UNIVERSITI PUTRA MALAYSIA

EFFECTS OF NOISE EXPOSURE ON OCCUPATIONAL STRESS AMONG PALM OIL MILL WORKERS IN MALAYSIA

ROYA LATIFI NAEINI

FPSK(m) 2015 49

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By

ROYA LATIFI NAEINI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

August 2015

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

EFFECTS OF NOISE EXPOSURE ON OCCUPATIONAL STRESS AMONG PALM OIL MILL WORKERS IN MALAYSIA

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ROYA LATIFI NAEINI

August 2015

Chairman: Assoc. Prof. Shamsul Bahri Mohd Tamrin, PhD
Faculty: Medicine and Health Sciences

Introduction: Although the foremost concern of chronic excessive noise exposure has been the potential of auditory effects, but noise as an ambient stressor cause a series of non-auditory effects which cannot be overlooked. The environmental noise resulted from operating machineries usually exceeded the NIOSH (1999) recommended exposure limit of 85 dB (A) and as one of the major environmental stressors in palm oil mills is always considered as a key factor in creation of a series of complaints and develop occupational stress as a chronic disorder among palm oil mill workers. The present study will promote a better understanding of the non-auditory effects of noise experienced by palm oil mill workers and, identify the workplace and personal factors contributing to the occupational stress. **Objective:** The general objective of this study was to determine the association between personal noise exposure and occupational stress among palm oil mill workers in Malaysia. The study had 9 specific objectives. Objectives 1, 2 and 3 were to determine the environmental sound levels at each section and to determine the average of personal noise exposure of the respondents at each mill and in each section and compare the personal noise exposure levels between the workers of noisy and normal working area. Objectives 4, 5 and 6 were to determine the prevalence of stress (PSI), average of personal stress levels and compare the mean of personal stress level between high exposed and low exposed groups. 7th specific objective of the study was to determine the salivary α-amylase concentration level (U/ml) among high-exposed and low-exposed groups and compare the α-amylase concentrations (U/ml) between the two groups in resting and stimulated condition. Finally last two specific objectives of the study were to determine the relationship between stress indicators (PSI (O'Donnell) and salivary α-amylase activity) with PNE and to determine the relationship between selected risk factors with stress levels. **Methodology:** This experimental research was implemented through a cross sectional study started since 2012 and took for two years. The study was conducted at seven sections of five selected palm oil mills and 173 participants were invited through purposive sampling based on inclusive criteria. Different materials and techniques were used in order to determine the occupational stress level among the workers, including salivary alpha amylase (sAA) assay kit as the physiological (bio marker) indicator and personal stress inventory (PSI) as the psychological indicator. Validation and reliability of the translated version

of PSI (O'Donnell) shows that the questionnaire was capable in assessing psychological symptoms of occupational stress (Cronbach's alpha= 0.96). Moreover, environmental sound level (ESL) meter (Model: Lutron SL-4112) and dosimeter (Model: wireless110A) were used to evaluate ambient noise level and personal noise exposure (PNE) level respectively. **Results:** The results indicated that, even though the environmental sound level in most of the sections exceeded the action level (85dB (A)), but the average of PNE level in all of the sections is below the action level (85 dB (A)). Meanwhile, there is no significant different in PNE mean between workers from noisy and normal working area (t=-1.742, p=0.083). Finding shows that the mean of PSI among high-exposed group (33.96 (19.10)) is higher than low- exposed group (14.48 (11.61)) and there is a significant different in PSI score level between two groups (t=-5.125, p<0.001). Moreover the outcome shows that there was a significant association between PSI score and PNE level (χ^2=36.185, p<0.001). Salivary α-amylase (sAA) concentration was compared individually among two groups. The results indicated that only in working condition, there is a significant different in sAA between high-exposed and low exposed groups (t=-3.983, p<0.001). Also findings shows that there is a significant association between PNE level with sAA concentration variation (r=0.770**, p<0.001). Similarly, the results of the PSI score support the finding about sAA and shows that, there is a significant association between PNE and PSI score among palm oil mill workers (r_s=579**, p<0.001). Personal factors have no significant relationship with stress level in this study but among work related stressors, only work shift (χ^2 =13.497, p<0.005), PPE usage (χ^2=14.353, p<0.005) and PNE level (χ^2= 36.185, p<0.005) are the three occupational risk factors significantly associated with occupational stress. **Conclusion:** The significant association between PSI and PNE, identified PNE as a significant predictor for occupational stress. The increment of sAA concentration in working situation among both groups shows that generally the workers were experiencing stress condition after 8 working hours but the difference is only significant among exposed group. Meanwhile the significant association between sAA concentration and PNE shows that, sAA could be a potential indicator of physiological symptoms of occupational stress. None of the personal stressors has significant association with occupational stress and only noise exposure, PPE using and work-shift, are identified as the significant predictors of occupational stress among palm oil mill workers.

Keywords: Noise exposure, Non-auditory effects, Occupational stress, Palm oil mill workers

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai keperluan untuk memenuhi ijazah Master Sains

KESAN PENDEDAHAN BUNYI BISING TERHADAP TEKANAN EKERJAAN DALAM KALANGAN PEKERJA KILANG SAWIT DI MALAYSIA

Oleh

ROYA LATIFI NAEINI

August 2015

Pengerusi: Prof. Madya. Shamsul Bahri Mohd Tamrin, PhD
Fakulti: Perubatan dan Sains Kesihatan

