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ORIGINAL ARTICLE

THE PREVALENCE OF HAND ARM VIBRATION SYNDROME AMONG AUTOMOBILE ASSEMBLY WORKERS

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ABSTRACT

The objectives of this study are to determine the prevalence of hand-arm vibration (HAVS) among the automobile assembly workers and the associated risks. A cross sectional study was conducted to determine the prevalence of HAVS and also ascertain the association between HAVS and reduction in VPT among workers using vibration hand held tool in automobile industry. Aim of this study was to determine the prevalence Hand Arm Vibration Syndrome (HAVS) among vibrating hand held tool exposed workers. A cross sectional study design using structured questionnaire and invasive measurement of vibrotactile perception threshold (VPT) at the fingertips was conducted in one of the automobile company in Klang Valley. All the respondents were hand arm vibration exposed workers. A total 109 assembly line workers with at least one year job tenure participated in this study. The finding revealed that 27.5% of workers reported HAVS through questionnaire. This study consisted of 109 respondents. All of them were male. The mean age was 32.9 years. The mean daily vibration exposure for 8-hours was 1.41m/s2. There was 11% of the tools measured were above the Action Level recommended by European Union Directive 2002. The overall prevalence of HAVS based on reported symptom through questionnaire was 27.5%. None of the respondent reported any whiteness at their fingers due to exposure to vibration. However, 36.7% of the respondent reported tingling sensation and 57.8 % reported the feeling of numbness in their hands. Only 10.1% claim that the pain was persistence. Since this study was done among exposed workers without control group, the thresholds were measured by comparing the observed VPT with the VPT of healthy population provided by ISO 13091-2. The result showed that 98.2% of the respondent in this study having positive threshold which indicate the percentage of respondent that having deterioration in finger tactile perception. The positive threshold from comparison above showed that the respondent of this study was affected with the vibration exposure. The value proven that the exposure has caused the deterioration of tactile sensitivity in 98.2% of respondent in this study which showed by having positive threshold compared to healthy population. The result also showed that there was a significant correlation between daily vibration exposure A (8) and VPT at both frequency tested which was 31.5Hz (r = 0.417, p = 0.002) and 125Hz (r = 0.480, p = 0.001). Even though the mean daily vibration exposure for 8-hours was low and below the recommended level, the workers still exposed to the effect of hand arm vibration

Keywords: *automobile assembly workers, impact wrench, vibrating tool, hand-arm vibration syndrome,*

INTRODUCTION

The Heavy Industrial Policy in the early 1980s marks a significant change of industrialisation strategy in Malaysia towards building a nationally owned and controlled automotive industry. Over the years, the number of workers in automobile industries has shown an increasing trend where for instance in Malaysia as the automobile manufacturing and assembly and the parts and components manufacturers generated nearly 50,000 jobs in 2008which shows the importance of this industry in Malaysia[1].

Car manufacturing involve with the installation of several hundred parts of machine components. In the process of fitting its part together, the use of vibrating hand tools or power tools required in most of the work process. The usage of vibrating hand tools can give an adverse health effect to the hands and arms. The vibration is transmitted to the body through hand and arm when a person is using vibrating hand tools. Prolong exposure to vibrating hand held tools can lead to development of Hand Arm Vibration Syndrome (HAVS) and health effect such as neurological, vascular and musculoskeletal disorders in the upper limbs[2]. The requirement of power tools may provide advantages such as productivity and efficiency, but this poses a higher risk for workers towards the effect of hand arm vibration which may develop hand arm vibration syndrome (HAVS).

Through the observation in the car manufacturing process, the used of vibrating tools in production line was repeatedly but in short duration for every cycle of the task. Reviewing previous study also showed that constant short daily exposure can cause HAVS. Study done among 806 Swedish car mechanics showed that HAVS is common among the mechanics in spite of short daily exposure to vibrating tools[3]. The longer duration of exposure and the higher the vibration magnitude, will increase the potential of the workers to develop HAVS[4].

