, 4].

Around 44 million workers across Europe are believed to grapple with occupational musculoskeletal disorders, as per specific estimates. Among various occupations, the role of assembly line operators stands out for its higher-than-average ergonomic risks. Findings from the Fourth European Survey on Working Conditions reveal that 35% of individuals engaged in plant and machine operation and assembly consistently report experiencing regular backaches and muscular pains [5]. Numerous studies across different countries corroborate these observations, underscoring the prevalent occurrence of musculoskeletal disorders among assembly operators. It is recommended that regular periodic examinations be conducted for assembly line workers due to the potential exposure to occupational musculoskeletal diseases and heavy metal and solvent exposure, depending on the production environment [6].

Wood manufacturing encompasses mechanized processes that heighten the likelihood of occupational incidents, such as workplace accidents or diseases. When factoring in using hazardous chemicals for finishing, the potential for

*Corresponding author:
Email address:* pinarcetintepe@gazi.edu.tr (Sultan Pinar Cetintepe)

worker illness or fatalities significantly escalates, diminishing the quality of their working life [7]. These operations pose hygiene risks, including elevated noise levels exceeding 85 dBA, exposure to particulate matter, and the application of organic solvents and paints through spraying, among other hazards [8].

This study aims to retrospectively review the files of cases that underwent periodic examinations in Ankara Occupational Diseases Hospital between January 2019 and January 2020, evaluating their overall health status. The objective is to assess the epidemiology and clinical conditions of the patients to identify significant factors for occupational health surveillance.

Materials and Methods

This study evaluated data from 27 male assembly/furniture workers who presented for routine examinations at Ankara Occupational and Environmental Diseases Hospital between January 2019 and January 2020. All assembly/furniture workers admitted to the hospital between these dates were included. The study is descriptive and obtained ethical approval from Gazi University's ethics committee. After gathering occupational histories from the patients, examinations were conducted based on their work-related risks. Subsequently, these cases were assessed for blood and urine tests, audiometry, chest X-rays, and eye examinations. The data used in the study were obtained through a retrospective review of patient records.

Information such as age, height, weight, duration of employment, smoking status, and duration were collected from the files of the cases. Height and weight measurements were taken when the employees visited the clinic; weight measurements were taken after removing heavy clothing and accessories, while height measurements were taken after removing high-heeled shoes and having individuals lean against the wall. Body mass index (BMI) of the cases was calculated by dividing body weight in kilograms by the square of height in meters (kg/m^2).

Collection of biological samples and manganese level measurement

Serum samples were taken at the end of the shift week in 16X100 mm tubes with red caps not containing gel (B.D.Vacutainer). Serum samples were separated after centrifugation at 1500 g for 10 min and stored at -80 ° C until the analysis time. Inductively coupled Plasma-Mass Spectroscopy (ICP-MS) (Agilent 7700X, U.S.A.) was used to analyze metal collected samples. Plasma torch argon purity was higher than 99.999% (H.A.B.A.S., Kocaeli, Turkey). Suprapur® nitric acid 65% and aqueous multi-element standard solution were obtained from Merck (Darmstadt, Germany) and high purity standard (Charleston, U.S.A.), respectively. Aqueous multi-element traditional solutions performed calibration. The method was validated by analysis of certified reference materials (Seronorm Trace Elements, Billingstad, Norway). Accurate results were obtained for manganese.

In this research, we hypothesized that there is no hearing loss among assembly/furniture workers.

Statistical analysis

This is the type of descriptive research. The researchers transferred the study data into a computerized format and underwent quality control procedures. Computers are used to perform statistical analyses of the data. Shapiro Wilk test was used to analyze the data for compliance with the normal distribution of continuous measurements. Mean and standard deviation values are presented for normal distributed data, while median and quartile values are for nonnormal distributed data. The categorical variables were presented as counts and percentages in the descriptive findings. The statistical significance levels were accepted as $p < 0.05$ in all analyses.

Table 1. Demographic characteristics of participants.