Pengenalan: Walaupun kebimbangan utama bagi pendedahan kronik bunyi bising yang berlebihan telah menjadi potensi terhadap kesan pendengaran, tetapi bunyi bising sebagai stresor ambien menyebabkan satu siri kesan bukan pendengaran yang tidak boleh diabaikan. Bunyi bising persekitaran hasil daripada jentera operasi biasanya melebihi had pendedahan yang disyorkan NIOSH (1999) sebanyak 85 dB (A) dan sebagai salah satu daripada tekanan alam sekitar utama di kilang minyak sawit sentiasa dianggap sebagai faktor utama dalam siri aduan dan membangunkan tekanan kerja sebagai gangguan kronik di kalangan pekerja kilang minyak sawit. Kajian ini akan menggalakkan pemahaman yang lebih baik mengenai kesan bukan pendengaran bunyi yang dialami oleh pekerja kilang minyak sawit dan sementara itu, dapat menentukan tempat kerja dan faktor peribadi yang menyumbang kepada tekanan pekerjaan. **Objektif:** Objektif umum untuk menjalankan kajian ini adalah untuk mengenal pasti hubungan antara pendedahan bunyi persendirian dengan tekanan pekerjaan dalam kalangan pekerja kilang minyak sawit di Malaysia. Kajian ini mempunyai 9 objektif. Objektif yang pertama, kedua dan ketiga adalah untuk mengenal pasti tahap bunyi persekitaran dalam bahagian masing-masing dan untuk mengenal pasti purata pendedahan bunyi persendirian bagi responden dari kilang dan bahagian masing-masing serta untuk membandingkan tahap pendedahan bunyi antara pekerja di tempat pekerjaan yang bising dan biasa. Memandangkan salah satu penunjuk dalam kajian ini ialah kelaziman tekanan (PSI), justeru objektif yang keempat, kelima dan keenam adalah untuk menentukan PSI dan purata tahap tekanan persendirian serta untuk membandingkan purata tahap tekanan persendirian antara golongan pendedahan tinggi dengan golongan pendedahan rendah. Penunjuk yang seterusnya dalam kajian ini adalah aktiviti salivary α-amylase (U/ml). Oleh itu, objektif yang ketujuh untuk kajian ini adalah untuk menentukan tahap kepekatan salivary α-amylase (U/ml) antara golongan pendedahan tinggi dengan golongan pendedahan rendah dan membandingkan kepekatan salivary α-amylase (U/ml) untuk kedua-dua golongan tersebut dalam situasi berehat dan dirangsang. Akhir sekali, objektif yang kelapan dan terakhir adalah untuk mengenal pasti hubungan antara penunjuk tekanan (PSI (O'Donnell) dan aktiviti salivary α-

amylase) dengan pendedahan bunyi persendirian serta untuk menentukan hubungan antara faktor risiko tertentu dengan tahap tekanan.**Metodologi:** Penyelidikan eksperimen telah dijalankan melalui kaedah kajian keratan rentas bermula pada 2012 dan mengambil masa selama dua tahun. Kajian ini dilakukan pada tujuh seksyen di lima kilang sawit yang terpilih, seperti Ramp Pemunggahan, Bengkel, Loji Nut, Rumah Boiler, Bilik Minyak, Tekan dan Pensterilan. Sebanyak 173 peserta dipilih melalui kaedah persampelan rawak berdasarkan kriteria inklusif. Bahan dan teknik yang berbeza digunakan untuk menentukan tahap tekanan pekerjaan di kalangan pekerja, termasuk air liur alfa amilase assay kit sebagai penunjuk fisiologi (bio penanda) dan inventori tekanan peribadi (PSI) sebagai penunjuk psikologi. Pengesahan dan kebolehpercayaan versi terjemahan PSI (O'Donnell) menunjukkan bahawa soal selidik mampu menilai gejala psikologikal tekanan pekerjaan. Pengesahan dan kebolehpercayaan versi terjenahan PSI shoes Bahawa soal selidik itu mampu menilai gejala psikologi tekanan kerja (Cronbach's alpha= 0.96). Selain itu, Meter paras bunyi persekitaran (Model: Lutron SL-4112) dan pengukur Dosis (Model: wireless110A) telah digunakan untuk menilai tahap bunyi ambien dan tahap pendedahan bunyi peribadi (PNE). **Keputusan:** Hasil kajian menunjukkan bahawa, walaupun hanya di Bengkel (80.04 (4.27)dB (A)), tahap bunyi persekitaran tidak melebihi tahap tindakan (85dB (A)), tetapi purata tahap PNE dalam kesemua seksyen di bawah tahap tindakan (85 dB (A)) dan tidak ada perbezaan yang signifikan di antara min PNE antara kumpulan terdedah dan tidak terdedah ($t = -1.742$, $p = 0.083$). Hasil kajian menunjukkan bahawa min PSI antara kumpulan tinggi terdedah (33.96 (19.10)) adalah lebih tinggi daripada min PSI antara kumpulan rendah terdedah (14.48 (11.61)) dan terdapat perbezaan yang signifikan dalam tahap skor PSI antara dua kumpulan ($t= -5.125$, $p <0.001$). Selain itu hasil yang menunjukkan bahawa terdapat hubungan yang signifikan antara skor PSI dan tahap PNE ($\chi2 = 36.185$, $p <0.001$). Kepekatan air liur α-amilase (sAA) dibandingkan secara individu di kalangan kumpulan-tinggi terdedah dan rendah-terdedah. Keputusan menunjukkan bahawa hanya di kalangan kumpulan terdedah tinggi, mempunyai perbezaan yang signifikan di antara SAA berehat dan keadaan kerja ($t = -3.983$, $p <0.001$). Hasil kajian menunjukkan terdapat hubungan yang signifikan antara tahap PNE dengan tahap kepekatan sAA ($r = 0.770^{**}$, $p <0.001$). Begitu juga, keputusan skor PSI yang menyokong penemuan tentang variasi sAA dan menunjukkan bahawa, terdapat hubungan yang signifikan antara pendedahan bunyi peribadi dan skor tekanan inventori peribadi di kalangan pekerja kilang kelapa sawit ($r_s = 579$, $p <0.001$). Faktor peribadi tidak mempunyai hubungan yang signifikan dengan tahap tekanan dalam kajian ini tetapi antara tekanan kerja yang berkaitan, hanya bekerja syif ($\chi2 = 13{,}497$, $p <0.005$), penggunaan PPE ($\chi2 = 14{,}353$, $p <0.005$) dan tahap PNE ($\chi2 = 36{,}185$, $p <0.005$) adalah tiga faktor risiko pekerjaan yang ketara berkaitan dengan tahap tekanan pekerjaan. **Kesimpulan:** Hubungkait yang signifikan antara PSI dan PNE, dikenal pasti sebagai prediktor tahap pendedahan bunyi bising yang signifikan untuk tekanan pekerjaan. Peningkatan kepekatan sAA dalam situasi bekerja di kalangan kedua-dua kumpulan menunjukkan bahawa umumnya para pekerja telah mengalami keadaan tekanan selepas 8 jam bekerja tetapi perbezaan signifikan hanya di kalangan kumpulan terdedah. Sementara itu hubungkait yang signifikan antara kepekatan sAA dan PNE menunjukkan bahawa, sAA boleh menjadi penunjuk potensi gejala fisiologikal tekanan kerja. Tiada seorang pun daripada tekanan peribadi mempunyai hubungan yang signifikan dengan tekanan pekerjaan dan

pendedahan bunyi sahaja, penggunaan PPE kerja syif dikenal pasti sebagai prediktor tekanan kerja di kalangan pekerja kilang minyak sawit.