Studies were being conducted to measure the effect of short term exposure to hand arm vibration. In order to quantify the sensory and functional effects resulting from a short-duration (30 minutes) exposure to hand arm vibration, laboratory experiment has been done to nine workers who had never been exposed to vibration. The result showed that the 32 minutes period of exposure at three different amplitudes of 5, 20 and 80 m/s2 (unweight) to vibration leads to a temporary thresholds shift (TTS) of the vibrotactile perception thresholds (VPT) and to the development of paraesthesia and numbness[5].

However, there has been inadequate study conducted currently in Malaysia in the area of hand arm vibration exposure especially in automotive industry. There was study done in automotive industry in Malaysia but not specifically on the effect of vibrating tool used in that particular workplace. Based on study done elsewhere, it was predicted that Malaysian workers were also affected to vibration exposure as they are working in similar industries and also using vibrating tools. There were studies had been conducted in other countries shown a high prevalence of HAVS within the range of 20% to 80% depending on type of industries and tools used [6, 7].

The vibration induced to the hand was believed to cause restriction of blood flow to the affected part of the body such as fingers. Intermittent or persistent tingling and numbness in the fingers and hands is the early symptoms of neurological component of HAVS, and continuous exposure make the symptoms worsen and can affect working capacity and life activities due to reduction in normal sense of touch, temperature, and pain as well as an impairment of manipulative dexterity[2].

Health effect due to the usage of vibrating power tools should not be allowed because the main intention of using the power tools is to help workers doing their task easier and more quality such as in tightening the screw or parts. However the effect of HAVS will put the workers and co-workers at risk of injury due to loss of grip strength and hand sensation. Loss of sensation at fingertips will create a lot of problem especially in manipulative work and in performing precise task. Accident could happen if the workers lose the dexterity of their hands because loss of tactile sense can disturb the manual control of power tools that increase the risk of accident at workplace and this problem will also could interfered workers quality of life[2].

Among the many neurological tests for hand arm vibration syndrome, vibration perception thresholds (VPT) has proved useful in evaluating sensory nerve impairment and has been measured in many countries[8]. The purpose of measuring tactogram is to establish a person's vibrotactile threshold at the fingertips. Since VPT is one of the useful methods in assessing the impairment in hand arm due to HAVS, the relationship between VPT and reported HAVS need to be established to determine the prevalence of HAVS in study population for situation in Malaysia.

METHODS

Subjects

A cross sectional study was done among 109 automobile assembly workers using instruments and a questionnaire to determine HAV related symptoms. All the respondents were hand arm vibration exposed workers with at least one year job tenure. The vibration acceleration magnitude was determined using a Human Vibration Meter (HAVPro). A P8 Pallesthesiometer (EMSON-MAT, Poland) was used to determine the VPT of index finger at frequencies of 31.5 Hz and 125 Hz. The prevalence was calculated using the mean and standard deviation of original data as cut-off value to differentiate HAVS and non-HAVS respondents.

Questionnaire

The questionnaire used in order to obtain information regarding the individual background (demographic information), occupational history of the usage of vibrating hand tools, social history related to smoking and alcohol consumption, ergonomic risk factors in their job and health status about symptoms concerning hand-arm vibration syndrome of respondents. The first stage of data collection was distribution of preliminary questionnaire in order to rule out the respondents that fulfil the exclusion criteria. Only the eligible respondents were selected to go for second stage of data collection which was measurement of VPT and fill up the study questionnaire. There were six parts in study questionnaire which were part A, B, C, D, E and F. Part A – C consisted of question about the background of respondent, employment history and respondent's lifestyle such as smoking and alcohol consumption. Part D asking about ergonomics risk factors related to hand arm area such as static posture of hand and arm during working, repetitive twisting of hand arm, any forceful movement and awkward posture of the hand arm. Part E of study questionnaire focused about the symptoms of HAVS that have been experienced by the respondent. Part F was data sheet in order to record the measurement data such as height, weight, skin temperature, VPT measurement and grip strength measurement.

