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THE PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDER AMONG OCCUPATIONAL TAXICABS DRIVERS IN NIGERIA

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ABSTRACT
This work investigates the opinion of operators of Taxicabs in Nigerian on some ergonomic factors influencing their safety, comfort and performance while driving. Participatory ergonomic intervention approach (PEIA) and workspace analysis were used in the evaluation of ergonomic suitability of driver-vehicle system. 1406 drivers were sampled randomly in the study area and a minimum responds rate of 92% was achieved. Significant prevalence of WRMD reported among respondents on the four body segments are located at the neck(67%), right and left wrists(18%, 20%), upper, middle and lower back (29%, 29%, 30%), and buttock (19%) of the operators. The potentials of carrying out ergonomic investigation on taxicab operators through direct involvement of major stakeholders in the transportation business has been demonstrated and found very useful in the development of user friendly vehicle for Taxicab operator in Nigeria.

Keywords: *Ergonomic Assessment; PEI, WRMD, Taxicab Operator, Extremity Link System, Workplace.*

1. INTRODUCTION

Design specifications of machinery, and other facilities need to take into account the safety, comfort and effective performance of would be operators. Specifically, the design of workplace of drivers of taxicabs needs as input for consideration, the human-body dimensions as well as other physical and psychological limitations of driver. Such data can only be obtained by involving the operator of the technological system. Recent years have seen increasing advocacy for "participatory ergonomics" [1]. Participatory ergonomics is defined as practical ergonomics with participation of the necessary factors in problem solving [2]. Many researchers have proved the positive outcomes of ergonomic interventions involving participatory processes [3]. The question 'why participation' is readily answered, while the question 'how are effective participatory programs achieved"' is further from being understood [4]. Studies have led to the following suggested elements as essentials for the success of a workplace participatory ergonomics process: 1) sufficient time and resources (time, people, finances), 2) a collaborative start-up stressing volunteers and attempts and generate motivation, 3) a non-directive approach but which addresses formalized purposes/goals, allows compromises, and promotes creativity and learning, 4) facilitators who are viewed as knowledgeable and non-biased, and 5) implementation of 'testable' solutions which are rolled out throughout the organization to promote the participatory processes as a means of everyday business practice [5].

1.1 Driving and Work Related Musculoskeletal Disorder

A driver-motor vehicle system is a complex system that involves the interaction of human, technological systems and their environment. Poor design of driver's workplace has been identified as a major risk factor responsible for the uncomfortable conditions which operators of motor vehicles are exposed to while driving especially for a long period [6][7][8][9]. Workspace of a driver includes areas covered by the locations of the various control and display points which should be arranged in such a way as to accommodate the required controls within his reach and to allow a compromise among competing priorities while seated in a fixed position. The design of automobile seat can affect the posture of drivers and posture in turn also can influence both comfort and physical conditions of a driver [10][11][12]. Work-related musculoskeletal disorders (WRMD) and other postural damage may result in physiological illness that may develop over a long period due to prolonged mechanical stresses imposed on the musculoskeletal system [13]. WRMDs are prevalent in occupational driving especially among Taxi drivers operating in Nigeria [14][15][16]. This is evident by the observed number of hawkers of herbal medications as well as Western medicine patronized by the drivers at their various garages. Poor design of driver's workplace and poor sitting posture are parts of what are responsible for stresses and strains imposed by the uncontrollable conditions of the elements of workplace on drivers. Consequently, there is a need to integrate both the driver's (operator/user) capabilities and vehicular performance requirements adequately in other to reduce or eliminate the untold occupational hazards to which drivers are frequently subjected. Driving includes several conditions, most notably

long term confined postures and whole-body vibrations. Other explanations for the association of driving with back pain problem include effects of constrained work postures and vibration-induced muscle fatigue on muscles and tendons [4][15].