Kata kunci: Pendedahan bunyi bising, kesan bukan audiotori, tekanan pekerjaan, pekerja kilang sawit.

ACKNOWLEDGMENTS

In the name of Allah,

I would like to thank all people who have helped me to make this study come true. First and foremost, my deepest gratitude should go to my supervisor Assoc. Prof. Shamsul Bahri Mohd Tamrin, who was behind me through every step of the way. He gave me a lot of opportunities to improve me and make me stronger. I will be always indebted to him since I have achieved a lot because of him. Meanwhile, I would like to express my great appreciation to my co-supervisor Prof. Zailina Hashim, who always spent extra time to guide me and never tried to withhold her mercy from me. And sincere heartfelt appreciation to dear Dr. Karmegam Karuppiah, dear Dr. Ng Yee Guan and my dear friend Hajar Mariah Hashim, who have always helped me through the whole process for preparing this project smoothly. I sincerely appreciate every second, these kind people have spent patiently on helping me.

Further, this study was supported by the Long Term Research Grant Scheme (LRGS) and Research University Grant Scheme (RUGS).I would like to thank all the people and organizations which directly or indirectly supported this project, the staff, managers and the workers of 4 selected palm oil mills, all the pathology laboratory staffs, Faculty of Medicine and Health Science, since this project could not be completed without their efforts, cooperation and contribution.

Lastly, I would like to thank my dearest parents, my dear husband and my lovely son who have cheered me up at everything I have tried to do. Without their dedications, sacrifices, encouragements and supports, I would not be where I am today.

Thank you all.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

≥	Equal or more than
<	Less than
%	Percentage
P	Significant value
et al	And others
OR	Odds ratio
SD	Standard deviation
CI	Confidence interval
SPSS	Statistical Package for Social Science
sAA	Salivary alpha-amylase
PSI	Personal Stress inventory
CHOPS	Cultural, Historical, Occupational, Psychological, Spiritual
ESL	Environment Sound Level
PNE	Personal Noise exposure
WHO	World Health Organization
dB (A)	Decibel (A)
OER	Oil Extraction Rate
NIOSH	National Institute of Occupational Safety and Health
TWA	Time Weighted Average Noise Levels
SPL	Sound Pressure Level
DOSH	Department of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
CCOHS	Canadian Centre for Occupational Health and Safety
ASI	American Institute of Stress
CDC	Center for disease control and prevention

CHAPTER 1

INTRODUCTION

1.1. Introduction

Palm oil is one of the 17 major oils and fats produced globally while it is the most efficient oilseed crop in the world. About 90% of palm oil is used as edible oil related products worldwide, and the other 10% is used for basic raw material for soap. Producing two types of oil, palm oil from the pulp of fresh fruits as well as kernel oil from the palm kernels, shows a unique feature of the palm oil industry (Basiron et al., 2004)

The world's second-largest oil palm plantation company, Felda Global Ventures Holdings (FELDA), is based in Malaysia. This country as the world's second largest producer and exporter of palm oil has an important role to play in fulfilling the growing global need for oils and fats sustainability. About 429 palm oil mills are operating all over Malaysia with the total capacity of 101, 958, 40 tonnes per year and produce about 47% of the world's supply of palm oil. In 2012, Malaysia produced 18.79 million tonnes of crude palm oil per month. But a well-managing and proper control and monitoring in each phase have resulted in increase productivity and efficiency of this industry in a sense that in 2013 the production of crude palm oil increased to 19, 22 million tonnes per month (Malaysian Palm Oil Board, March 2014). In 2013 the total export of palm oil was 18,146,823 tonnes and the total palm kernel oil was 1,170,800 tonnes which had dipped to 45.27 billion ringgit ($13.85 billion). This industry employed an estimated 491,000 workers and created variety of job opportunities for local and foreign people.

Due to importance of palm oil industry in Malaysia, any physical, chemical or psychological hazard that poses a threat to the health of organization cannot be underestimated. In palm oil mills, the excessive noise resulting from operating the machineries is considered as a hazardous factor in creation a series of complaints. However the evidence emphasize that non-auditory effects of environmental noise are various, serious and, very prevalent, but mostly the researchers followed up the auditory effects rather than non-auditory effects of noise or usually the researchers focused only on one of the non-auditory effects of noise individually such as study on the risk of hypertension, cardiovascular disease, annoyance, sleep disturbance and so on, from exposure to harmful levels of noise in a sense that so far only one experimental study in a palm oil mill in Johor indicated that there is a significant association between noise exposure and occupational stress level. Therefore, there was a need in depth to determine the relationship between noise exposure and occupational stress in a larger sample size by using a combination of two well-known indicators (PSI and salivary Alpha –amylase).

1.1.1. Palm Oil Mill Processing

Several processing operations are used to yield the telic palm oil that meets the users' requirements (Malaysian Palm Oil Board, March 2014). The various steps in extraction at the mills are shown in the Flow Chart (Figure 1.1).

1.1.1.1. FFB Preparation

The first step is to prepare the fruits. The fresh fruit bunches (FFB) are dumped onto the platform, or directly into the ramp. These bunches are then loaded into the cages. The cages come in variety sizes based on the capacity of the sterilizer. The most important process among the milling steps is the cooking and sterilizing the FFB. This step could be carried out by different types of sterilizers (Horizontal, Vertical or continues). Proper steam should result in stripping bunches however the rotary drum incorporate to increase stripping efficiency. The cooked loose fruits will be conveyed from the thresher to the extraction steps.

1.1.1.2. Extraction

The first step of extraction is digester. The loose fruits are slowly homogenized by the slow moving stiller. In this step steam is injected also to drain the oil just before the fruits are pressed. The crude oil is channeled through a pipe into the vibrating screen and then pumped into the clarification tank while the unfiltered solid or residue is recovered and redirected to the digester. The fiber, nuts and are separated by winnowing and dried fiber is used as boiler fuel and the nuts is sent to the kernel plant.

