*Research Article*

# Workplace Hand–Arm Vibration Syndrome; A Cross-Sectional Study on El-Minia Quarries' Workers

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## Abstract
**Background:** HAVS causes changes in sensory perception which can lead to permanent numbness of fingers, muscle weakness and, in some cases, bouts of white finger. It is caused by working with vibrating tools. This study aims at detecting the magnitude of HAVS among El-Minia quarries' workers. **Methodology:** A total of ٣٣٤ male subjects working at ٩ different quarries took part in the study which included screening for HAVS manifestations by personal interviews and clinical evaluation. **Results:** Almost ٩.٦٪ of subjects had HAVS, ٥٦٪ of them had predominant vascular symptoms and ٤٤٪ had predominant neurological symptoms. Only exposure to segmental vibration and smoking were confirmed risk factors of HAVS (P<٠.٠٠١). Age, years of work, history of injury and diabetes showed no difference between cases and controls (P>٠.٠٥). **Conclusion:** HAVS prevalence was detected amongst quarries workers and clinical assessment for vascular and neurological manifestations was performed. Risk factors influencing expression of HAVS were studied.
**Keywords:** HAVS Smoking Occupational Quarries

## Introduction
Hand–arm vibration syndrome (HAVS) is vibration transmitted to the hand and arm during the operation of hand-held power tools and hand-guided equipment, or holding materials being processed by machines. Hand–arm vibration is commonly experienced by workers who regularly use tools such as jackhammers, chainsaws grinders, drills, riveters and impact wrenches[١].

Physical characteristics of exposure that appear to play a role in the development of HAVS include the type of vibration (frequency, amplitude and direction), the vibratory force and impulse type, the cumulative hours of exposure, the intermittency of exposure, the state of tool maintenance and a cold environment. Biodynamic factors such as the grip force, required to use the tool, the operator's control of the tool and the surface area of the tool handle, as well as factors such as the patient's medical history of injury, susceptibility and protective practices also play a role[٢].

With continued exposure to vibration the worker may suffer periodic attacks in which the fingers change color when exposed to a stressor, usually cold. Although the pathophysiologic features explaining HAVS are not well understood, anatomic vascular changes occur with hypertrophy of the vessel wall and endothelial cell damage. The cold induced vascular spasm is thought to be mediated by adreno-receptors in vessel walls[٣].

Pathologic changes have also been described in the digital tuft mechanoreceptors (Pacinian corpuscles) and among myelinated digital fibers[٣].

If both blood vessels and nerves are affected, the worker may notice whiteness or feel numbness in the finger by the end of the day affecting only the tips of the fingers in mild cases and propagate to knuckles in late ones[٤].

In more severe forms, attacks may occur frequently and may last up to an hour causing

considerable pain and loss of manual dexterity and reduced grip strength which refers to a combined muscular and neurological effect[٤].

Although, the clinical manifestations of HAVS have been assessed and its prevalence and complications have been detected in many studies with varying results[٥-٦], this is the first study to determine the magnitude of HAVS amongst quarries workers in Egypt. The study also aims to establish the clinical characteristics of the syndrome amongst the workers and detect any associations or determinant factors for HAVS.

**Subjects and Methods**

The study was carried on ٣٣٤ male subjects working at ٩ different quarries, locating on the Eastern side of the Nile Valley of El-Minia, ٢٦٠ km South to Cairo; an area known for its dry and hot climate.

Throughout a well-designed and simple questionnaire, all subjects were asked about their ages, career histories including years of experience in this field and number of working-hours every day. Surely, this data was not precise enough because many workers changed their career many times and some workers were not working on a regular basis.

Subjects were also asked about the tools and machines they were using during work, and then these machines were categorized to machines or tools causing segmental vibration; and machines causing generalized vibration and non vibrating machines. All subjects were also asked about their medical profiles, especially history of diabetes and or arm injuries. Habits of medical importance such as smoking were also asked for.

Then, clinical manifestations of HAVS were explained in details by the researchers to all the study subjects and the researchers asked the subjects if any of them had experienced any of these symptoms before.

Those who stated that they had manifestations, suspected to be HAVS, were referred to El-Minia University Hospital, where vascular and neurological examination was done by a team of specialists.

Subjects with confirmed manifestations of HAVS were then categorized according to Stockholm category, based on number of digits affected and number of attacks per year to detect the severity of their conditions.

