

# Ergonomic Risk Assessment using Cornell Musculoskeletal Discomfort Questionnaire in a Grocery Store

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## Research Article

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## Abstract

In most grocery stores in Turkey, workers are standing while their shift. They are also subjected to repetitive tasks and awkward postures. The aim of this cross-sectional analysis was to explain the prevalence of work-related symptoms of musculoskeletal in grocery shops. The study participants ( $n = 10$ ) included supermarket staff from five separate grocery stores in a medium-sized grocery chain. In particular, the perceived pain of each worker was determined using Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). The results obtained using CMDQ work positions are in need of change. Furthermore, the results can be used for recommendations to improve ergonomics factors of the tasks in form of a guideline or general statements presenting recommendations for mitigating risks.

**Keywords:** Ergonomics Assessment; CMDQ; Musculoskeletal Disorders; Grocery

**Abbreviations:** CMDQ: Cornell Musculoskeletal Discomfort Questionnaire; MSDs: Musculoskeletal Disorders; DC: Distribution Center.

## Introduction

The complaints among grocery workers about musculoskeletal disorders (MSDs) have been increasing in the last decade and have become a major health issue. Work-related MSDs may cause disability workers.

WMSDs account for the highest proportion of workers' compensation claims and permanent disability. [1]. WMSDs are types of disorders affecting various body parts that are associated with movement, including the upper limbs, lower limbs, and back. These affect the different structures of the body such as tendons, joints,

muscles, and nerves and are primarily caused or aggravated by work-related activities [2].

Other risk factors were proposed that were of special interest, such as joint positions such as cramped positions, extreme positions and steep forward bending of the head. Therefore, the problems can be aggravated by high repetitiveness, high pressure, high static muscles and joint load [3]. The frequency of WMSDs can be determined by the workers' compensation claims among any working population. A higher incidence or prevalence of these workers in a workplace population indicates that they are more vulnerable to the physical risk factors. Nonetheless, incidence estimates require large employees to be sampled. Moreover, the prevalence of WMSDs in compensation claims are frequently underestimated [4].

Studies into musculoskeletal symptoms may provide closely related estimates of WMSD in different body areas. The study aimed at preventing musculoskeletal symptoms related to work in grocery store workers from various departments and determining the risk factors with the use of CMDQ. In warehousing / grocery distribution center (DC) activities, a small amount of research has been conducted specifically addressing ergonomics. NIOSH researchers performed a supermarket warehouse risk study in which the incidence of back injuries was 16 per 100 employees. They considered lift loads exceeding acceptable limits and levels, locations from or to which objects are selected or put to be too low, too high, or too deep, and work times exceeding 8 hours to be troubling [5]. In a previous study on Wholesale Selectors [6], the development of storage systems placed excessive reach positions that would cause half male and 90 percent of females to over exercise on the job, based on biomechanical modeled jobs. The researchers identified factors in many aspects of the work system in an analysis of the problematic working factors for inventors of warehousing surfaces that made the job less productive and dangerous [7].

Although WMSDs affect all sectors of the working population, there are particularly high MSD rates among grocery employees. During the period 1997-2005, grocery stores in Washington State had a level of musculoskeletal injury 1.8 times higher than the state average and 5th in all industries' compensable upper extremity WMSDs [8]. Like shoulder, rotator cuff syndrome, wrist tendonitis, carpal tunnel syndrome, and back disorders like sciatica, grocery jobs ranked in the top 25 injury occupations. Health Assessment & Research for Prevention (SHARP) concluding that grocery work has become one of the "top

twelve industries in need of focused research and prevention efforts."

Most of the research carried out in grocery workers focused on repeat hand movements by cashiers and the checkout station layout [9-13]. Workers in grocery markets are, therefore, impaired by physiological conditions and WMSDs pose risk factors. Types involve heavy carrying to the shelf from the warehouse. High force occurs while heavy product is lifted. And, it affects shoulder position.

The rest of the paper is as follows described. Section 3 details the methodological steps, including participants, procedure, CMDQ, and study steps. Section 4 addresses the results. Ultimately, in sections 5 and 6, respectively, the discussion and conclusions are presented.

## Methodology

### Participants

There were 5 healthy male and 5 healthy female from different departments among the study groups. The population was between the ages of 18 and 49. The ergonomic risk analysis using CMDQ for the grocery practiced in the well-known grocery store in Ankara, Turkey. The mean values and the standard differences between age, height and weight of the individuals were  $33 \pm 10,58$  years,  $167 \pm 13,02$  cm, and  $64,1 \pm 9,31$  kg, respectively (Table 1). The study informed the participants and each of them indicated their willingness to participate with a participatory consent form. The participants received and read the information letter before responding to questionnaire. None of the participants reported musculoskeletal problems during the study.

	Mean	SD	Minimum	Maximum
Age	33	10.58	18	49
Height (cm)	167	13.02	150	183
Weight (kg)	64.1	9.31	50	80
Work experience (years)	6.8	5.62	1	20
Working hours	9.7	1.13	8	12

**Table 1:** Demographic Statistics.

### Procedure

The subjects were explained the questionnaire and the CMDQ was used in order to gather data. The questionnaires began with demographic questions regarding gender, age, years of experience, and number of

hours per shift. Subjects were allowed to spend as much time as they needed to answer each question. The researcher answered any questions that arose during the administration of the questionnaire but provided no assistance on content. The subjects were not allowed to consult other respondents or discuss with them before or

during the study. This was achieved by having all the subjects filling the questionnaires at the same time in different cubicles.