1.1.1.3. Purification

The purification step starts at the clarification tank. Crude oil comprises of water, oil, solids and oil soluble materials. The clarification step basically utilizes the physical properties of the products. The underflow is released into the sludge tank and then centrifuged (separator) to recover the trapped oil. The ex-purifier oil is passed directly into the vacuum drier and then stored in the storage tank for dispatch (Figure1.1).

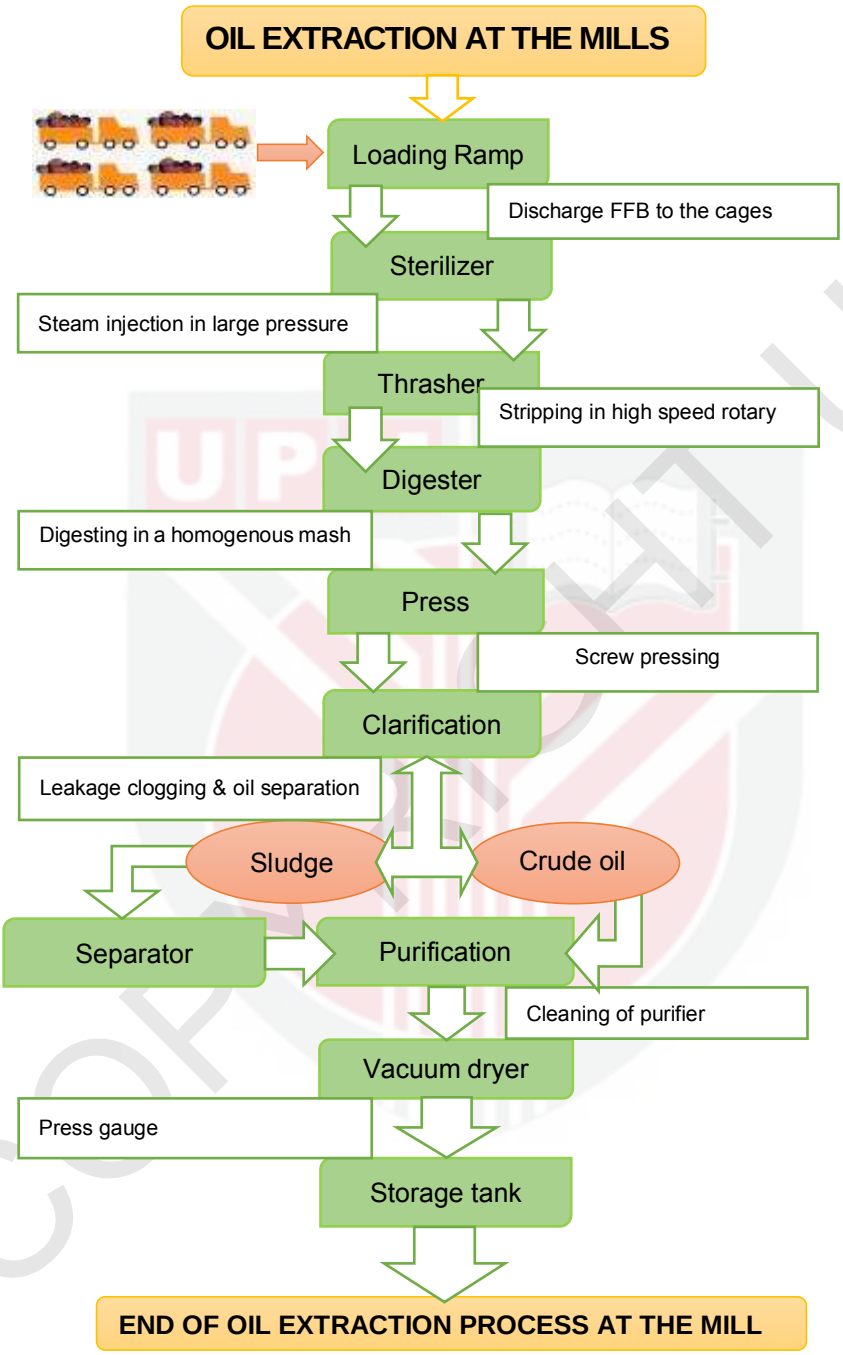

Figure 1.1: Palm Oil Processing Flow Chart

1.1.2. Current Working Condition

Most of the mills are working non-stop for 24 hours to earn more and more profit for the country. Statistically all the evidences lead Malaysian government to feel more responsibility toward advancing production, procurement and use of sustainable oil palm products through development, implementation and verification of credible global standards (Malaysian Palm Oil Board, March 2014).

In response to Malaysian government call for increased industrialization, 5 years extensive research in investing the oil extraction rate (OER) established from 2012 with the support by the Ministry of Higher Education. The main objective of this program is to enhance productivity and sustainability of palm oil milling industry. Thus any menace which may jeopardize the productivity of this industry will be examined.

1.1.3. Occupational Stress and Noise Exposure in Palm Oil Mill

Occupational stress is the major occupational concern in palm oil industry. Stress as a physical, chemical or psychological hazard threatens the health of the workers and health of the organization subsequently. In fact occupational stress is a psychosocial hazard that poses a threat to the health of organizations (NIOSH, 1999).

Palm oil mill is one of the plethora of industries where in several sections such as the Engine room, Boiler room, Nut plant, Sterilizing and Press the sound level is usually above the action level of noise(85dB(A)). According to Factory and Machinery Act (Noise Exposure) Regulation 1989, the action level of noise is 85 dB(A) and any sound level exceeded the action level is considered as the excessive noise level.

Excessive noise is always considered as a key factor in creation of a series of complaints. In fact one of the most important environmental stressors in palm oil mills is the excessive environmental noise that can develop occupational stress as a chronic disorder among palm oil mill workers.

1.1.4. World and local problem due to the non-auditory effect of noise

Continuously working at exposure to high levels of noise, after a period of time will cause two types of effects, auditory and non-auditory (Juraj, 2012). Permanent hearing loss as the auditory effect of noise exposure is one of the common problems among Palm Oil Mills workers. In addition excessive noise as a hazardous stress factor links to variety of non-auditory effects.