1.2 Legislative Support and Anthropometric Database Development

Nigeria is recognized as a major importer of vehicles most of which have been found to be a potential contributor to ergonomic risks experienced by taxi operators. These risks can be associated with design error which results from the use of anthropometric dimensions of population whose body measurements differs that of Nigerians. Though there are legislative control on the types and condition of imported vehicles, the problem of lack of effective enforcement of the control is still in place. Also where there is no anthropometric database to assist automobile manufacturers in the design of user friendly vehicles, people are forced to be fitted into the unfit technological system that is available in the market. Usual cases of body pains and other musculoskeletal disorders will be minimized if statutory government agencies in charge of consumers' protection [17], like Federal Road Safety Commission (FRSC) and International Standard Organization (ISO) could ensure that required data are collected and used by both local and foreign automobile industries.

In this work effort is made to evaluate some in-vehicle elements in taxicabs used in Nigeria employing participatory approach in which the judgments of statistically significant number of drivers of the vehicle are harvested and analyzed.

2. MATERIALS AND METHODS

Four urban centres which represent adequately the distributive spread of Southwestern Nigerian were selected and a sample size of 1406 derived from ISO15535 was used for the survey [18].

Six models of vehicles were considered in this work. These are Nissan, Mazda, Toyota, Mitsubishi, Peugeot and Opel (these are common models in use as taxicabs in Nigeria). Noticeably, driver's workspace elements which consist of dashboard, controls, seat, gear lever, steering wheel, clutch, brake and acceleration pedals, side door, side mirror and seat belt were studied in relation to their ergonomic suitability.

The participatory ergonomic intervention (PEI) approach used includes structured questionnaire, interview, operators and ergonomic expert opinion poll and physical assessment of relevant elements of driver-taxicab system. [13][19].

2.1 Personal Data

Personal information about respondent like name, sex, nationality, state of origin, town, city, age, and educational background were requested. Also included in this section were information about driving license, years of experience in public vehicle driving, hour per day on wheel, model of vehicle used and number of passenger capacity of the vehicle used.

2.2 Musculoskeletal Problems

This section is designed to investigate the time dependency of impact of stress on twenty-one selected body areas. Investigations were made on the work related musculoskeletal problem (i.e. pain, discomfort, numbness, or tingling) experienced by respondents (drivers) in the last twelve months, and last seven days. The effect of each problem experienced on normal activities like job, housework, and sport was also sought for. To reduce the burden of attending to the long sets of questions involved, the questionnaire is designed to allow respondent to indicate a yes or no answer to each question.

2.3 Evaluation of Some Selected In-Vehicle Components

Six components of driver's environment were considered for personal opinion and assessment of operators of different models of taxi cabs. The components evaluated were: wind screen, pointer, wiper, dash board, side mirror, and seat belt. Criteria employed as appropriate for evaluation include functionality, ease of use, effectiveness, positioning, availability and mode of operation. Drivers were also asked to make general remark at the end of the major assessment. In anticipation of a low level of education of public vehicle driver and in order to make simple the filling of the form, the questions were designed for yes or no response.

3. RESULTS AND DISCURSION

The result of the driver's characteristics explains the fact that occupational driving using taxicab is a major means of livelihood in the study area considered. However language barrier could constrain intending adult who wish to make his living from taxicab operation. Respondents' age was found to be normally distributed with average age of 35years. 67% were legally licensed to operate taxicab among which 17% having their license expired. This explains

partly the reason behind unsafe conditions causing accidents. One quarter of the respondents have more than 15year of experience in taxicab driving with about two-third having low level of education.

Nigeria being a major importer of automobile is evidenced by the large variety (model) of Taxicab found on her roads. About 33 models of 11 makes of Taxicabs were found operating in the urban centres studied. Most of the cabs come into the country as used vehicles (also referred to as *Tokunbo*). Also noticed is that the cabs were manufactured in different countries ranging from developed countries such as United State of America (USA), Germany, Japan, France, Europe and other developing countries like India, China, South Africa and Taiwan.