### Cornell Musculoskeletal Discomfort Questionnaire

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) was used to assess discomfort. Professor Alan Hedge and Ergonomics students of the Cornell University developed a well-designed data collection tool named

CMDQ [14]. The CMDQ is a 54-item questionnaire that includes a body chart and questions about musculoskeletal ache, pain or discomfort occurrence in 20 parts of the body over the past week. (Figure 1). It has been used in working groups such as healthcare provider and machine operator in the evaluation of musculoskeletal pain. The musculoskeletal discomfort score was calculated in accordance to the CMDQ scoring guidelines for the determination of the rate of discomfort and the quantification of the discomfort level.

	During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
	Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shoulder (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shoulder (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upper Back	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upper Arm (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upper Arm (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower Back	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forearm (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forearm (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wrist (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wrist (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hip/Buttocks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Thigh (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Thigh (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knee (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knee (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower Leg (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower Leg (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 1: Cornell Musculoskeletal Discomfort Questionnaire, male version.

The assessment of musculoskeletal discomfort was presented as follows. Firstly, the level of discomfort recorded during the survey by the operators was calculated as: “Never (0), 1 or 2 times/week (1.5), 3 or 4 times/week (3.5), every day (5), or several times every day (10)”. In order to reach the weighted musculoskeletal discomfort level, the result will then be multiplied by the severity rate (“slightly uncomfortable = 1, moderately uncomfortable = 2, very uncomfortable = 3”) and interference rating (“Not at all = 1, slightly interfered = 2, substantially interfered = 3”). The most severe cases were thus described.

### Study Steps

The study has been divided into three phases. The first phase was preparatory and included:

- Informing the participant about the purpose, method and risk assessment
- Obtaining informed consent of the individual
- Recording subject age, height, weight, gender, educational situation, work experience, working hours in a day, the grocery they work.

The Cornell assessment portion of the study started after the paperwork was finished. The researchers first demonstrated the procedure to ensure that participants understood what was needed. The process involved CMDQ:

- Participant was given brief introduction and requested the complete CMDQ independently
- Each participant was interwoven about clarity and understandability of the questionnaire.

## Results and Discussion

The results of CMDQ reported total body discomfort and high impact long working hours and unfavorable working conditions. To evaluate concurrent validity, the Cornell musculoskeletal discomfort questionnaire was also employed. The studies of musculoskeletal disorders consider International Musculoskeletal Disorder (MSD) Questionnaire as an essential feature [15]. Since the CMDQ examines discomfort levels according to frequency and severity and it also analyzes the rate at which work performances of individual are negatively influenced and

this statement was mentioned by previous recent studies [16,17].

According to the total discomfort score of CMDQ (Table 2), it was concluded that grocery workers felt discomfort mostly in the upper back (17,29%), lower back (13,23%) and the right shoulder (9,52%), while it was less pronounced in the left foot (0,72%), right foot (0,72%) and left thigh (1,62%). The low and the upper back were anatomical areas with the highest prevalence of symptoms, similar to other studies conducted by grocery workers [10,13,18].

Body parts referred to in the questionnaire	Frequency	Discomfort	Interference	Discomfort score	%
Upper back	57	22	20	25080	17,292
Lower back	50,5	20	19	19190	13,231
Shoulder_R	47	21	14	13818	9,5273
Neck	50,5	18	14	12726	87,744
Shoulder_L	45	19	14	11970	82,532
Upper arm_R	31,50	17	15	8032,5	55,383
Upper arm_L	31,50	17	15	8032,5	55,383
Lower leg_R	25	15	15	5625	38,784
Forearm_L	29,5	14	13	5369	37,019
Forearm_R	27,5	15	13	5362,5	36,974
Lower leg_L	25	14	15	5250	36,198
Wrist_R	22,5	14	13	4095	28,234
Wrist_L	20,5	14	13	3731	25,725
Hip	18,5	16	12	3552	24,491
Knee_R	16,5	14	15	3465	23,891
Knee_L	13	16	14	2912	20,078
Thigh_R	16,5	11	13	2359,5	16,268
Thigh_L	16,5	11	13	2359,5	16,268
Foot_R	13	9	9	1053	0,726
Foot_L	13	9	9	1053	0,726

**Table 2:** Total discomfort score felt by the grocery workers.

Differences between studies over the years of industry work and demographic differences like the gender distribution of samples may cause a variance in the prevalence of studies. In the present study, the results could have been affected by some limitations. Firstly, it could have been possible to use other forms of exposure assessment. Violante and colleagues [13] used the lifting equation of NIOSH to estimate a low, moderate, and high risk of heavy lifting in a study of low back injuries among grocery employees, for example.

## Conclusion

Musculoskeletal discomforts and symptoms related to work are largely due to psychological (stress, cognitive

load, etc) and organizational (unsuitable working-rest period, lack of work-enrichment etc.) factors in the work environment (static and bad postures, repetition of movements, non-ergonomic workstation configuration, etc.). It is important to improve working conditions, design and layout of workplaces by organizations and successful ergonomic interventions in the workplace. An assessment of the workplace, monitoring of the associated risk factors, medical management and education are important for preventing and eliminating WMSDs. The study showed that in the upper and lower back, the feeling of discomfort felt subjectively by grocery workers was higher. The relationship between musculoskeletal discomfort and productivity needs to be further studied. The result of this analysis can therefore

be used to further assess the impact of MSD on productivity.

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