The main problem due to non-auditory effect of noise is the less known about the fact that not only auditory organs are affected by noise, but also stress resulting from excessive noise exposure is a complex of veriety of non-auditory symptoms. It could be Just because of difficulty of providing a direct causal link since the majority of disease and syndromes commonly attributed to stress have multiple causes. Some of the researches have studied on each one of the non-

auditory effect of noise individually. The health risks of noise (e.g., noise annoyance, sleep disturbance, hypertension, cardiovascular risks, and poorer school performance) have been extensively documented by a numerous epidemiological studies (Brunekreef and Holgate, 2002, Hoek et al., 2002, World Health Organization, W. H. O., 2012, World Health Organization, W. H. O., 2013 and Basner et al., 2014). These health and wellbeing risks generate substantial costs for society.

It is increasingly documented by the European Ministerial Conferences on Environment and Health and WHO that in order to effectively and efficiently manage environmental quality, it is essential to take into account all costs and benefits of alternative policy scenarios for use in rational planning procedures (Randall, 1986) and to develop ways to make them more transparent (World Health Organization, 2000). The assessment of willingness-to-pay (WTP) is a common approach to valuate individual preferences and the prices of non-market goods such as environmental quality (Hoevenagel, 1994 and U.S. Environmental Protection Agency, 2011).

For instant recent (2013) estimates suggest that more than 100 million Americans are exposed to exceeded action level of noise which is given significant harmful effects of noise pollution (Goines et al., 2007; Tracy et al., 2015). While the initial findings show a significant economic impacts from environmental noise-related cardiovascular disease, it is important to mention that every 5dB noise reduction scenario would reduce the prevalence of hypertension by 1.4% and coronary heart disease by 1.8%. The annual economic benefit was estimated at $3.9 billion. “In Australian, more than $133.9 million was paid in benefits to workers who had made claims related to workplace stress during the 2004/2005 tax year. According to the National Health and Safety Commission, work-related stress accounts for the longest stretches of absenteeism (Stavroula, 2007).”

The direct clear links between work-related stress and a variety of physical and mental disorders have been approved in previous researches. The effects of work-related stress on ill-health operate in physiological, cognitive, emotional and behavioral ways and finally the productivity of organization will be affected negatively (LLixin, 2015). In many countries, legislation obliges employers to take care of the health and safety of their workers. This duty is normally interpreted to include the management of stress-related hazards, work stress and mental as well as physical health outcomes (Bowen et al., 2014).

1.1.5. Stress Indicators

1.1.5.1. Stress Symptoms and Indicators in NIOSH

According to National Institute for Occupational safety and Health (NIOSH**,** 1999) stress in workplace can be the result of any number of situations including:

- Factors unique to the job
- Role in the organization
- Career development
- Relationships at work (Interpersonal)
- Organizational structure/climate
- Work-Life Balance

Stress can have an impact on overall health. Our bodies are designed with a set of automatic responses to deal with stress. This system is very operative for the short term "fight or flight" responses since we encounter with an instantaneous hazard. One of the distinctive features of the human body is dealing with all types of stress in the same way. Experiencing stress for long periods of time (such as lower level but constant stressors at work) will activate this system, but it doesn't get the chance to "turn off". (CCOHS, 2015)

There are a number of warning signs and symptoms introducing by Canadian Centre for Occupational Health and Safety to indicate stress level for someone is having difficulty coping with the amount of stress as below:

- **Physical:** headaches, insomnia, clenched jaws, chest pain, fatigue, shortness of breath, pounding heart, high blood pressure, muscle aches, indigestion, increased perspiration, frequent illness, constipation or diarrhea.

- **Psychosocial**: anxiety, irritability, sadness, lower motivation, defensiveness, anger, apathy, depression, slowed thinking or racing thoughts; feelings of helplessness, hypersensitivity, hopelessness, or of being trapped.

- **Cognitive**: decreased attention, narrowing of perception, forgetfulness, less effective thinking, reduced ability to learn; easily distracted, less problem solving.

- **Behavioural**: loss of appetite, impatience, quickness to argue, procrastination, increased use of alcohol or drugs, increased smoking, withdrawal or isolation from others, neglect of responsibility, poor job performance, poor personal hygiene, change in religious practices, change in close family relationships.

There are variety of validated questionnaire and tests to indicate stress level based on each one of the categories and symptoms. The Indicators could be a standard questionnaire point out a combination of symptoms such as PSI (O'Donnell), CHOPS (Cultural, Historical, Occupational, Psychological and

Spiritual), The Holmes and Rahe Stress Scale, Daily Hassles Scale, Workplace Stress Survey (AIS), computer-assisted psycho-diagnostic tests. Whereas in response to stress, the level of various hormones changes therefore another appropriate stress indicator could be measuring the variation of enzymes in fluids of body. Reactions to stress are associated with enhanced secretion of a number of hormones including Cortisol, Catecholamines, Vasopressin, Gonadotropins, Thyroid Hormones, Growth Hormone, Prolactin and Insulin. The effect of each one is to increase mobilization of energy sources and adapt the individual to its new circumstance.

Therefore each one of the categories of symptoms could identify stress level but whereas this study aimed to identify occupational stress level therefore PSI (O'Donnell) which is a well-known questionnaire used in most of the researches regarding occupational stress was utilized as an indicator for occupational stress level among the workers. Meantime, to access the physiological symptoms, the variation of alpha-amylase resulting from occupational stress was measured to study in a wide range of symptoms and have more accurate results. Alpha-amylase is known as a stress hormone and the collection of this hormone is easy and confident due to existence of this hormone in all the fluids of body as well as in saliva.

1.1.5.2. Alpha Amylase

In this circumstance of sympathetic and endocrine stimulation, the stress hormones are secreted in urine, blood and saliva and mobilized in order to prepare the organism to cope with the stressor. (Babisch, 2003). Alpha-amylase, the enzyme produced in oral cavity by salivary glands increases in stress condition (Pilgrim, 2014; Unno, 2013; Behringer, 2012) is identified as the reliable stress indicator for CNS (Central Nervous System) activity under stimulation.

1.1.5.3. Personal Stress Inventory (PSI)

Besides various questionnaires, some standard inventories and some designed by the author are used to explore the stress level. One of the well-known questionnaires which is utilized in most of the studied related to occupational stress is Personal stress inventory (PSI) (O' Donnell 1984). PSI consists of psychological and physiological subscales which add up to 52 items including musculoskeletal system, gastrointestinal system, physical system, depression, anxiety, energy level, diet, activities, relationship and sleep. PSI is usually used to measure the prevalence of stress and its associated influencing factors among respondents.