Percentage difference in the makes of the Taxicabs show that Toyota(28.1%) > Opel(15.8%) > Nissan(13%) > Mitsubishi(11.7%) > Mazda(9.4%) > Volkswagen(8.9%) > Peugeot(8.3) > Tassel(2.1%) > Audi(1.7%) > Honda(0.8%) > Benz(0.2%). Each of this makes has models. Toyota has the highest percentage (21%) of models followed by Nissan(15%), Mitsubishi(15%), Opel(10%), Volkswagen(10%), and Peugeot(10%) Mazda(10%). Others are Benz(6%), Honda(3%), Tassel(3%) and Audi(3%). Physical observation and measurement of the in-vehicle characteristics of each model show significant deference in design and esthetics. Investigation reveals that the choice of the type of cab used by driver was based on factor such as Axle type, fuel economy, maintainability, availability, reparability, salvage value and price. Forty two percent (42%) of the sampled respondents reported that they always or often spends/works more than 8hour/day which is the regulated working hour limit (Table 1).

The demographic characteristics of the operators was observed to be normally distributed around 30-35 age group. However, the average age of the drivers falls between the ages of 36-39 years. It is important to note that operation of taxicab and public transportation in particular is largely the job for the adults. Less than one percent of the respondents are 60 years and above. This explains that old age and the associated musculoskeletal troubles impede safe and comfortable operation of taxicabs. None of the drivers belong to teenage age (13-19) in all the centres. This is in agreement with the Federal Government regulation on the requirements for obtaining driver's license. Less than six percent of respondents are 50 years of age and above. Likewise less than five percent of the respondents are more than twenty-five years of age.

With such long hours of seated operation it could be argue that the most important component of the Taxicab operator's working environment is the cab seat. This also indicates that the driver is exposed to high level of risk which could result in musculoskeletal problems, poor performance, injury and/or accident. In spite of the large variations in the model of vehicles used as taxis, the passenger capacity does not vary significantly. Up to four fifth (81%) of the cabs are four passenger type with three passengers seated at the back and one in front adjacent to the driver.

A little above one third (36%) of the respondents carry two more passengers than the design capacity (4 for saloon cabs and 5-6 for wagon cabs). Problem of overloading is frequently noticed during the survey especially in the centres where the law enforcement agents who are to ensure compliance with the transportation rules are weak, ineffective and corrupt.

3.1 Work Related Problems on the Head and Neck Area.

The survey of the respondents' opinion about their experience on work related musculoskeletal problems over a period of time (last 12months and 7days) as presented in Table 2 shows that not less than two third (64%, 79%) indicate that they had musculoskeletal problems at both times on their neck though that did not prevent about two third (64%) of them from carrying out their normal activity. In the case of the effect of the same problem on the eye lesser percentage of respondents (36%, 21%) experience discomfort in the last 12months and during the last 7days respectively. However higher percentage (>36%) signified that they were prevented by the problem from carrying out normal job. This suggests that work related problem on the eye may not be as frequent as it occurs at the neck. Its effect could be more traumatic and disturbing.

3.2 Work Related Problems at the Upper Extremity Link-System

This extremity link-system consists of twelve body parts and the respondent perceived pains in relation to Work Related Musculoskeletal Problems is presented in Table 3. Only at the left and right wrists that significant WRMD are mostly felt. Not less than 19% agreed that they experienced the problem in the last 12months. Comparatively higher percentage of the drivers surveyed had similar trouble at the two mentioned points during the last 7days with only 18% and 20% having a prior WRMD respectively agreed that they were prevented from carrying out normal activity as a result of the problem. Although slightly smaller percentage (8.2%) of the respondents indicated having the problem in the 12months. Slightly higher percent respondent agreed that they experienced it during last 7days and about 10% of respondent who identified with the problem were actually prevented from doing their normal job. The percentage of respondents who denied having experienced WRMD (on other body parts different from the wrists in the last 12months and last 7days) range from 4.14-8.4% and 2.83-10.38% respectively. Least WRMD was experienced at the left elbow. The level of involvement of elements of this extreme link system in the operation of

taxicabs is comparatively higher hence the effect of stress on any of these could produce adverse effect on performance of the driver.

