Working Postures Analysis for Cashiers in A Highway Toll Station

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Abstract: The movements of collecting cash and tickets for cashiers in highway toll stations are highly repetitive. This research investigated the working postures of the cashiers using OWAS method in Young-May Toll Station in Taiwan. Action Category 3 (AC3) postures were found in the head/neck postures for cashiers in small car lane. The same level of working pastures were also discovered in head/heck and arm postures for cashiers in Truck/Bus lane. The postures of other body segment/lane combinations could all be categorized as either AC1 or AC2. These results were consistent with the information obtained from interviews with the cashiers. The presence of AC3 working postures implied the need of improvement of working space and/or job design. The redesign of both the vertical and horizontal distance between the toll station and the lane to reduce the unnatural working postures were recommended.

Keywords: posture analysis, OWAS, highway toll station, cashier

1 Introduction

Work-related musculoskeletal disorders (MSDs) are common among workers in workplaces. Identification of the risk factors associated with MSD is essential so that ergonomic intervention may be applied. Analysis of working postures has been one of the major approaches to identify the MSD risks. Examples of working posture analysis were common in workplaces such as construction sites, farms, hospitals, garages, and so on. But working posture analysis for highway toll station cashiers, if any, was rare. This article describes our experience of analyzing the working postures of the cashiers in a highway toll station in northern Taiwan.

The OWAS method was based on the concept of work-sampling [1], which provided the frequency of each posture and time spent in it. The basic OWAS coded the postures of the back, arms, and legs. This three-code OWAS has been used in studying the working postures of steel workers and stock workers [1]. In addition to the three body segments mentioned, head/neck and load/effort were added later which extended the posture code to four or five digits. Four digits OWAS code (including load/effort) has been used in analyzing the postures of construction workers [3-5], farmers [6] and nursing personnel [7]. Five digits OWAS were used in investigating the postures of garage workers [7] and nursing personnel [8]. The working postures were classified as AC1, AC2, AC3, or AC4, according to the harmfulness of the postures. AC1 indicated normal postures. AC2, AC3, and AC4 noted slightly harmful, distinctly harmful, and extremely harmful postures, respectively.

The national highways in Taiwan are toll highway. Drivers passing each toll station need to pay tolls according to their vehicle type. For each toll station, lanes are divided into car (including sedan, van, and pickup) lane, bus/truck lane, and heavy truck/tractor/trailer lane. The cashier stands in the toll booth, on the island by each lane, to collect the toll. The current fair is NT40, NT50, and NT65 for cars, buses/trucks and heavy trucks/tractors/trailers, respective. Cash and pre-purchased ticket are acceptable ways of payment. Drivers of the bus/truck and heavy truck/tractor/trailer may choose to pay either cash or ticket at their toll booths. The car lanes are divided into cash lane and ticket lane. The cash lane accepts either cash or ticket. The ticket lane accepts ticket only. The toll station operates 24 hours daily. All the cashiers work under a three shifts backward rotation system. The three shifts are day shift (08:00~16:00), evening shift (16:00~24:00), and night shift (00:00~08:00). The three shifts rotated every six months. During the same shift, the cashiers also rotated between the lanes. This rotation occurs on daily basis.

There are ten toll stations along Highway No.1 from north to south. The Young-May toll station is the third one. There are 12 lanes, including two heavy truck/tractor/trailer lanes, four bus/truck lanes, and six car lines on the north and south bound, in this station. Two of the car lanes are cash lanes, two are ticket lane and the other two are E-ticket lanes. According to the official statistics of this station [10], the highest daily traffic flow was in one of the car-ticket line. In this lane, cashiers collected 9,438 tickets per day on average. The lowest daily traffic flow was the heavy truck/trailer lane (the 12th lane). Cashiers in this lane collected ticket or cash from 3,691 drivers daily on average. The cashiers picked up ticket and/or cash thousands of time, especially on the day and evening shifts. The major activities of the cashiers are picking up ticket and/or cash from the drivers using their left hands. A stool was provided for each cashier. But all the cashiers stood up to reach the drivers when picking up the toll. The cycle time to pick up ticket

and/or cash was normally in a few seconds. This task was highly repetitive task, according to Putz-Anderson [9]. A systematic working posture analysis would be beneficial to this type of work.

In this study, the working postures for cashiers collecting tickets and cash were observed and analyzed.

2 Method

2.1 The Cashiers

There were 53 cashiers in Young-May station. All of them was female with the mean age 27.6 (±2.9) yrs. All the 53 cashiers in the Young-May toll station were females. All the cashiers participated in the study. Their ages and body dimensions were shown in Table 1. Forty one (77.4%) of the cashiers had been working in their current jobs between two to five years. Five cashiers (9.4%) had been in the position for less than two years. The rest had the experience of more than five years. The ages and body dimensions of these cashiers were shown in Table 1. All the participants were interviewed concerning their experience of musculoskeletal pain or discomfort during or right after work in the past 12 months.

Table 1 Age and body dimensions of the cashiers (N=53)

	Mean	Std	5th ile	95thile
Age(yrs)	27.61	2.94	23.70	33.00
Stature(cm)	165.06	2.14	160.85	168.15
Shoulder height(cm)	135.01	2.32	131.35	139.00
Elbow height(cm)	102.38	1.51	99.85	105.15
Knuckle height(cm)	65.44	2.15	62.00	69.15
Arm length*(cm)	66.22	1.82	62.35	68.50

*from acromin to knuckle

2.2 Working posture analysis

The postures of the cashiers when picking up the toll were affected by the hand positions of the drivers when paying the toll. Eighty observations were made for the car, bus/truck, and heavy truck/tractor lanes, each. Both the vertical and horizontal distances of the drivers' left hands were recorded (see Table 3). The vertical and horizontal distances were the distances between the tip of the thumb to the floor and to the side door of the booth, respective.