1.2. Problem Statement

Palm oil industry in Malaysia has created many opportunities and social benefits for the locals. Besides this industry is contributed the biggest income to the country. The World Bank and Asia Development Bank stated that the Malaysian palm oil industry currently employs 570,000 people and produces export earnings of more than RM68 billion (about $22 billion Australian dollars) per year (World Bank and Asia Development Bank).

Due to the importance of palm oil industry, any hazard that poses a threat to the health of organization cannot be overlooked. Palm oil industrial processing is started from picking the oil palm to how it gets into stores. The relation between different phases of palm oil industry is a chained process in a sense that if any phase of the process is disrupted by a hazardous factor, the quality and quantity of oil extraction will also be affected negatively (Makky & Soni, 2014). There is not any statistical evidence to show that how disruption in any stage of palm oil processing is wasting the time and losing the profits but excessive noise as the major stressor, resulting from the operating machineries is a certain problem that cannot be underestimated in palm oil mills.

According to Factory and Machinery Act (Noise Exposure) Regulation 1989, the action level of noise is 85 dB(A) while in palm oil mills, the excessive noise as the major stressor, resulting from the operating machineries is a certain problem that cannot be underestimated. Excessive noise as a hazardous stress factor links to variety of auditory and non-auditory effects. The direct clear links between excessive noise exposure and auditory effects have been approved in a significantly high number of previous researches, however it would be difficult to provide a direct causal link between non-auditory effects and noise since the syndromes commonly attributed to stress have multiple causes but the direct clear links between work-related stress and a variety of physical and mental disorders have been approved in previous researches. The effects of work-related stress on ill-health operate in physiological, cognitive, emotional and behavioral ways and finally the productivity of organization will be affected negatively (Bowen et al., 2014).

Along this line a WHO working group (1971) stated: Noise must be recognize as the major threat to the human well-being (Duarte et al., 2015). Many researches have been conducted their researches in variety of workplaces and the statistical evidences have indicated that not only the worker's mental capacity is negatively affected by excessive noise exposure but also the performance is gradually affected and may lead to a higher risk for injury or accident (Ljungberg et al., 2007).

WHO (2014) assessed that in developed western European countries with the population about 340 million people, at least 1 million healthy life-years are lost every year because of environmental noise. Most of these DALYs (disability-adjusted life-years) can be endorsed to noise-induced sleep disturbance (N=903000) and annoyance (N=654000). Cardiovascular disease (N=61000) and cognitive impairment (N=45000) are also closely interrelated with environmental noise (Whitfield , 2014; Basner, 2014). Annoyance is the most prevalent response among population exposed to high level of occupational

noise which is increasing, with noise-induced stress linked to burnout, reduced wellbeing, and work performance (Chen et al., 2013). Many studies hypothesized that exposure to high level of noise is able to change the complexity of brain activities into a characteristic level and it might have significant effect on work activities (Zhou, 2012). Meantime evidences suggest that stress caused by noise could be a reason for workers to lose their reflection speed and ultimately affects the working performance (Basner, 2014).

Continuously working at exposure to high levels of noise, after a period of time will cause variety of non-auditory effects for the workers in palm oil mills. However the evidence emphasize that non-auditory effects of environmental noise are various, serious and, very prevalent, but mostly the researchers followed up the auditory effects rather than non-auditory effects of noise or usually the researchers considered only one of the non-auditory effects of noise individually and studied on the risk of that from exposure to harmful levels of noise in a sense that so far only one experimental study among palm oil mill workers indicated that there is a significant association between noise exposure and occupational stress among palm oil mill workers in Johor ($\chi 2=42.204$, p value=0.000) while the high-exposed group have 48 times of probability of stress more than low-exposed group (OR=47.51, 95% CI=11.88-190.06) (Syazani, 2012).

Based on the fact that the number of respondents in that study was small (25 respondents), and the methodology was very simple as the researcher used only PSI to determine the occupational stress level among the workers and the study was undertaken at only one mill, thus there is a need in depth to determine the relationship between noise exposure and occupational stress in a larger sample size while using a combination of two well-known indicators (Personal Stress Inventory and salivary Alpha –amylase) in this study helps the researcher to achieve more accurate results. Moreover the statistically evidences point the sustainable need to reduce environmental noise exposure by reengineering the sources especially the machineries at the workplaces. Since the previous study was carried out at only one mill, therefore the researcher was not able to compare different types of devices but in this research the researcher would be able to determine the human respond to excessive noise caused by different types of devices and potentially can assist the other researchers to pay more attention on the qualification of the machineries from all perspectives. For example the results of this research would help to design and implement a program to assess whether the noise annoyance of horizontal sterilizer is significantly different from vertical or continual sterilizer. Briefly, still some unanswered questions exist for these specified five palm oil mills such as:

- Is there any significant association between noise exposure and occupational stress level among the workers in these selected five palm oil mills?
- Is there any relationship between stress levels and risk factors?
- Is there any documented source to refer to clarify the occupational stress level at different sections of palm oil mills?

1.3. Study Justification

The main purpose of this study is to reply the unanswered questions: “Is there any significant association between noise exposure and occupational stress level among the workers in these five palm oil mills” and “Is there any relation between occupational stress levels and risk factors”. In fact, there is no evidence to show that in recent years any research has been conducted to find the prevalence of occupational stress as the non-auditory effect of excessive noise and its association with personal noise exposure in five specified palm oil mills. The result of this study clarifies the occupational stress level and its association with personal noise exposure among the workers who were working in these 5 mills.

Due to the importance of palm oil industry in Malaysia, this study attempted to highlight the adverse effects of noise which threaten the productivity and profitability of this industry. Whereas the workers’ and researcher’s engagement provides a community with a better understanding of research plan, goals and major initiatives, thus the proposed research would raise public awareness of the adverse effects of noise. Developing a method that actively engage the community in the progress would potentially avoid difficulties and delay in the overall improvement.

Furthermore, because occupational noise exposure affects workers’ performance and inevitably has an impact on the yield of organization, this study attempted to highlight some parts of non-auditory effects of noise which might have negative influences on individuals' performance. The outcome of the study could be used for the executive managers to allocate the more capable workers in critical situations.

The research would produce periodic report on obtained results to LRGS (long term research grant scheme). The results describe an overview of the noise condition at any specified section with different types of devices and are capable to provide a suggested guidance to control the potential effects of noise. The result of this study will assist the researchers in developing a new integrated method to mitigate the noise of devices and machineries by incorporating of technology and innovation. In deed the results shows the future research capacity in this field.