3.3 Work Related Problems at the Thoracic Extremity Link-System

Table 4 shows that at the thoracic extremity link-system, low back pain (LBP) is recognized as the most prominent (affecting not less than one-third of the respondents) musculoskeletal problem experienced by the respondents. This same problem also proved to have highest potential of preventing drivers from normal activity when they occur. Stomach pain is rarely experienced by respondents and where it occur lesser percentage (6.63%) are prevented from carrying out their normal activity. Similarly, adverse effect of WRMP at the chest is very low (5%). The upper and middle back problems are ranked nearly the same by the respondents. Both problems also can have adverse effect on the performance of respondents who experience them. This link system is considered as only one segment as shown in Table 5. This study has further supported the widely reported view that low back problems (LBP) is a predominant trauma experienced by operators of equipment and machineries while in sitting posture [20][3][21][22][23].

Table 1 Number of hour driver spent in driving task

Working Hours	Respondents									
	Ibadan		Ogbomoso		Oyo		Iseyin		Total Base	
	N	%	N	%	N	%	N	%	N	%
1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	0	0.00	1	0.54	0	0.00	1	0.59	2	0.25
3	2	0.83	1	0.54	1	0.47	3	1.78	7	0.86
4	2	0.83	5	2.70	2	0.93	10	5.92	19	2.34
5	6	2.48	16	8.65	5	2.33	23	13.61	50	6.17
6	16	6.61	22	11.89	8	3.72	21	12.43	67	8.26
7	26	10.74	17	9.19	27	12.56	11	6.51	81	9.99
8	55	22.73	52	28.11	89	41.40	45	26.63	241	29.72
Above 8	135	55.79	71	38.38	83	38.60	55	32.54	344	42.42
Total	242	100.00	185	100.00	215	100.00	169	100.00	811	100.00

% = Percent Responded, N = Number of Responses

Table 2 Responses by percentage of operator's opinion on work related musculoskeletal problem over a period of time at the head and neck body area

Head/Neck	Adverse Effect of Work related trouble in the last 12 months (%)	Operator have had Work related trouble during the last 7 days (%)	Operator was prevented from carrying out normal activity due to the problem (%)
Eye	36.00	21.43	41.67
Neck	64.00	78.57	58.33

% = Percent Responded,

Table 3 Responses by percentage of operator's opinion on work related musculoskeletal problem over a period of time at the upper extremity link-system.

Upper Extremity Link-System	Adverse Effect of Work related trouble in the last 12 months (%)	Operator have had Work related trouble during the last 7 days (%)	Operator was prevented from carrying out normal activity due to the problem (%)
Shoulder Right	8.26	8.88	10.38
Shoulder Left	7.48	6.51	7.55
Upper Arm Right	6.97	8.88	7.55
Upper Arm Left	6.06	4.14	4.72
Elbow Right	3.87	4.14	6.60
Elbow Left	3.87	4.14	2.83
Fore Arm Right	5.68	7.69	4.72
Fore Arm Left	4.90	8.28	4.72
Hand Right	7.87	6.51	7.55
Hand Left	6.45	6.51	5.66
Wrist Right	19.23	15.98	17.92
Wrist Left	19.35	18.34	19.81

% = Percent Responded,

Table 4 Responses by percentage of operator's opinion on work related musculoskeletal problem over a period of time at the thoracic extremity link-system

Thoracic Extremity Link-System	Adverse Effect of Work related trouble in the last 12 months (%)	Operator have had Work related trouble during the last 7 days (%)	Operator was prevented from carrying out normal activity due to the problem (%)
Chest	12.86	5.34	5.52
Upper Back	24.97	29.54	28.73
Middle Back	28.18	29.89	28.73
Lower Back	30.66	31.67	30.39
Stomach	3.34	3.56	6.63