Hand-arm vibration measurement

Measurement of the hand tool magnitude was done using Human vibration meter (HAVPro) where a tri-axial accelerometer that embedded in an adapter is attached to the tool handle at the grasping area. The magnitude of vibration was measured while workers perform their job. The accelerometer was attached to the tools handle as close as to the gripping area. The vibration reading is in acceleration unit (m/s2) r.m.s which complies with the ISO 5349-1 standard. The measurement of acceleration magnitude was done using sub-sample method due to the suitability of the task. Some of the tasks were not suitable to do measurement such as task for attaching the seat belts at the back seat to the car because of the nature of the task posed a high possibility of knocking the accelerometer. It will affected the reading as the value of peak due to knocking will be calculated making the acceleration value not accurate. The acceleration magnitude measured in this study was according to the actual working condition where the workers was free to work as usual after fastening the accelerometer at tool handle.

Measurement of the acceleration magnitude was done to power hand tools and battery driven hand tools. All the measurement and calculation of the acceleration magnitude was according to the ISO 5349-1:2001. The magnitude of vibration was described by the root-mean-square (r.m.s) frequency-weighted acceleration in meter per second squared (ms-2). Since vibration enters the hand in three directions of x-, y- and z- axes, the frequency-weighted r.m.s were noted as ahwx, ahwy, ahwz respectively. The vibration magnitude is represented by the vibration total value ahv. Data have been downloaded using software Quest Profesional II and the total value of ahv for every measurement has already been calculated by the software. After the vibration total value of the tool was obtained, the daily vibration exposure of the workers can be estimated using the below:

$$A(8) = a_{hv} (T/T_8)^{1/2}$$

The total daily duration of exposure to the vibration ahv (T) in the equation above was calculated by multiplying the duration of vibrating tool used on a car (consider as one cycle) with the average of numbers of car per day. The average of cars per day was 300 cars. The reference duration of 8 hours (T0) was based on their working shift. This company only has one shift which is normal shift start from 8.00 am to 5.00 pm with total break time of one hour.

Vibrotactile perception threshold
The tactile acuity at fingertips was measured by using ISO 13091-1 standard equipment called P8 Pallesthesiometer (EMSON-MAT). The measuring system consisted of a vibrometer unit, a subject response button, a set of vibrotactile meter working state indicators and a vibrometer software. The measurement is non-invasive method. The simulating probe is a flat-ended with 5 mm in diameter. The respondent puts their fingertips onto the probe during measurement. The equipment was developed with hand and arm special support to ensure the required contact between the probe and fingertips. The location of measurement at fingertips is on the distal phalanx at a point of midway between the centre of the whorl and the fingernail. During measurement, the respondent will press the probe with a constant force of 0.1 N. The measurement was done on the index finger for both hands.

This equipment used the Von Bekesy algorithm to determine vibrotactile perception thresholds. The vibration magnitude introduced will increase until the respondent was able to perceive it. The respondent pressed the response button held in other hand until he cannot perceive the stimulus. Pressing response from respondent caused decrease in vibration level and releasing button caused the vibration level to increase again. In this study, the vibration magnitudes introduced are at frequency of 31.5 and 125 Hz. The P8 Pallesthesiometer was equipped with an automatic test program to establish the threshold level at selected vibration frequency by repeating the test procedure above.

The chosen frequencies of 31.5Hz and 125Hz was used because previous experimental studies have shown that these frequencies induce greater changes in finger tactile perception thresholds than some lower or higher frequencies do [2,5,9].Before conducting the measurement, respondent was briefed about the purpose and how the measurement will be done. The respondent was introduced to the vibration stimuli and measurement procedure by performing pre-test in order to familiarize with the test. The respondent needs to perform the pre-test once before actual measurement to ensure that he understood the test procedure. The finger skin temperature was measured on the distal phalanx before VPT measurement using non-contact infrared thermometer. In order to ensure the consistency of measurement, the test was conducted according to a standard operating procedure.

Statistical analysis
Descriptive analysis was used to show the basic statistical data of information such as age, education level, dominant hand, occupational history and social lifestyle. In this study, univariate analysis was used to determine the prevalence of the HAVS among the study population. The t-test analysis was used to determine the difference in mean daily vibration exposure of different types of tools used. The t-test also used to determine the difference in mean vibrotactile perception threshold of the

respondents between two different frequencies tested (31.5Hz and 125Hz). Analysis of variance (ANOVA) was used to determine if there is any statistically significant difference in mean of vibrotactile perception threshold between three sections of work area. Pearson Correlation test was used to determine the correlation of vibrotactile perception threshold with other factors that can influence the value of vibrotactile perception thresholds level. The regression performed using stepwise method.