Parameters	Mean ± Standard Deviation/ Median [IQR]	CI (95%)
Age (n=27)	36.0 [27.0-45.0]	29.19-40.14
Height (n=27)	176.19 ± 6.81	171.04-178.82
Weight (n=27)	80.0 [70.0-92.0]	70.28-83.32
BMI (n=27)	26.19 ± 3.89	22.98-27.31
Years of Employment	7.0 [3.0-20.0]	6.50-15.50
Smoking (n=15)	10.0 [5.0-20.0]	8.36-16.04

BMI: Body Mass Index, IQR: Interquartile Range, CI: Confidence Interval.

Table 2. Hematological results of the participants.

Parameters	Mean ± Standard Deviation/ Median [IQR]	CI (95%)
WBC (mm^3)	7.31 [6.42-9.70]	7.64-11.27
Hemoglobin (g/dL)	16.35±0.92	15.76-16.65
Hematocrit (%)	49.70±2.91	47.66-50.84
RBC	5.57±0.46	5.26-5.81
Platelet (mm^3)	256.56±41.42	234.58-289.69

WBC: White blood cell, RBC: Red blood cell, IQR: Interquartile Range, CI: Confidence Interval.

Table 3. Biochemical results of the participants.

Parameters	Mean ± Standard Deviation/ Median [IQR]	CI (95%)
Sedimantation (mm/hour)	7.44±3.26	5.56-9.78
Glukose	98.00 [93.00-104.00]	83.61-135.06
Creatin	0.85 [0.78-0.90]	0.79-0.91
AST (IU/mL)	20.00 [16.00-25.00]	18.18-27.02
ALT (IU/mL)	22.00 [16.00-40.00]	21.08-36.79
TSH	2.09 [1.31-2.72]	1.85-2.98
PSA	0.64 [0.44-0.76]	0.51-1.40
Free PSA	0.22 [0.10-0.38]	0.15-0.45
Hippuric acide	286.0 [108.0-852.0]	166.73-660.61
TCA	3.30 [2.20-5.70]	3.08-7.10
Manganese	9.90 [7.20-11.10]	6.83-10.50

AST: Aspartate Aminotransferase, ALT: Alanine Aminotransferase, TSH: ThyroidStimulating Hormone, PSA: Prostate-Specific Antigen, TCA: Trichloroacetic Acid, IQR: Interquartile Range, CI: Confidence Interval.

Table 4. Assessment of Participants' PAAG (Posteroanterior -Anteroposterior Graph).

	Number (n)	Percent (%)
Normal	20	74.1
Nodules in both lungs	3	11.1
Bilateral paracardiac bronchovascular prominence	3	11.1
Aortic arch prominence	1	3.7
Total	27	100.0

Table 5. Hearing test results of the participants.

	Number (n)	Percent (%)
Normal	12	44.5
Left 4 kHz SN drop	4	14.8
Bilateral 4 kHz SN drop	2	7.4
Bilateral very mild SNHL (Sensorineural Hearing Loss)	2	7.4
Bilateral 2 kHz SN drop	1	3.7
Bilateral severe SNHL	1	3.7
Bilateral high-frequency SN drop	1	3.7
Left very mild SNHL	1	3.7
Left high-frequency SN drop	1	3.7
Right 4 kHz SN drop	1	3.7
Right high-frequency SN drop	1	3.7
Total	27	100.0

SN: Sensorineural, SNHL: Sensorineural Hearing Loss.

Results

The study included 27 male assembly/furniture workers without active complaints. The median age of the workers was 36.0 [27.0-45.0] years, with an average height of 176.19±6.81 centimeters, median weight of 80.0 [70.0-92.0] kilograms, and an average BMI of 26.19±3.89. The duration of employment for the cases ranged from 1 to 26 years (median: 7.0 [3.0-20.0] years). Among the working group, 12 (44.4%) were non-smokers, while 15 (55.6%) were smokers. The median duration of smoking among smokers was 10.0 [5.0-20.0] years (Table 1).