% = Percent Responded,

Table 5 Body segment markers and link model

System	Segment	Marker Link
A	Upper Arm	Shoulder Marker (S) and Elbow marker (E)
	Fore Arm	Elbow marker (E) and Wrist marker (W)
	Hand	Wrist marker (W) and end of the hand marker (H)
B	Thoracolumber Spine	Thoracic marker (T) and Lumber marker (L)
C	Thigh	The hip marker (P) and knee marker (K)
	Fore leg	Knee marker (K) and ankle marker (A)
	Foot	Ankle marker (A) and ball of the foot marker (F)

Table 6 Responses by percentage of operator's opinion on work related musculoskeletal problem over a period of time at the lower extremity link-system

Lower Extremity Link-System	Adverse Effect of Work related trouble in the last 12 months (%)	Operator have had Work related trouble during the last 7 days (%)	Operator was prevented from carrying out normal activity due to the problem (%)	
Buttock	27.06	35.99		18.57
Hip/Thigh	16.04	12.11		10.48
Knee Right	5.13	7.27		7.62
Knee Left	6.52	5.19		11.43
Ankle Right	6.95	8.65		11.90
Ankle Left	7.38	8.30		7.62
Feet Right	16.90	13.49		19.52
Feet Left	14.01	9.00		12.86

% = Percent Responded,

3.4 Work Related Problems at the Lower Extremity Link-System

The lower extremity link-system which consists of four main joints form a mechanical structure fitted together to carry important tasks. Among the group of body parts under this link-system buttock is considered as the body part on which WRMP is mostly felt. As shown in Table 6 buttock pain is observed to cumulate with time the driver remain seated the consequence of this adversely affect taxicab operator's performance and also prevents normal operator's activity. It was also observed that respondents experience WRMP on the right and left knees as well right and left ankle rank low with percentage of those who had the problem in the last 12month ranging between 5% and 7% while the percentage of those with the problem during the last 7days range between 5% and 8%. Less than twelve percent (12%) are prevented from carrying out normal activity. It is important to observe that on the average the opinion of effect of WRMP on these four parts are almost the same for yes or no response. Percentage of respondents who experience the problem on Right feet in the last 12months and 7days (17% and 14% respectively) are more than those feed the problem on the left feet (14% and 9% respectively). Higher percentage of the respondents(19%) indicated that WRMP on right feet prevent them from normal activity while fewer percentage(13%) maintained that such problem on the left do not prevent their normal activity. Also this suggests that the supports provided for the thigh and left foot are slightly adequate and can be improved upon. Work related musculoskeletal injuries experienced by the respondents are influenced by the design of his workplace. A number of important tasks such as the control of clutch, brake and throttle pedals using both left and right feet.

4. CONCLUSION

This work has demonstrated the potentials of carrying out ergonomic investigation on taxicab operators through direct involvement of major stakeholders in the transportation business. Much of the musculoskeletal trauma have been considered and tackled base on data collected through the participatory process. The result demonstrates general experience of low back and upper back pain, and other explainable musculoskeletal stress occurs at wrist pain, buttock right feet and neck of driver. The level of discomfort is more pronounced among long distance business drivers. However it is clear that direct involvement of taxicab operators in the design considerations and modification of in-vehicle component may enhance ergonomic advantages. Based on the outcome of this study it important to stress that information on the user friendliness and other ergonomic matters be regularly harvested from all stakeholders through newsletters, bulletin boards, meetings and internet based survey. Occupational hazard suggested by this investigation has been traced significantly to the misfit between local driver body requirements and the imported technological system characteristics. A number of legislative instruments are necessary to control frivolous importation of vehicles that do not meet ergonomic standard. Also government should establish an ergonomic department in the ministry of Productivity/Works whose responsibility is to develop reliable database for different categories of user population in the Country. Such data which should be reviewed and updated at specified periods will serve as useful information to manufacturer of any product for use by Nigeria population. It is also worthwhile to note that PIE approach has effectively combined the strengths of both subjective and objective methods in addressing ergonomic problem.

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