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Assessment of occupational hazards contributing to work-related musculoskeletal disorder of Filipino pedicab drivers

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Abstract

Pedicab is a composite of bicycle and side car. Pedicab has a high potential of being used as a sustainable transportation to improve air quality and congestion management in the city. Hence, improving the conditions of pedicab is vital. While there had been ergonomic improvements on the passenger sidecar, there had been none for the driver. Pedicab drivers usually come from below poverty-line families. The physical, physiological and psychological exertions of pedicab drivers pose as occupational hazards that develop certain risk of musculoskeletal disorders. Hence, the focus of the study was to assess occupational hazards causing work-related musculoskeletal disorder for pedicab drivers. The study was based on the results of a survey based on the standardized Nordic Musculoskeletal Questionnaire (NMQ). Thirty-five side car drivers were interviewed. All respondents were male around 40 years old; all work every day for 11.5 hours a day for around 9 years. Majority of the respondents (62.9%) claimed that given the opportunity, they would work other jobs. While the working area of the side car drivers were established as flood-prone, uneven, and uphill; around 54.3% of the respondents stated that their working condition was tolerable but the rest admitted they hated it. It was found out that 45.7% of the respondents were already experiencing back pain. There had been several occurrences of head ache (8.57%), neck pain (14.3%), leg cramps (8.57%), elbow/forearm (2.86%), thigh (2.86%) and legs numbness (2.86%). The data indicated that the posture poses a very high risk and change must be implemented immediately.

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1. Introduction

Pedicab, also known as sidecar, tripes or padyak is a composite of a bicycle and a side car and had a capacity of two or three persons. The side car weighs about 20kg to 50kg. Pedicabs are used for public transport for convenient traveling inside villages.

Pedicab, a form of non-motorized transportation, has a high potential of being used as a sustainable transportation to improve air quality standards and congestion management in the city [1]. Hence, pedicab is an integral part of the transportation system in the Philippines, especially in the metro. Promoting proper conditions for the transportation system, including the drivers is thus necessary.

In cycling, the neck, shoulders, back (especially the lower), hips, buttocks and groin area, as well as the arms, hands, legs and feet are already at risk due to repetitive motion, muscle exertion, and soft tissue compression [2]. The risks can be magnified when pulling up to three passengers at once during extreme weather conditions and at extended period of time.

Furthermore, the World Health Organization revealed that disorders of the musculoskeletal system represent a main cause for absence from occupational work. Aside from the loss of income during absence and individual cost of medication, musculoskeletal disorders also lead to considerable costs for the public health system [3].

In the genesis of WMSD, three sets of risk factors can be considered [4]: (1) physical (e.g. sustained or awkward postures, hand-arm vibration), (2) psychosocial (e.g. work pace, work/rest cycle, social support, job uncertainty), (3) individual (e.g. age, gender, alcohol/tobacco consumption, previous WMSD). The physical, physiological and psychological exertions of pedicab drivers pose as occupational hazards that develop certain risk of musculoskeletal disorders.

There had been a few anthropometric and other ergonomic interventions in the design of pedicabs which focused on the passenger side. Also, redesign of independent bicycle was attempted in other countries. However, there had been no ergonomic bicycle redesigns in the Philippines meant for the Filipinos.

One method of prevention is the ergonomic improvement of their postures by altering or regulating the conditions they are in today. The focus of the study then was to identify the degree of work-related musculoskeletal disorder for Philippine pedicab drivers through ergonomic applications and make respective recommendations for their working conditions afterwards.

The primary significance of the study was to improve the working conditions of the pedicab drivers. While physical environment conditions like the weather and road discomforts were unavoidable; proper posture and the design for such posture can be induced.

2. Methodology

Thirty-five (35) randomly selected pedicab drivers were interviewed face-to-face in the CAMANAVA area (Caloocan, Malabon, Navotas and Valenzuela) to ensure reliable and high response rate.

2.1. Sampling procedure

The sample size necessary was obtained through the formula:

\[ n = \left( \frac{z_{a/2} \sigma}{E} \right)^2 \]  

where \( z_{a/2} \) is known as the critical value, \( \sigma \) is the population standard deviation, \( n \) is the sample size, and \( E \) is the maximum deviation from the sample size.