The hematological results of the cases are presented in Table 2. The median value of WBC (White Blood Cells) was 7.31 [6.42-9.70] mm^3. The mean values were determined as follows: Hemoglobin average was 16.35±0.92, Hematocrit average was 49.70±2.91, RBC (Red Blood Cells) average was 5.57±0.46, and Platelet average was 256.56±41.42.

The average sedimentation rate of the cases was 7.44±3.26 mm/hour. The median of fasting blood sugar was 98.00 [93.00-104.00], creatinine was 0.85 [0.78-0.90], AST (Aspartate Aminotransferase) was 20.00 [16.00-25.00], ALT (Alanine Aminotransferase) was 22.00 [16.00-40.00], TSH (Thyroid-Stimulating Hormone) was 2.09 [1.31-2.72]. PSA (Prostate-Specific Antigen) and free PSA medians were 0.64 [0.44-0.76] and 0.22 [0.10-0.38], respectively. The hippuric acid median was 286.0 [108.0-852.0], the Trichloroacetic acid (TCA) median was 3.30 [2.20-5.70], and the manganese median was 9.90 [7.20-11.10] (Table 3).

Twenty cases showed normal findings on chest X-rays, while abnormalities were detected in seven patients. Among them, three cases (11.1%) presented nodules in both lungs, three patients (11.1%) showed bilateral paracardiac bronchovascular prominence, and one point exhibited aortic arch prominence (Table 4).

The hearing tests on the cases determined average hearing results in 12 patients while hearing test abnormalities were identified in 15 patients. Four participants (14.8%) had a sensorineural drop at 4 kHz in the left ear; two cases each had bilateral sensorineural reduction at 4 kHz and bilateral very mild sensorineural hearing loss. Other findings are provided in Table 5.

Discussion

Our study group's median age is 36.0 years. The youngest individual is 23 years old, while the oldest is 52. The probability of experiencing a workplace accident is notably higher among younger workers, particularly those aged 20 to 35. This age bracket demonstrates the highest likelihood of workplace accidents. The reasons behind the heightened exposure of individuals in these age groups to accidents might stem from their engagement in generally hazardous or high-risk tasks, coupled with their limited experience, reduced attention, and a lesser sense of responsibility. On the other hand, older workers tend to possess more knowledge, attention to detail, and a heightened sense of responsibility, potentially resulting in decreased accident rates. Additionally, as individuals age, their involvement in hazardous tasks tends to diminish, aligning with the observed decrease in workplace accidents [9].

Weight indicates the weights of these 27 individuals. The median weighs 81.37 kilograms. The lightest individual weighs 58 kilograms, while the heaviest weighs 112 kilograms. Stands for Body Mass Index, calculated from height and weight. The average BMI is 26.19. The lowest BMI recorded in this group is 18.31, and the highest is 35.08. Metabolic syndrome, diabetes, obesity, and cardiovascular diseases are among several chronic illnesses, and this factor holds substantial significance as a risk factor [10]. Researchers observed that prolonged sitting during work contributes to heightened metabolic risks like increased waist circumference, BMI, triglyceride levels, and plasma glucose levels. Additionally, extended sedentary behavior and a lack of physical activity have been linked to a fourfold rise in mortality rates [11]. On the contrary, integrating ten minutes of movement during the workday notably diminishes the risks related with metabolic syndrome [12].

Years of work represent the years these individuals have worked. As median time, they have worked for 7.0 years. The shortest recorded duration of work is one year, and the longest is 26 years. Upon examining the data for the year 2018, it was determined that the group with the highest rate of workplace accidents consisted of individuals employed for 1-12 months. Despite individuals working for 1-30 days being more cautious as they are new to the job and familiarizing themselves with the environment, their accident rate is 13.39%. On the other hand, the group with the highest incidence of workplace accidents comprises those who have worked between 1-10 years (36.76%). The group

experiencing the most minor workplace accidents was identified as individuals working for ten years or more [13].