Moreover the findings of this study provide a series of baseline data on non-auditory effects of noise exposure, stress and the related illness caused by stress which can result in financial costs and affect the productivity and sustainability of the company. This research identifies the illnesses caused by occupational stress and provides a consistent approach to noise modeling and make the more reliable analyses of noise effects and its costs which will assist the managers to improve the productivity of the company by controlling the effects.

1.4. Conceptual Framework

Figure 1.2 shows the conceptual framework of the study. This conceptual frame work shows the start point of the study and guides the researcher to move in the correct direction toward the study target. Based on general objective of this study which was looking for the association between personal noise exposure and occupational stress level, personal noise exposure (PNE) has been determined as the independent variable while occupational stress based on PSI score and variation of alpha amylase concentration is determined as the dependent variables. The other selected risk factors are considered only as the confounding factors related to occupational stress level.

Palm oil industrial processing is started from picking the oil palm to how it gets into stores operated in several sections of the mills. In palm oil mill the environmental noise, resulting of operating the machineries and other activities, usually is exceeded the action level (85 dB (A)) (Syazani, 2012). To access the data of independent variable of this study, two appropriate noise assessments are necessary to conduct by personal noise exposure and environmental noise measurement.

In fact noise is one of the more widely and frequently experienced problems of most of the workers working at different sections of palm oil mills. The effects of excessive noise will lead to auditory and non-auditory. Auditory effect of noise due to intense noise or prolong stay in a noisy environment can lead to a temporary or permanent reduction of hearing sensitivity (Basner et al., 2014).

Moreover, exposed to high level of noise has been linked to a range of non-auditory effects such as performance effects including annoyance, sleep disturbance, cognitive performance, speech intelligibility and dissatisfaction (Basner et al., 2014). Also the negative impact of noise upon physiological effects is including cardiovascular symptoms, respiratory symptoms and endocrine responses (Kroesena et al., 2010; Leather, 2011).

The dependent variable of this study is occupational stress level as the non-auditory effect of noise exposure. Whereas the none-auditory effects of noise exposure has two types of symptoms as physiological effects (Rohleder et al., 2009) and performance effects (Basner et al., 2014), therefore, in this study, salivary alpha amylase activity and PSI are two indicators were used to determine the stress level based on physiological effect and performance effect respectively.

The respondents were selected based on inclusive and exclusive criteria and required to full fill the socio-demographic questionnaire. The socio-demographic and occupational characteristic data sets provide the necessary information to evaluate the relationship between occupational stress level and risk factors such as BMI, marital status, age, education, household, work-shift, using PPE, work experience, working hours per day and salary.

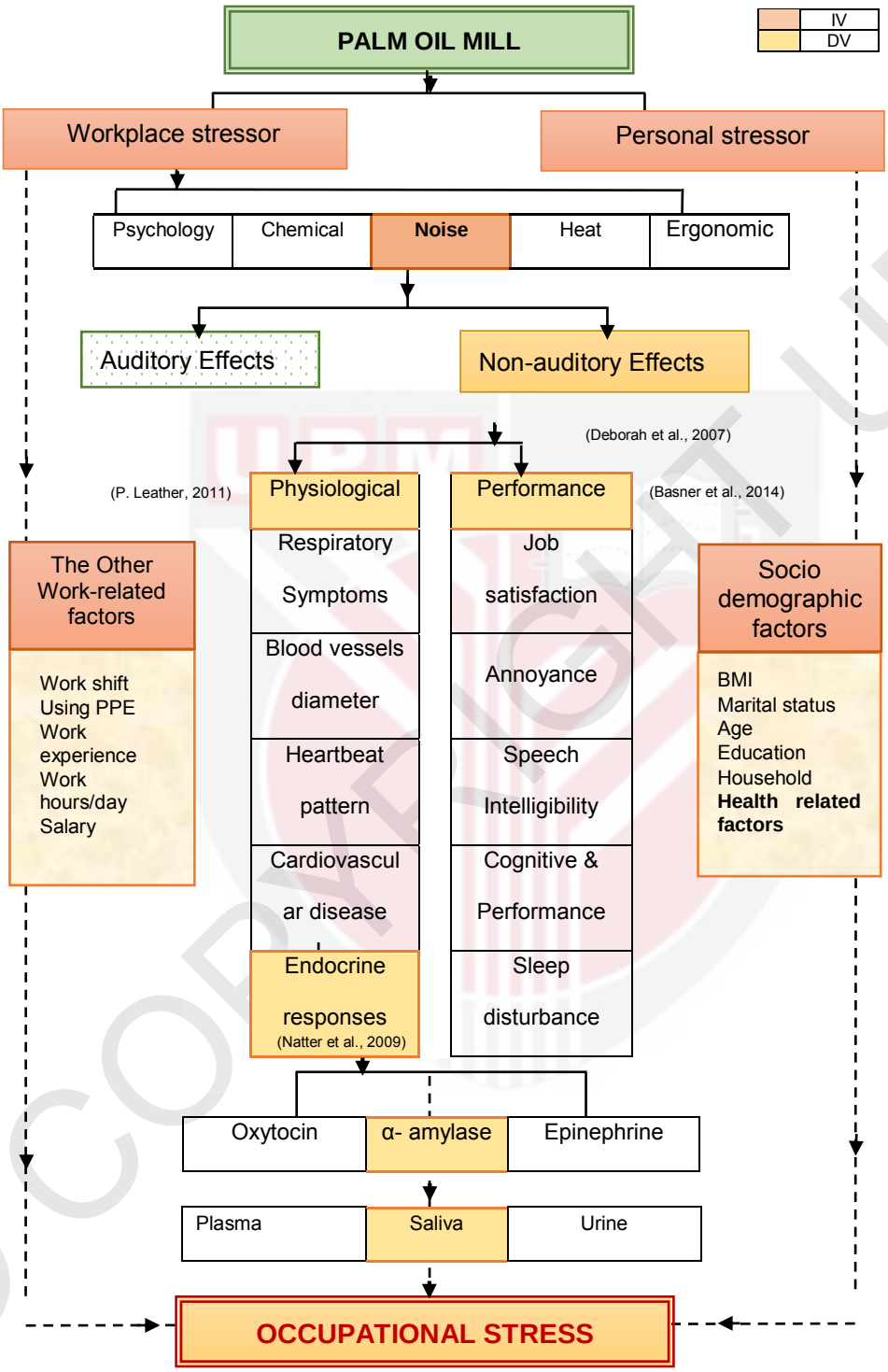

Figure 1.2 Conceptual framework

1.5. Definition of Variables

According to objective of the study, this study has one independent variable which is Noise exposure measuring in personal noise exposure and Environmental sound level. The dependent variable of this study is Occupational stress measuring by alpha amylase activity and PSI. The conceptual definition and operational definition of variables are described subsequently.