**Ethical considerations:**

The study was approved by the ethical committee of the Faculty of Medicine, El-Minia University. The questionnaires included explanations about the purpose of the study with confirming confidentiality of data.

## Statistical analysis

Data were analyzed using the software, Statistical Package for Social Science, (SPSS) version ١٨. Frequency distribution with its percentage and descriptive statistics with mean and standard deviation were calculated. Chi-square, t-test, correlations were done whenever needed. P values of less than ٠.٠٥ were considered significant.

## Results

Of ٥٠٠ quarries male workers who were asked to take part in the study, a total of ٣٣٤ workers, from ٩ different quarries, accepted to participate giving us a response rate of ٦٦.٨%. The age of the participants ranged from ١٩ to ٥٧ years (٣٦.٠٩$\pm$ ٨.٩٩) with mean years of experience in the same career ٦.١٤$\pm$٣.٣٨ years.

Only ٢٩.٣٪ of the surveyed were current smokers, while ٥٣٪ stated than they have never smoked. Further, less than ٧٪ of the subjects were known to be diabetics.

When the subjects were asked if they had ever had arm complaints related to work, only ٤٥ workers ١٣.٥٪ admitted the arm complaints. Then, the ٤٥ workers were referred for further investigation at the vascular and neurological clinics of El-Minia University Hospital, where vascular refilling, coarse and fine movements of the arms were examined and staged according to Stockholm staging criteria. Of the ٤٥ subjects with arm complaints, ٣٢ workers were confirmed to have HAVS representing ٩.٥٨٪ of all participants.

A high of ٩٣.٨٪ of those who had HAVS had been exposed to segmental (focal) vibration

during work in the form of drilling, grinding, and using hammers and saws (Table ١).

Almost ٢٠٪ of workers with HAVS were current smokers, and ١٥.٦ % of them were diabetics. Further, most of the workers with HAVS stated that they had been injured before (Table ١).

All subjects with HAVS showed white fingers and numbness, however ١٨ (٥٦.٣٪) of them had predominant vascular manifestations and ١٤ (٣٣.٧٪) had predominant neurological ones. Of the ١٨ who experienced vascular symptoms, only ٥ showed slow refill time, and half of those who had predominant neurological manifestations showed persistent numbness or reduced hand grip (Table٢).

Amongst the studied risk factors of HAVS, only exposure to segmental vibration and smoking were statistically related to development of HAVS (P< ٠.٠٠١). Age, tenure, being diabetic and history of injury showed no difference regarding HAVS (Table ٣).

**Table ١: Characteristics of subjects with HAVS**

| General Characteristics | Frequency (n=٣٢) , % |
|---|---|
| **Age** | ٣٨.٩±٨.٣ |
| **Duration of work** | ٦.٨±٣.٥ |
| **Smokers** | ٢٠ (٦٢.٥) |
| **Diabetics** | ٥ (١٥.٦) |
| **History of injury** | ٣٠ (٩٣.٨) |
| **History of consultation** | ١٢ (٣٧.٥) |
| **Segmental vibration exposure** | ٣٠ (٩٣.٨) |

**Table ٢: Clinical characteristics of subjects with HAVS**

| Clinical Characteristics | | Frequency (%) |
|---|---|---|
| **Predominant Vascular n= ١٨** | **Normal Refill Time** | ١٣/١٨ (٧٢.٢) |
| | **Slow Refill Time** | ٥/١٨ (١٨.٨) |
| **Predominant Neurological n= ١٤** | **Occasional Numbness** | ٧/١٤ (٥٠.٠) |
| | **Persistent Numbness** | ٤/١٤ (٢٨.٦) |
| | **Reduced Hand Grip** | ٣/١٤ (٢١.٤) |
| **Stockholm Staging n= ٣٢** | **Stage ٢** | ٢٢/٣٢ (٦٨.٧) |
| | **Stage ٣** | ١٠/٣٢ (٣١.٣) |
| **Digits affected Mean ± SD** | | ٥.٣±١.٩ |
| **Attacks / Year Mean ± SD** | | ١٠.٣±٦.٨ |