Cigarettes might refer to the number of cigarettes a subset of individuals smokes. The information provided indicates a range (12.20-6.93), which suggests a range of cigarette consumption, with the lowest being 6.93 and the highest being 12.20 cigarettes within this subset. In the meta-analysis, a compilation of 88 studies was analyzed. Among industrial workers, the prevalence of smoking stood at 41%, with a confidence interval ranging between 35% and 48%. Expressly, the majority of current smoking among industrial workers was noted at 39% [14].

The median count of white blood cells is 7.31 mm³. The range spans from a minimum of 5.58 mm3 to 16.29 mm3. Shift work's impact on WBC counts aligns consistently with findings from diverse occupational groups like steelworkers, police officers, office staff, and healthcare providers [15]. Previous studies on past industrial workers and those currently engaged in shift work have highlighted a correlation with higher WBC levels [16]. However, contrasting opinions exist as certain studies have failed to establish a clear association between industrial work and WBC counts [17].

The average hemoglobin level in the blood is 16.35 g/dL. The recorded range varies from a minimum of 14.4 g/dL to a maximum of 18.3 g/dL. Hematocrit (%): The average hematocrit percentage is 49.70%. The values range from a minimum of 44.0% to a maximum of 55.8%. RBC (Red Blood Cells): The average count of red blood cells is 5.57. The recorded range extends from a minimum count of 4.74 to a maximum count of 6.67. Obesity was associated with elevated WBC count, RBC count, hemoglobin, and hematocrit levels. Previous research findings align with the notable rises observed in WBC count, hemoglobin, hematocrit, MCV, and MCH among individuals who smoke [18]. In four of the seven countries investigated, men involved in industrial labor exhibit slightly reduced hemoglobin (Hgb) levels compared to similar counterparts [19].

The average sedimentation rate is 7.44 mm/hour. The observed range varies from a minimum of 1 mm/hour to a maximum of 17 mm/hour. The Erythrocyte Sedimentation Rate (ESR) can significantly differ based on age and gender, leading to proposed reference values. Additionally, lifestyle choices like physical activity, smoking, and alcohol intake, along with metabolic conditions such as obesity and related metabolic syndrome, might also impact ESR measurements [20].

The median glucose level is 98.00. The range spans from a minimum of 81 to a maximum of 274. Globally, diabetes mellitus (DM) stands as one of the most widespread health threats affecting individuals. In 2019, an estimated 463 million people were impacted by DM worldwide, and projections anticipate this number to escalate to 578 million by 2030 [21]. Research findings indicate that diabetes mellitus (DM) significantly impacts individuals' quality of life and productivity [22].

The median AST level is 20.00 IU/mL. The range extends from a minimum of 13 IU/mL to a maximum of 40 IU/mL. ALT (Alanine Aminotransferase): The median ALT level is 28.96 IU/mL. The recorded range spans from a mini-

mum of 12 IU/mL to a maximum of 78 IU/mL. Assessing liver function in individuals exposed to solvents holds immense importance. Liver transaminases, notably ALT, serve as frequently monitored enzymes, detecting damage within hepatocytes, including the cell membrane, due to the toxicant's impact. Elevated bilirubin levels also signal potential severe liver disease, making it an indicator worth considering in liver injury assessment [23].

Previous studies investigated liver damage induced by organic solvents. They identified elevated levels of transaminases and total bilirubin in a sizable cohort exposed to these solvents. Similarly, scientists reported analogous findings among furniture workers. Additionally, shoemakers exposed to organic solvents showed notably elevated levels of ALT, AST, and conjugated bilirubin [24]. A statistical analysis conducted among workers in an automotive manufacturing plant unveiled higher AST and ALT values in the exposed group, yet this disparity lacked statistical significance [25].

The median hippuric acid level is 286.00. The range observed varies from a minimum of 0 to a maximum of 1730 (Reference value (<1500 mg/L)). A recent investigation discovered various factors contributing to increased levels of hippuric acid. Specifically, the study noted that cigarette smoking facilitated the elimination of toluene and hippuric acid from the body. However, when examining the relationship between cigarette smoking and hippuric acid levels, no statistically significant difference emerged between the two groups.