1.5.1. Conceptual Definition

1.5.1.1. Occupational Stress

The National Institute for Occupational safety and Health (NIOSH**,** 1999) defines occupational stress as "the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources or needs of the workers". Stress in the workplace can have many origins or come from one single event. It can impact on both employees and employers alike. As stated by the Canadian Mental Health Association (Canadian Centre for Occupational Health and Safety, 2008)

1.5.1.2. Workplace stressor

Workplace stressor is a chemical or biological agent, environmental condition, external stimulus or an event that causes stress to an organism stressor (NIOSH, 1999) Work stressors can be defined as "Antecedent conditions within one's job or the organization which require adaptive responses on the part of the employees" (Chang, 2006).

1.5.1.3. Noise

Noise is unwanted sound which is one of the most common occupational health hazards (Canadian Centre for Occupational Health and Safety). The recommended exposure limit (REL) for occupational noise exposure is 85 dB,A-weighted as an 8-hr time-weighted average (85 dBA as an 8hr TWA). Exposure at and above this level are considered hazardous (NIOSH, 1999).

1.5.1.4. Non-auditory Effects

In general, exposed to high level of noise has been linked to a range of non-auditory effects such as performance effects including annoyance, sleep disturbance, cognitive performance, speech intelligibility and dissatisfaction (Basner et al., 2014). Also the negative impact of noise upon physiological effects is including cardiovascular disease, respiratory symptoms and endocrine responses (Kroesena et al., 2010; P. Leather, 2011; Rohleder et al., 2009).

- **Endocrine responses**

Endocrine response is defined as multiple psychophysiological reaction involved in perceiving, reacting to, and recovering from threat and challenge. The endocrine system responses the nervous system to form and control the body to cope with the stressors (Laurent, 2013).

- **Alpha amylase**

Salivary alpha-Amylase (sAA) is one of the major salivary proteins (Zakowski, 1985). Recent studies have found alpha-amylase as a digestive enzyme and marker of SNS activity. This enzyme digests starches by hydrolyzing the connections of starch and allows the organism to use the stored starch as an energy source (Rohleder et al., 2009). Saliva products are released by acinar cells after neurotransmitter stimulation (Behringer et al., 2012). This enzyme is a biological indicator for stress reactions that has been proposed to indicate stress-reactive body changes in psychophysiological research and clinical practice (Nater, 2006). Evidence indicates the relationship between intra-individual changes in sAA and physical and psychological stressors (Strahler et al., 2010).

1.5.2. Operational Definition

1.5.2.1. Occupational stress

Occupational stress measured using O'Donnell personal stress inventory (PSI). This is a validated questionnaire widely used to measure the effect of occupational stressors on individuals. PSI consists of three parts; family and house, disease and environmental factors (O'Donnel et al., 1984). Occupational stress is based on O'Donnell PSI score as the total sum of the score below 36 is considered as the no stress condition and the total sum of score above 36 is considered as the stress condition. (Honda et al., 2014; Res et al., 1989; O'Donnel et al., 1984).

1.5.2.2. Workplace stressor, Noise

- **Environmental sound**

The environment sound level was identified individually using Lutron SL-4112 Sound Level Meter. Prior to environmental sound measurement, based on SOP of the equipment, the SLM was calibrated using a sound-level calibrator (TES-1356, TES Electronic Corp., Taipei, Taiwan).

- **Personal noise exposure (PNE)**

The wireless110A personal noise dosimeter was used for personal noise exposure measurement upon each selected worker. The dosimeters were calibrated to verify the dose badges before and after each measurement. The personal noise exposure (8-hour TWA) with the range of 45–120 dB (A) used to measure all subjects' noise exposure

1.5.2.3. Non-auditory Effects/ Endocrine respondents/ α-amylase

The salivary samples were taken from the respondents according to the instruction of salimentary oral swab. The taken saliva was kept in specific condition of -20°C at most for two months using the salimentary storage tubes. The samples taken from the respondent were analyzed using the salivary α-amylase assay kit according to manufacturer's manual.

1.6. Objectives

General objective:

To determine the association between personal noise exposure and occupational stress among palm oil mill workers in Malaysia

Specific objectives:

i. To identify the environmental sound levels at each section of the mills
ii. To identify the average of PNE of the respondents at each mill and in each section
iii. To compare the PNE levels between the workers of noisy (ESL≥85 dB) and normal (ESL<85 dB) working area
iv. To identify the prevalence of stress (PSI) among the high-exposed and low-exposed groups based on the PNE level
v. To identify the personal stress levels (PSI) and compare the mean of personal stress level between high exposed and low exposed groups
vi. To determine the association between the PNE level with PSI score
vii. To identify the salivary α-amylase concentration level (U/ml) among high-exposed and low-exposed groups and compare the α-amylase concentrations (U/ml) between the two groups in resting and stimulated condition in 5 mills
viii. To determine the relationship between stress indicators ,PSI (O'Donnell) with Salivary α-amylase activity (U/ml) and the relationship between them with PNE levels among the high-exposed group
ix. To determine the relationship between selected risk factors with PSI levels

1.7. Hypothesis

i. There are two different working area (Noisy and Normal) based on Environmental sound level measurement
ii. The workers are classified in two groups (High exposed and low exposed groups) based on PNE measurement
iii. There is a significant difference in PNE between workers from noisy and normal working area
iv. There is a significant difference in PSI scores between the two high-exposed and low exposed group
v. There is a significant association between PSI scores and PNE
vi. There is a significant difference in salivary α-amylase concentration (U/ml) variation between resting and working situation (stimulated condition) among the high-exposed group
vii. There is a significant relationship between stress indicators, PSI (O'Donnell) score and α-amylase activity(U/ml)
viii. There is a significant relationship between stress indicators (PSI and salivary α-amylase activity(U/ml) with PNE
ix. There is a significant relationship between selected risk factors with PSI level

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