The recommended sample size thirty-five (35) with a level of confidence was 95%, \( z=1.96 \). The intended maximum difference between the observed sample mean was 1, and the population standard deviation was let as 3.
2.2. Survey

The study’s objectives were accordingly disclosed to the participants. The interview was conducted in the vernacular language, and the questions were based on the set of risk factors on WMSD, which are physical, psychosocial, and individual factors.

2.3. Data summary and analysis

The answers of the participants were accordingly summarized and processed. Since smoking was identified as a risk factor for WMSD, specifically lower back pain, the correlation of smoking and having a WMSD was identified.

Posture and movement analysis such as Rapid Entire Body Assessment (REBA) was performed to identify the degree of risk the current drivers have if they continue the postures and conditions they work with.

3. Results and discussion

All thirty-five (35) pedicab driver respondents were male. Their average age is 40 years old.

From the survey, it was gathered that the average number of years they work as a sidecar driver is nine (9) years. All of the respondents work seven (7) days a week. The average time spent on their work is 11.5 hours. Every one of the respondents start their shift in the morning, though with varying starting time. The average number of trips that the side car drivers make a day is thirty-five (35). It was established that a trip back and forth their terminal averages ten (10) minutes.

Majority of the respondents, 68.6% of the total, think that they have an interesting job. Only 37.1% admitted that their current job gives them personal satisfaction. Most of them wanted a different high-paying and easier job if given a chance. Those who said that they had a good relationship with their co-workers comprised 71.4% of the respondents.

Working in the flood-prone CAMANAVA area, the roads were often uneven in elevation. Pedaling uphill is usual. Some roads were rocky as well. The current changing weather, especially the harsh temperatures, was included in the work environment.

More than half (54.3%) of the respondents did not hate their working conditions and considered it as tolerable. The other 45.7% hated their current working conditions.

The average day offs induced by sickness, mostly muscle pains, and was 10 days a year. None of the respondents said that they had other health conditions that were made worse by their work. However, none of them consulted a doctor recently, and it was possible that the respondents had some sickness undiagnosed. Only nine (9) had a recent accident.

| Body part     | pain | cramps | numbness |
|---------------|------|--------|----------|
| Head          | 3    | 0      | 0        |
| Neck          | 5    | 0      | 0        |
| Shoulder      | 0    | 0      | 0        |
| elbow/forearm | 0    | 0      | 1        |
| hand/wrist    | 0    | 0      | 0        |
| Finger        | 0    | 0      | 0        |
| upper back    | 0    | 0      | 0        |
| Lowerback     | 16   | 0      | 0        |
| Hip           | 16   | 0      | 0        |
| Thighs        | 3    | 0      | 1        |
| Legs          | 0    | 3      | 1        |
| Feet          | 3    | 0      | 0        |
| Knees         | 1    | 0      | 0        |
There had been occurrences for headache (8.57%), neck pain (14.3%), lower back (45.7%) and hip (45.7%) pain, feet pain (8.57%) and knee pain (2.86%). Occurrence of leg cramps happened to 8.57% of the respondents. There had been a 2.86% occurrence each for elbow/forearm, thigh and legs numbness.

The occurrences of muscle pains can be supported by a (Rapid Entire Body Assessment) REBA score of 13. According to the scoring of REBA, a score of 11 and above states that the posture poses a very high risk and change must be implemented.

From the data gathered, it can be observed that the 45.7% of the respondents smoke and experience back pain. Lower back pain can be associated with different kinds of activities. According to a previous study, lower back pain has a correlation to smoking.

A chi-squared test of independence was used to see whether lower back pain manifested by pedicab drivers is really dependent on smoking. And it showed that smoking and lower back pain are independent, based on the data from the sample.

Furthermore, only one side car driver exercise (stamina, stretching). However, 34.3% play the sports basketball. Additionally, one of the thirty-five respondents lifts weights.

Anthropometric data of Filipino workers were incorporated with the design of the bicycle part of the pedicab. Anthropometric measurements were used in order to design a bicycle for the average male population in the Philippines. While the average age in the study was 22.8 years, and the average age of side car drivers is 40 years old, the subjects for anthropometric measurement at least involved 21.41% of men in the age 31-50 years old.