**Table ٣: Determinants of HAVS amongst studied quarries workers**

| Risk Factors | | HAVS Subjects n =٣٢ | Controls n=٣٠٢ | P Value |
|---|---|---|---|---|
| **Age (Years)** | ≤ ٣٥ | ١٢ (٣٧.٥) | ١٤٦ (٤٨.٣) | ٠.١٦ |
| | > ٣٥ | ٢٠ (٦٢.٥) | ١٥٦ (٥١.٧) | |
| **Years of Work** | ≤ ٥ | ١٢ (٣٧.٥) | ١٥٤ (٥١.٠) | ٠.١٠ |
| | > ٥ | ٢٠ (٦٢.٥) | ١٤٨ (٤٩.٠) | |
| **Diabetes** | Yes | ٥ (١٥.٦) | ١٨ (٦.٠) | ٠.٠٦ |
| | No | ٢٧ (٨٤.٤) | ٢٨٤ (٩٤.٠) | |
| **History of Injury** | Yes | ٣٠ (٩٣.٨) | ٢٧٦ (٩١.٤) | ٠.٤٨ |
| | No | ٢ (٦.٢) | ٢٦ (٨.٦) | |
| **Smoking** | Yes | ٢٠ (٣٧.٥) | ٧٨ (٢٥.٨) | < ٠.٠٠١ |
| | No | ١٢ (٦٢.٥) | ٢٢٤ (٧٤.٢) | |
| **Segmental Vibration Exposure** | Yes | ٣٠ (٩٣.٧) | ١٦٥ (٥٤.٦) | < ٠.٠٠١ |
| | No | ٢ (٦.٣) | ١٣٧ (٤٥.٤) | |

## Discussion

Almost ٩.٦٪ of the studied subjects were diagnosed with HAVS. This prevalence coincided with two previous studies[٥&٧]. However, it is worth pointing out that both studies examined subjects working in tropical and subtropical areas.

A systematic review suggested that the dose-response relationship for propagation of HAVS differ according to weather differences which explain the relatively low prevalence of HAVS among our subjects[٨].

However being low, the magnitude of HAVS should not be overcome as Mason and colleagues (٢٠٠٥) strengthened in their study on the importance of preventing HAVS exacerbation, especially the neurological component to alleviate the upper extremity disability outcome[٩].

As noticed in most previous studies, numbers of subjects with predominant vascular manifestations were more than those with neurological ones[٥&٧].

Our study also confirmed some emerging results from previous studies concluding a significant relationship between regular exposure to segmental vibration and expression of HAVS[٢&٥-٧]. To date, adreno-receptors hyper-sensitivity and demyelination of digital fibers resulting from regular exposure to segmental vibration are the most accepted theories explaining HAVS[٢].

Although history of arm injury was previously proved to be a risk factor for HAVS[٢], we noticed that history of arm injury showed no difference between subjects with HAVS and their controls. A recently published study concluded that cold sensitivity on daily life did not change with arm injury but did change with HAVS[١٠]. Meanwhile, we can make an assumption that the arm injury does not always lead to HAVS and does not even share HAVS the same consequences.

Again, unlike many previous studies[٢&٥&٧], both age and years of experience did not show a statistically significant difference between patients and their controls. But, this can be explained by the fact that many workers could not remember how long had they been working in this career. In addition, many participants changed their jobs many times and some of them left the work for a while and resumed the work after a while. We could not also find records for workers showing their tenure, days of work and working-hours.

Our study also showed that smoking was a significant risk factor for developing of HAVS (P < ٠.٠٠١). A previous study suggested that regular smoking sensitizes the peripheral

vasculature to the vasoconstricting effects of the next cigarette, and that at least part of this sensitization is mediated by the inhibition of endothelial prostacyclin synthesis[١١].

History of diabetes was recorded amongst ١٥.٦٪ of subjects with HAVS compared to only ٦.٠٪ of their controls; however this difference was not statistically different (P > ٠.٠٥). This finding was similar to a previous cross-sectional study on more than ١٥٠٠ men and women which concluded that diabetes did not influence expression of HAVS[١٢].

Further studies on the risk factors of HAVS are needed in order to better understand the impact of many determinants such as seasonal variation on the expression of HAVS. The relation between quitting of smoking and an expected improvement of HAVS manifestations should also be a future topic for research. Moreover, the vascular biology of HAVS and the effectiveness of some interventional dietary programs, namely vitamin D and omega fatty acids can be an aspect for future researches.

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