RESULTS

This study consisted of 109 respondents. All of them were male. The mean age was 32.9 years. The mean daily vibration exposure for 8-hours was 1.41m/s2. There was 11% of the tools measured were above the Action Level recommended[10]. The overall prevalence of HAVS based on reported symptom through questionnaire was 27.5%. None of the respondent reported any whiteness at their fingers due to exposure to vibration. However, 36.7% of the respondent reported tingling sensation and 57.8 % reported the feeling of numbness in their hands. Only 10.1% claim that the pain was persistence. Since this study was done among exposed workers without control group, the thresholds were measured by comparing the observed VPT with the VPT of healthy population provided by ISO 13091-2. Table 1 showed that 98.2% of the respondent in this study having positive threshold which indicate the percentage of respondent that having deterioration in finger tactile perception. The positive threshold from comparison above showed that the respondent of this study was affected with the vibration exposure. The value proven that the exposure has caused the deterioration of tactile sensitivity in 98.2% of respondent in this study which showed by having positive threshold compared to healthy population. Table 2 also showed that there was a significant correlation between daily vibration exposure A (8) and VPT at both frequency tested which was 31.5Hz (r = 0.417, p = 0.002) and 125Hz (r = 0.480, p = 0.001).

Table 1 - Prevalence of HAVS

Method	HAVS Symptom (n=109)	
	Yes n (%)	No n (%)
Questionnaire	30 (27.5)	79(72.5)
Mean + 2sd	14 (12.8)	95(87.2)
ISO Threshold Shift	107(98.2)	2(1.8)

Table 2- Correlation of VPT and Other Factors.

Variables	31.5 Hz		125Hz	
	r	p	r	p
Daily Vibration Exposure A (8) (m/s^2)	0.417**	0.002	0.480**	0.001
Temperature (right)	0.201*	0.037	0.265**	0.005
Temperature (left)	0.233*	0.019	0.272**	0.004
Age	-0.221*	0.021	-0.081	0.403
Exposure duration	-0.217*	0.024	-0.078	0.423
Grip Strength	-0.166	0.085	-0.108	0.262
HAVS Symptoms	-0.081	0.400	-0.015	0.877

DISCUSSION

Prevalence of HAVS

The prevalence of HAVS was determined using three different methods which was questionnaire, by calculation the mean plus two times standard deviation (mean+2sd) and comparing the measurement VPT value with the ISO reference data as shown in Table A.2 on the ISO 13091-2 Standard. However the comparison between measured VPT values with ISO 13091-2 was to compare the result with reference value of healthy person. The percentage obtained was the indication of respondents of this study was affected by the usage of vibrating tools by having higher VPT value than healthy people specified in ISO 13091-2.Based on the Table 1, the reported symptom from the respondents through questionnaires gave the prevalence of HAVS of 27.5% among the study population. However the prevalence rate through calculation gave lower prevalence (12.8%) compared to questionnaires. These data were based on the sensitivity of the respondent can perceive the vibration stimuli introduced.

The prevalence rate obtained from this study was lower compared to the previous study done among hand arm vibration exposed workers. Study was done among 165 workers in heavy engineering company gave the prevalence of neurological symptoms of 62%[11]. Besides, there are another study done among 344 shipyard workers gave higher prevalence of 78.2%[12]. Another study is conducted among 308 car mechanics in Sweden showed the prevalence of 40% having neurological symptoms after 20 years of exposure[3].The prevalence of HAVS obtained from this study was relatively lower compared to other studies and it could be due to several other factors linked to exposure condition such as short working period with vibrating tools (mean= 84 minutes/day), relatively low daily vibration exposure (mean = 1.41 m/s2) and the intermittency of tool used. The mean daily vibration exposure in this study was below the action level (2.5m/s2) provided[10]. It was supported by comparing the vibration level of the above studies. For example study was reported that the workers were exposed to the daily vibration exposure of 3.5 m/s2 which was higher than this study (1.41 m/s2)[3]. The exposure in total vibration (ahv) of 6.6 m/s2 which also higher from this study (ahv=3.9 m/s2)[12].