Table 2 Picking-up position when tolling (cm)

	Mean	Std
Small car		
Vertical distance	47.19	10.13
Horizontal distance	56.44	7.53
Bus/truck		
Vertical distance	56.88	8.17
Horizontal distance	51.31	2.59
Heavy truck/tractor		
Vertical distance	142.75	10.08
Horizontal distance	51.38	2.58

The working postures of one randomly selected cashier from each of the car-cash, car-ticket, bus/truck, and heavy truck/tractor lane were recorded. The observations were carried out in the morning for a three-hour-session (9:00 to 12:00) during a typical weekday. A four-digit posture code (see Table 3) was recorded every 30 seconds by the research personnel. A total of 360 postures were recorded for the cashiers in each lane.

3. Results

3.1 Cashiers Interviews

Fifty five percent of the cashiers reported that they experienced pain or body discomfort during or right after work in the past 12 months. Among these cashiers, 70% of them experienced symptoms in the left arm. The percentages reporting musculoskeletal symptoms in neck, back, and legs were 4%, 16%, and 10%, respectively.

3.2 Postural Analysis

Table 4 shows the distribution of postural categories for the four body parts of the cashiers who worked in the car-ticket lane. For head/neck posture, 73.89% of the observed postures were categorized as AC3. This was due to the high frequency of bending of the head. For back postures, 78.33% of the postures were categorized as AC2. The problematic posture for back was bending. All the arms postures were in AC1. For the leg postures, 87.78% of the postures were in AC2. This was due to the long time standing by both legs.

The activities between the cashiers of car-ticket lane and car-cash lane were similar. However, the cashier in cash lane needed to count the money she picked up and to gave exchange to the driver. These movements extend the cycle time of tolling.

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Table 3 OWAS code of four body segments

	OWAS Code	Posture
Head	1	Free
	2	Bent forward
	3	Bent to one side
	4	Bent backward
	5	Twisted
Back	1	Straight
	2	Bent
	3	Twisted
	4	Bent and twisted
Arms	1	Both arms under shoulder level
	2	One arm at or above shoulder level
	3	Both arms at or above shoulder level
Legs	1	Sitting with the legs under the buttock level
	2	Standing with both legs straight
	3	Standing with one leg straight
	4	Standing or kneeling with both legs bent at the knee
	5	Standing or kneeling with one leg bent at the knee
	6	Kneeling on one knee or both knees
	7	Walking or moving

Table 4 Percentages of postures for each action category(%)

		AC1	AC2	AC3	AC4
H	car-ticket lane	26.11	--	73.89	--
E	car-cash lane	46.11	--	53.89	--
A	Bus/truck lane	68.89	31.11	--	--
D	Heavy truck/ tractor/ trailer lane	52.78	--	47.22	--
B	car-ticket lane	21.67	78.33	--	--
A	car-cash lane	63.89	31.11	--	--
C	Bus/truck lane	97.78	2.22	--	--
K	Heavy truck/ tractor/ trailer lane	100	--	--	--
A	car-ticket lane	100	--	--	--
R	car-cash lane	100	--	--	--
M	Bus/truck lane	52.22	47.78	--	--
	Heavy truck/ tractor/ trailer lane	0.56	--	99.44	--
L	car-ticket lane	12.22	87.78	--	--
E	Small car-cash lane	100	--	--	--
G	Bus/truck lane	0.56	99.44	--	--
	Heavy truck/ tractor/ trailer lane	--	100	--	--

The height of the bus/truck drivers' hands when tolling was higher than that of the cars'. The cashier in this lane did not need to bend her head and back to pick up ticket or cash. However, she had to raise her arm when picking up the toll. Table 6 shows the cashier's body posture. In this table, no AC3 posture was observed. However, all the body segments showed AC2 postures. The percentages of AC2 postures for head, back, arms, and legs, were 31.11%, 2.22%, 47.78%, and 99.44%, respectively.

4. Discussion

The differences between the vertical distance of the tickets and the knuckle height of the cashiers were apparent. The cashiers was forced to bend or lateral deviate their back and neck when picking up the tickets since the

height of the tickets were lower than the knuckle height at small car lane. At the heavy truck lane, on the other hand, the cashiers needed to lift their arms when tolling since the ticket position was higher than the shoulder height. Some AC3 postures were observed on head/neck for cashiers in small car lane. The percentage of AC3 postures for cashier in the car-ticket lane was higher than that of the car-cash lane. This might be attributed to the ticketing frequency. The cycle time in the cash lane was higher than the ticket lane which reduces the frequency of tolling.

The major difference between the car lane and the bus/truck and heavy truck/trailer lane was the height of the tolling position. This difference had already been considered in the design of the platform of the station islands. The islands of the bus/truck and heavy truck/trailer lanes were 7 cm higher than that of the car lane. It was apparent that raising the island 7 cm high was not enough for heavy truck/tractor /trailer lane. There was 99.44% of the postures of the arm was classified as AC3 which implied distinctly harmful situation.

In summary, the cashier in Young-May station experienced risk of musculoskeletal injuries ranging from AC2 to AC3, according to the results of OWAS analysis. Musculoskeletal symptoms were also reported by the cashiers. Job rotation is being implemented among the cashiers. Redesign of the station should be considered. It was recommended that the islands of the car lane should be lowered so that the cashier wouldn't have to bend their back and when working. The islands of the heavy truck/ trailer lane should be raised so that the cashier wouldn't have to raise their arms and extend their neck to pick up the ticket or money.

A limitation of the study was the small sample size of the participants. Even though the sample size was small, the results in this study were believed to be un-biased for the cashier population in the highway toll stations.

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