This study contrasts with the findings of Wang et al. [26] which focused on blood toluene levels in the general population not occupationally exposed. In their research, smokers displayed notably higher blood toluene levels compared to non-smokers, with the duration since the last cigarette being a more influential factor than the frequency of smoking [26]. The worker, typically foregoing a filter mask and aprons, exhibited subpar personal hygiene practices and consequently faced the highest level of exposure among the group. Additionally, among paint workers, 14.9% displayed hippuric acid levels exceeding 1.6 g/g creatinine. This subset did not adhere to using Personal Protective Equipment (PPE) at work and demonstrated inadequate hygiene habits, neglecting practices like handwashing before and after work. Hence, emphasizing self-protection remains crucial as adopting appropriate behaviors mitigates the risk of exposure to hazardous substances [27].

The median manganese level is 8.99. The observed range varies from a minimum of 0 to a maximum of 15.20. The assessment of whole-blood manganese concentration has been explored as a tool to differentiate between exposed and unexposed groups within populations. However, this method lacks precision when applied to individual cases, as indicated by various studies [28]. Similarly, while elevated serum manganese levels have been observed in actively exposed welders, this elevation isn't correlated with the duration of employment in welding [29]. Attempts to utilize manganese concentrations in plasma and serum for assessing manganese exposure have shown limited success. Investigations into manganese levels in urine, hair, and nail clippings have yielded inconsistent data, lacking the precision needed to accurately distinguish between exposed

and unexposed workers.

Our research found that 55.5% of workers showed varying degrees of abnormalities in their audiometric tests. Literature highlights differences among countries regarding criteria for occupational hearing loss. A study investigating work-related hearing issues noted a frequency range of 11.2% to 58.0%, with higher occurrences documented in developing nations [30]. A meta-analysis exploring noise-induced hearing loss in China revealed a prevalence of 21.3%. The analysis highlighted that male gender, exposure to chemicals, advancing age, and longer durations of exposure were associated with an increased risk [31]. Research pinpointed a 28.82% prevalence of noise-induced hearing loss among employees in China's automotive sector. The study underscored that as age advances and noise exposure escalates while the usage of protective equipment decreases, incidences of hearing loss tend to rise [32]. A longitudinal study with metallurgy employees noted consistent declines in audiometric test outcomes during routine check-ups for those exposed to occupational noise [33]. Hearing impairment due to noise exposure is common among manufacturing employees. Studies have found that workers may experience hearing loss during regular check-ups, and an increased risk of such failure is associated with prolonged exposure to noisy environments without protective gear. Measuring workplace environments and making essential adaptations are vital to preventing and detecting hearing loss early in noisy work settings. Equally important is consistently monitoring employees' hearing health through regular check-ups that include audiometric tests.

Our study found abnormalities in seven out of twenty-seven (25.9%) using lung imaging scans conducted during routine check-ups. A study in Japan revealed that 10.6% of lung X-rays from regular check-ups displayed abnormalities. Among individuals with these irregularities, diagnoses included conditions like tuberculosis, infections, and lung cancer [34]. A study assessing ceramic workers' X-rays in Izmir, following ILO standards, found that 82.9% belonged to Category 0. Among them, 34.3% were 0/0, and 48.6% were 0/1. Additionally, 11.6% were categorized as Category 1, while 4.6% were classified under Category 2 [35]. Both in the literature and our study, abnormalities have been identified in the lung X-rays of workers during routine check-ups, even in the absence of symptoms. These observed abnormalities could stem from chronic conditions, smoking habits, or environmental and occupational exposures.

Definitive studies strive for conclusive answers but have limits. Findings often stay context-specific, and not broadly applicable. Ethical concerns about participant safety can be challenging, and limited resources, like time and funding, affect their scope. Unforeseen factors or biases might affect accuracy, calling for ongoing validation. Complementary research helps strengthen and contextualize these definitive study outcomes.