Factor that might contribute to the low prevalence of this study was the climate condition. Warmer condition can initiate the vasodilatation of blood vessels, which can enhance the blood flow. The prevalence in warmer climate also show lower rate as reported from study done among South African gold miner gave prevalence of 15%[13]. Study done in Vietnam among quarry workers also gave lower prevalence in the range of 5-10% of the rock-drill operators suffering from HAVS[14].

The mean+2sd cut-off method has been used in order to determine the numbers of most affected respondent among the exposed workers. The respondents with a high value of VPT that deviates more than two times of standard deviation from the mean is considered the worst case in this study which showed that the fingers' tactile was badly deteriorated. The worst case group was referred as HAVS group and has given lower prevalence of 12.8% compared to prevalence of reported symptoms through questionnaire which was 27.5%.Many studies estimate prevalence based on the answers to questionnaires. However it has been shown that using questionnaires and objective test does not give the same result[15].

A study done on the car mechanics in Sweden also showed different in prevalence of HAVS which was 24% reported cold induced white finger, 25% persistent numbness and 13% reduced grip force that being reported through questionnaire[3]. However, after clinical examination showed that the prevalence of vibration induced white finger was only 15% where the clinical examination consist of detail history of symptoms and other diseases, medication, used of alcohol as well as a timed Allen test, Tinel's and Phalen's test. It showed that the used of questionnaire alone will give higher prevalence compared to objective test or enhancement of the assessment with clinical examination. The differences in prevalence between questionnaires and subjective test could be due to overestimate of the respondent in answering questionnaire toward the symptom experienced. Therefore, the accuracy of research relied on the honesty and perception of respondents in answering the questionnaires as the identification of HAVS and some other information were based on questionnaires without diagnosis of physician.

Data from the questionnaires could be subjected to respondent's recall bias. Respondents who are not satisfied with their work load and condition or with high tendency to report complaints might have led to overestimate or underestimate of the effect of the risk factors[16].Other factors that could influence higher result of reporting syndrome through questionnaire was ergonomics risk factors occurred in their job such as repetitive movement, awkward posture of hand, forceful task and static posture in their hand arm system. The different of prevalence rate in this study obtained through the questionnaire and cut-off point of VPT could be due to the numbness felt by workers was the effect of ergonomics risk factors rather than vibrating tools. Respond through questionnaires also showed that the frequency of ergonomics risk factors performed by the workers were more than 50 times per shift. The score of occurrence of the ergonomics risk factors (Table 3) also shows the overall score was more than 3. It shows that the respondents of this study also exposed to ergonomics risk factors in their task. Those ergonomics risk factors were believed to give certain impact towards the cause of musculoskeletal disorders in hand arm area since numbness sometimes does not follow the vibration exposure profile because numbness also associated with the upper extremity musculoskeletal disorders[3]. Workload increases musculoskeletal symptoms, but may also have an effect on sensorineural symptoms[8]. Study done among forestry workers showed the prevalence of VWF decreased but numbness was increase[17]. In that study numbness was associated with upper extremity musculoskeletal disorder as metalworkers also performed repetitive and forceful movements that mayexplain both their neurological and musculoskeletal problems.

Table 3 – Ergonomic Risk Factors

Ergonomic Risk Factor	Score				
	1	2	3	4	Mean±sd
Static posture	8(7.3)	11(10.1)	9(8.3)	81(74.3)	3.50±0.95
Repetitive	12(11.0)	12(11.0)	15(13.8)	70(64.2)	3.31±1.05
Forceful	13(7.3)	9(10.1)	17(8.3)	70(74.3)	3.32±1.05
Awkward	25(22.9)	8(7.3)	19(17.4)	57(52.3)	2.99±1.24
Overall					3.28±0.83