Table 2. Anthropometric measurements of average Filipino.

| Body part                | Anthropometric measurement (m) |
|--------------------------|-------------------------------|
| Shoulder-elbow           | 33.05 (b)                     |
| Forearm-hand             | 44.06                         |
| Hand length              | 19.75                         |
| Shoulder height-sitting  | 49.79                         |
| Popliteal height         | 43.33 (d)                     |
| Buttock-popliteal length | 46.40 I                       |

Fig. 1. Recommended bike design for Filipino pedicab drivers.
According to a published study on ergonomic design of a bike, a rider with a height of 1.60 m to 1.68 m has the optimum distance of 0.43 m between the seat and the handle. The difference in height of the handle and the seat was found to be optimum at 1 to 4 inches. Also, the following angles were said to be followed in order to have the proper cycling posture: between shoulder-elbow and forearm 150 degrees, between upper and lower legs 150 degrees and trunk should bend at 10 to 15 degrees.

Using the Cosine and sine law, the height of the seat to the lowest pedal position was computed as 0.60 m. The handle distance must be the same as the shoulder width of the rider which is 0.45 m for the average male.

Angle A on the framework of the bicycle corresponds to the Head Tube Angle, a steeper head angle results to faster steering since less effort is required to steer while a slacker head angle results to slower steering. Angle B corresponds to the Seat Tube angle. Distance C refers to the Fork Rake. Fork rake is the offset of the fork dropout center from the tube. Increasing the fork rake makes steering faster. The Chain stay length provides the bike stability. A longer chain stay increases the wheelbase.

4. Conclusion

In conclusion, pedicab drivers have a high risk of developing work-related musculoskeletal disorders. It was found out that 45.7% of the respondents were already experiencing back pain. There had been several occurrences of headache (8.57%), neck pain (14.3%), leg cramps (8.57%), elbow/forearm (2.86%), thigh (2.86%) and leg numbness (2.86%). Also, posture must be changed accordingly, and a design was proposed by the proponents (see figure 1). Also, occurrences of lower back and hip pain were especially prevalent.

Furthermore, the most respondents were not satisfied in their work, and this might affect their performance. Also, the pedicab drivers do not consult with medical doctors regularly, hence their state of health was not known exactly. Many of them tolerate the working environments for the sake of earning money, and it is possible that they have the same outlook towards help.

5. Recommendations

The proponents recommend that more respondents in other places should be included in the study. Also, for further research, the biomechanics of pedaling, especially with about three persons on board the pedicab, should be identified. The anthropometric data for the Filipino men at around age 40 must be identified and considered as the average age of the obtained sample had such average age.
Appendix A. Rapid Entire Body Assessment Score Sheet

## REBA Employee Assessment Worksheet

### A. Neck, Trunk and Leg Analysis

- **Step 1:** Locate Neck Position
  - Score: [Add up to 11, subtract 1]

- **Step 2:** Locate Trunk Position
  - Score: [Add up to 11, subtract 1]

- **Step 3:** Locate Leg
  - Score: [Add up to 11, subtract 1]

### B. Arm and Wrist Analysis

- **Step 7:** Locate Upper Arm Position
  - Score: [Add up to 11, subtract 1]

- **Step 8:** Locate Lower Arm Position
  - Score: [Add up to 11, subtract 1]

- **Step 9:** Locate Wrist Position
  - Score: [Add up to 11, subtract 1]

- **Table A:** Neck
  - Score: [1, 2, 3]

- **Table B:** Trunk
  - Score: [1, 2, 3]

- **Table C:** Leg
  - Score: [1, 2, 3]

- **Table D:** Upper Arm
  - Score: [1, 2, 3]

- **Table E:** Lower Arm
  - Score: [1, 2, 3]

- **Table F:** Wrist
  - Score: [1, 2, 3]

### Scoring Rules
- Score 1: Minimum risk, unlikely for musculoskeletal problems.
- Score 2: Possible risk, further investigation needed.
- Score 3: Maximum risk, immediate attention needed.

### Activity Score
- Score 1: All areas of the body are held for less than 1 minute.
- Score 2: 1 to 5 minutes.
- Score 3: More than 5 minutes.

### Total REBA Score
- Calculated by adding the scores from all categories.

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