Definitive studies in occupational diseases offer robust insights due to their focused and meticulous approach. Their strength is providing conclusive evidence regarding specific occupational hazards and their health impacts. These studies often involve rigorous methodologies, such as longitudinal designs or randomized controlled trials, allowing for precise monitoring and assessment of the relationship between workplace exposures and health outcomes over time. Their thoroughness in considering and managing various confounding factors enhances the findings' reliability. Additionally, definitive studies contribute significantly to establishing causality, guiding preventive measures, and shaping occupational health policies by offering concrete evidence of the risks associated with specific workplace exposures, ultimately aiming to improve workers' health and safety.

Accordingly, occupational health physicians must conduct lung film screenings for employees during initial employment and periodic check-ups, considering the industry's risk profile. Even without complaints, this proactive measure holds significance for early diagnosis and treatment planning.

Ethical approval
Ethical approval was received for this study from Gazi University Ethics Committee (2022-1120).

References

1. Vosoughi, S., et al., Identification, Selection and Prioritization of Key Performance Indicators for the Improvement of Occupational Health (Case Study: An Automotive Company). J UOEH, 2020. 42(1): p. 35-49.
2. Amrina, E. and S.M. Yusof, Key Performance Indicators for Sustainable Manufacturing Evaluation in Automotive Companies. 2011 Ieee International Conference on Industrial Engineering and Engineering Management (Ieem), 2011: p. 1093-1097.
3. Clarke, S., Contrasting perceptual, attitudinal and dispositional approaches to accident involvement in the workplace. Safety Science, 2006. 44(6): p. 537-550.
4. Hazavehei SM, S.S., Asgari T, Pourabdian S & Hasanzadeh A, The effect of safety education based on Health Belief Model (HBM) on the workers practice of Borujen industrial town in using the personal protection respiratory equipments. Iran Occup Health 2008. 5(1-2): p. 21-30.
5. Maimaiti, N., et al., Cervical musculoskeletal disorders and their relationships with personal and work-related factors among electronic assembly workers. Journal of Safety Research, 2019. 71: p. 79-85.
6. Reif, J., et al., Effects of a Workplace Wellness Program on Employee Health, Health Beliefs, and Medical Use A Randomized Clinical Trial. Jama Internal Medicine, 2020. 180(7): p. 952960.
7. (OSHA), O.S.a.H.A., Wood dust. Comments from the January 19. Final Rule on Air Contaminants Project extracted from 54FR2332 ET. Seq. This rule was remanded by the U.S. Circuit Court of Appeals and the limits are not currently in force CAS: None; Chemical Formula: None. 1989, OSHA: WASHINGTON DC.
8. Gómez, M.E., et al., Health and Working Conditions in Carpenter's Workshops in Armenia (Colombia). Industrial Health, 2010. 48(2): p. 222-230.
9. Kaplan M, Ç.K.M., Türkiye'de Çalişanlarin Demografik Özelliklerinin Iş Kazalarina Etkilerinin Analizi. Journal of Management and Economics Research 2019. 17(2): p. 74-89.
10. Strauss, M., et al., Occupation and metabolic syndrome: is there correlation? A cross sectional study in different work activity occupations of German firefighters and office workers. Diabetology & Metabolic Syndrome, 2016. 8.
11. Ding, D., et al., Traditional and Emerging Lifestyle Risk Behaviors and All-Cause Mortality in Middle-Aged and Older Adults: Evidence from a Large Population-Based Australian Cohort. PLoS Med, 2015. 12(12): p. e1001917.
12. Ekblom-Bak, E., et al., Isotemporal substitution of sedentary time by physical activity of different intensities and bout lengths, and its associations with metabolic risk. European Journal of Preventive Cardiology, 2016. 23(9): p. 967-974.
13. Serin, H. and F. Ozdemir, Çalişan Ve Sektörlere Göre Iş Kazasi Ve Meslek Hastaliği Istatistiği Üzerine Bir Araştirma. Turkish journal of forest science (Online), 2022. 6(1): p. 275-285.

14. Amiri, S. and S.M. Hosseini, Prevalence of current and former smoking in industrial workers worldwide: a systematic review and meta-analysis. Journal of Addictive Diseases, 2021. 39(3): p. 288-306.