n=109

Daily vibration exposure A (8) of different type of tools

In this study there were two types of tools which were categorized into battery driven tools and air tools. Result from the field measurement in Table 4 shows that there was a significant different in acceleration magnitude between air tools and battery driven tools (t=4.006, p = 0.001). The results showed that the air powered tools have higher magnitude for 8 hours of daily vibration exposure A (8) compared to battery driven tools. Comparing the overall daily vibration exposure value of this study, the mean of overall daily vibration exposure A(8) did not exceed the action value of 2.5 m/s2 as recommended by European Parliament and the council of the European Union (2002) Directive 2002/44/EC. When comparing every single value of the tool measured, there were 11.3% (6 tools) of the tools measured in this study exceeded the action value of 2.5 m/s2 but were below the permissible exposure limit of 5.0 m/s2. Based on the data obtained, all the battery driven tools had the daily vibration exposure below the action value of 2.5 m/s2.

The total vibration (ahv) and daily vibration exposure A (8) obtained from this study was not much different from other study[18]on screwdrivers, wrenches and various types of power tools. The mean total vibration (ahv) from this study was (mean=3.90, range 1.38 – 8.48 m/s2) compare to screwdrivers and wrenches mean=4.90 and range 1.4-10.4 m/s2[18]. The risk of development of HAVS cannot be relied on the vibration magnitude of the tools only but also need to consider the long periods of use of tools[18].The significant difference of mean between battery driven and air tools type were due to different of power source operation. Pneumatic powered tools were gives significantly higher acceleration magnitude as compared to battery driven tools. The source of power operation was one of the possible caused contributed towards the difference in acceleration magnitude. The battery driven tools was operated using rechargeable battery of 12 volt. From the observation at workplace, the type of tool selected was based on the torque needed to tighten the nuts and bolts. Air tool type was used in the task that required application of high torque that gave the significant difference in total vibration produced by the tools. Based on tool specification from product catalogue, the air tool used in this study can produced the torque of 260 ft.lbs compared to the battery driven produced the max torque of 103 ft.lbs only.

Table 4 –Daily Vibration Exposure A(8) according to Types of Tools

Daily Vibration Exposure A (8)	n	Mean(m/s^2)	SD	t	P
Battery Driven	31	1.02	±0.47	4.006	0.001
Air Tools	22	1.96	±1.02		
Overall daily vibration exposure A(8)	53	1.41	±0.88		
Exposure Limit (EU Directive 2002)		**n**	**(%)**		
Below AL(<2.5m/s^2)		47	88.7		
Above AL(<2.5m/s^2)		6	11.3		

Relationship between vibrotactile perception thresholds and A (8)

The result predicted that the VPT level will increased with the increase value of daily vibration exposure A(8) and the VPT value will increased more at frequency 125Hz than frequency 31.5Hz. In this study, daily vibration exposure seems to be main contributor towards the variance of VPT level. It was a significant positive relationship between daily vibration exposure A(8) and VPT value. This relationship showed that the exposure play important role in changes of VPT value as the higher daily vibration exposure may cause increase in the VPT value.

Table 4 showed that the overall daily vibration exposure A(8) in this study (1.41 m/s2) did not exceed the Action Limit (2.5 m/s2) of the European Union Directive 2002. Only 11.3% of the tool measured exceeded the Action Limit. It shows that the respondent was not exposed to high level of vibration. However, 98.2% of the respondents having positive thresholds shift of VPT when comparing with the reference value of normal person in ISO 13091-2 indicate that the respondent was affected by vibrating tools used. This result revealed that even though the daily vibration exposure of 1.41 m/s2 in this study was lower than standard, there was still some effect to the exposed area of vibration.

The study also found that HAVS is common among Swedish car mechanics in spite of short daily exposure times[3]. The workers using nut runner were exposed to intermittent vibration with mean usage time of the tools was 14 minutes per day and average vibration level of 3.5 m/s2. Results from the study showed that estimated 25% of the car mechanics have neurological symptoms with numbness and reduced sensory perception in their hands. Study also showed that the increased of VPT value among railway workers which exposed to higher acceleration magnitude tools (10-14 m/s2) compared to lumberjacks workers (2-4 m/s2)[19]. There also study done showed that there was a significantly increased of VPT among the vibration exposed workers compared to non-exposed workers[15]. The results also suggest that increase of tactile sensitivity is related to the degree of exposure.