15. Hanprathet, N., et al., Shift Work and Leukocyte Count Changes among Workers in Bangkok. Annals of Work Exposures and Health, 2019. 63(6): p. 689-700.

16. Kim, S.W., et al., Night shift work and inflammatory markers in male workers aged 20-39 in a display manufacturing company. Annals of Occupational and Environmental Medicine, 2016. 28.

17. Buss, M.R., M.D. Wirth, and J.B. Burch, Association of shift-work and leukocytes among national health and nutrition examination survey respondents. Chronobiology International, 2018. 35(3): p. 435-439.

18. Smith, M.R., et al., Smoking status and differential white cell count in men and women in the EPIC-Norfolk population. Atherosclerosis, 2003. 169(2): p. 331-337.

19. Lin, Y.Z., et al., Hemoglobin Levels Among Male Agricultural Workers Analyses From the Demographic and Health Surveys to Investigate a Marker for Chronic Kidney Disease of Uncertain Etiology. Journal of Occupational and Environmental Medicine, 2022. 64(12): p. E805-E810.

20. Alende-Castro, V., et al., Factors influencing erythrocyte sedimentation rate in adults New evidence for an old test. Medicine, 2019. 98(34).

21. Andrup, S., What is the best treatment for type 2 diabetes? Tidsskrift for Den Norske Laegeforening, 2023. 143(10): p. 852-852.

22. Kirigia, J.M., et al., Economic burden of diabetes mellitus in the WHO African region. Bmc International Health and Human Rights, 2009. 9.

23. Solter, P.F., Clinical pathology approaches to hepatic injury. Toxicologic Pathology, 2005. 33(1): p. 9-16.

24. Tomei, F., et al., Liver damage among shoe repairers. American Journal of Industrial Medicine, 1999. 36(5): p. 541-547.

25. Mohammadi, S., et al., The effect of exposure to a mixture of organic solvents on liver enzymes in an auto manufacturing plant. Journal of Public Health-Heidelberg, 2010. 18(6): p. 553-557.

26. Wang, G.Z., et al., Reference Values for Blood Toluene in the Occupationally Nonexposed General-Population. International Archives of Occupational and Environmental Health, 1993. 65(3): p. 201-203.

27. RW, R., Cognitive and physiological processes in fear appeals and attitude change: revised theory of protection motivation. Social psychophysiology, 1983. 153(76).

28. Apostoli, P., R. Lucchini, and L. Alessio, Are current biomarkers suitable for the assessment of manganese exposure in individual workers? American Journal of Industrial Medicine, 2000. 37(3): p. 283-290.

29. Lu, L., et al., Alteration of serum concentrations of manganese, iron, ferritin, and transferrin receptor following exposure to welding fumes among career welders. Neurotoxicology, 2005. 26(2): p. 257-265.

30. Chen, K.H., S.B. Su, and K.T. Chen, An overview of occupational noise-induced hearing loss among workers: epidemiology, pathogenesis, and preventive measures. Environmental Health and Preventive Medicine, 2020. 25(1).

31. Zhou, J.N., et al., Occupational noise-induced hearing loss in China: a systematic review and meta-analysis. Bmj Open, 2020. 10(9).

32. Chen, Y.L., et al., Prevalence and determinants of noise-induced hearing loss among workers in the automotive industry in China: A pilot study. Journal of Occupational Health, 2019. 61(5): p. 387-397.

33. Silva, V.A.R., et al., Effect of Noise Exposure on 1,382 Metallurgical Workers in Periodic Audiometric Evaluation: A Cohort Study. Audiology and Neuro-Otology, 2020. 25(6): p. 309314.

34. Watanabe, Y., et al., Descriptive study of chest x-ray examination in mandatory annual health examinations at the workplace in Japan. Plos One, 2022. 17(1).

35. Kurtul, S., Ak, F. K., & Turk, M., Frequency of Pneumoconiosis and Related Factors in Ceramic Workers Admitted between 2016-2018 to the Occupational Diseases Clinic of a University Hospital in Turkey. Iranian Journal of Health, Safety and Environment, 2021. 7(2): p. 1437-1443.