The mean VPT of workers from Chasis section was the highest among the three sections as shown in Table 5, indicate that the respondents from this section have greater exposure. There was significantly difference in mean value of VPT at frequency 125Hz. The difference could be due to most of the tools used in this section were air tool types which were significantly has a higher magnitude than battery driven tools. Through consultation with the supervisors, air tool types were mostly used in Chasis section where 87% of the tool used was air tools type. The high usage of air tools in Chasis section was due to the need of the task to tighten bigger bolts and nuts compared to the other section.

The other two sections which are Trim and Final section used battery driven tools more than air tools. Comparing the VPT level based on the tool used also shows that air tool users have slightly higher VPT level. The results showed that workers exposed to the higher magnitude of vibrating tools have a potential of having higher VPT as some studies showed that the temporary threshold shift depend on the acceleration level. In addition, the significant difference was only at frequency 125Hz could be related to the sensitivity of the Pacinian corpuscle. According to previous studies hand arm vibration disturb the high frequencies at first [19]later spread to low frequency area which indicates disturbance in Meissner corpuscle.

In this study, there were eight respondents (57.1%) of the HAVS group that calculated using mean+2sd cut-off point were came from chasis section. The result indicates that the magnitude of the tool used has certain effect towards the VPT value. This finding was in line with the previous study[20], where ten healthy subjects were exposed towards the frequency-weighted acceleration of 5 m/s2 with a combination of different periods of exposure and rest periods. The study revealed that the exposure significantly influenced vibrotactile perception thresholds value.

Table 5 –Comparison of Mean Threshold Level of VPT between Three Sections

	Sections	Mean±SD	F	p
31.5H z	Trim	111.63 ±8.73	0.397	0.674
	Chasis	112.645 ±9.07		
	Final	110.51 ±7.93		
125Hz	Trim	113.85 ±9.74	3.634	0.030
	Chasis	119.14 ±12.42*		
	Final	112.43 ±11.15*		

**Post Hoc Test: Significance Difference.*

Limitations of the study

There were several limitations to the design of this study. The study focused on the workers in assembly line of an automobile industry. Therefore, the findings from this study can only be generalized to population with similar characteristic. The identification of HAVS and some other information were based on questionnaires without diagnosis of physician. Therefore, the accuracy of research relied on the honesty and perception of respondents in answered the questionnaires. Data from the questionnaires could be subjected to respondent's recall bias. Sometimes the respondents have a tendency to overestimate or under estimate the symptoms.

Many studies related to the effect of vibrating tools were done in other sectors such as construction[17], mining[13,14] and work of engineering[11,12]. The focus towards those sectors could be due to the high magnitude of vibrating tool used, number of tool used and also the exposure duration. Study on the effect of vibrating tool in automobile manufacturing process has been given less attention than construction and mining that limit the references.

It was difficult to determine the actual exposure accurately without interrupting the production. The workers need to do their task as usual without interruption since they work based on conveyor pace and must finish the task within index time given for every workstation. Any interruption can cause delay and need to avoid since the workplace selected running one shift only. The exposure estimated could be not represent the actual exposure as cross sectional study design only consider of the exposure at that particular time of measurement. The willingness of workplace with the same type of industry to participate in the study was not encouraging as only one company agreed to join the study. In addition with the number of respondents allowed to participate was based on the management permission and study selection criteria gave limitation to the number of respondent eligible for the study.

CONCLUSION

As a conclusion, HAVS was prevalent among vibrating hand held user in automobile industry even though it was low prevalence rate of 27%. Though this study shows a low prevalence of HAVS among the respondent, the findings of this study have been able to demonstrate the considerable effect of the vibrating tools on the tactile at fingertips.

ABBREVIATIONS

VPT-Vibrotactile Perception Threshold, HAVS-Hand Arm Vibration Syndrome

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COMPETING INTERESTS

There is no conflict of interest.

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