ORIGINAL ARTICLE

Received: 10/07/2017
Accepted: 02/19/2018
Funding: none

Assessment of disability and quality of life among ceramic industry workers

Avaliação da incapacidade e qualidade de vida de trabalhadores da produção de indústrias cerâmicas

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ABSTRACT | Background: Ceramic industry workers are subjected to several factors, such as high temperature, dust and work in standing position, which in greater or lesser degree might cause discomfort and work-related disorders. **Objective:** To investigate the quality of life and functional capacity of ceramic industry workers. **Methods:** The present study had a quantitative cross-sectional design. A total of 189 ceramic industry workers were analyzed. Muscle strength was assessed by means of dynamometry, and the following questionnaires were applied: WHOQOL-Bref for quality of life; Nordic Questionnaire of Musculoskeletal Symptoms, pain Visual Analog Scale (VAS), Oswestry Low Back Pain Disability Questionnaire (ODQ 2.0) and Disabilities of the Arm, Shoulder and Hand (DASH). **Results:** Overall, 115 (60.8%) participants described their quality of life as average. The lumbar spine was the body segment most often mentioned as the location of pain 68 (36.0%) participants reported occurrence of pain in the past 12 months and 38 (20.1%) in the past 7 days. A total of 107 (56.6%) participants exhibited upper limb muscle weakness. **Conclusion:** The results evidenced a higher prevalence of pain compared to other professional categories. Muscle weakness, mainly affecting the upper limbs, and self-perceived quality of life as predominantly average show that the state of health of a part of the sample was partially impaired, and while it was not associated with disability, it was perceived as having impact in their personal and professional lives.

Keywords | musculoskeletal diseases; ceramics; occupational health; quality of life.

RESUMO | Introdução: As indústrias cerâmicas estão sujeitas a uma gama de fatores, como temperatura elevada, poeira, trabalho em pé, que, em maior ou menor grau, podem levar a desconfortos e adoecimentos relacionados ao trabalho. **Objetivo:** Avaliar a qualidade de vida e a funcionalidade de trabalhadores de indústria cerâmica. **Métodos:** O presente estudo envolveu uma abordagem transversal quantitativa. Foram avaliados 189 trabalhadores de indústrias cerâmicas, aos quais foram aplicados o Questionário de Qualidade de Vida WHOQOL-Bref, a avaliação da força muscular por meio de dinamômetros, o Questionário Nórdico de Sintomas Osteomusculares (QNSO), a escala visual analógica (EVA), o Oswestry Low Back Pain Disability Questionnaire (ODQ 2.0), bem como *o* Disabilities of the Arm, Shoulder and Hand (DASH). **Resultados:** Na média geral, 115 (60,8%) responderam que sua qualidade de vida é regular. O segmento que os trabalhadores mais se referiram à dor foi a coluna lombar: 68 (36,0%) apresentaram dor nos últimos 12 meses, e 38 (20,1%) nos últimos sete dias. Em membros superiores, 107 (56,6%) exibiram fraqueza muscular. **Conclusão*:*** Os achados desvendam a presença de sintomatologia dolorosa em percentual superior ao encontrado para outras categorias profissionais. A fraqueza muscular, principalmente nos membros superiores, e a percepção sobre a qualidade de vida, que prevaleceu como regular, denotam comprometimento parcial da saúde de parte desses trabalhadores, pois embora não tenha demonstrado ser incapacitante é percebido como impactante nos seus contextos de vida e trabalho.

Palavras-chave | doenças musculoesqueléticas; cerâmica; saúde do trabalhador; qualidade de vida.

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DOI: 10.5327/Z1679443520180113

INTRODUCTION

In Brazil, the production of ceramic materials is concentrated in some regions. Southern Santa Catarina, recognized as an international industrial park, hosts the largest ceramic companies in the country[1].

While attempts are made to improve the comfort and living conditions of workers in their everyday life, health hazards derived from excess work, among other factors, seem to hinder the satisfaction of the ever more demanding needs and desires associated with social life[2].

Consistently, ergonomics seeks to increase the attention paid to comfort, quality, work environment, efficacy and workers' performance in industrial activities. As concerns the health of such workers, diseases associated with occupational activities have a high musculoskeletal cost, resulting in absenteeism, accidents and organizational complaints[3].

Backache is the main cause of work-related health problems and absenteeism. According to estimates, 70 to 80% of the population might develop one episode of strong backache in life, which might result in permanent disability for work[4-6]. Musculoskeletal disorders account for a large number of sick leaves and have direct influence on the workers' quality of life and well-being[7].

The ceramic industry processes are developed at high temperatures[8,9]. According to Iida[10], some factors associated with discomfort at work involve unfavorable environmental conditions, such as temperature, which increase the risk of accidents and might cause considerable harm to health[11]. The physiological effects that unfold when the human body temperature reaches, or exceeds, 38°C interfere with the body systems and organs and hinder the ability to perform productive work[12]. In addition, physical activity accelerates the metabolism, with consequent increase of heat. As a function of the intensity of physical effort and the environmental conditions, the core temperature might increase to harmful levels[13]. Some of the possible consequences are skin vasodilation and thermal lesions, such as exhaustion and thermal stress, besides fatigue, sleepiness and additional risk of accidents[14,15]. Also inadequate clothing, insufficient ventilation and high humidity might impair the performance of workers[15]. Couto listed the main implications of working in hot environments: cramps, tendinitis, musculoligamentous strain and dizziness, in addition to syncope due to dehydration, which impair the functional capacity of workers[5].

Exposure to air particulate matter (breathable dust) derived from solid materials, which exhibit a high dust formation rate, might cause progressive impairment of the functional capacity of workers. Dust is released along the manufacture of ceramic materials, especially when their composition includes crystalline silica, which is harmful for workers, causing respiratory system problems, among which silicosis is the most significant[16]. Silicosis is a chronic progressive disease[17] derived from inhalation and accumulation of silica dust in the lungs[18]. Dyspnea on exertion is the most common symptom of disease, which has a slow and progressive course. In time, silicosis might result in full disability for work[19].

During the performance of many activities, workers are compelled to adapt to various body postures, and often need to remain in the same position over long periods of time, which demands continuous use of the same muscle groups, which can thus result in fatigue. Staying bent long or repeatedly might result in spine complaints. Repeated gestures might trigger joint pain, in addition to causing musculoskeletal disorders[20]. Extreme discomfort considerable reduces performance and increases fatigue, and as such it behaves as a cause of stress for workers[11].

Another significant problem, and a source of concern in the case of the ceramic industry, is the occurrence of work-related musculoskeletal disorders (WMSDs) which affect the muscles, tendons and nerves of the upper limbs, and might also involve the neck and trunk. WMSDs are characterized by overload of the musculoskeletal system; their main feature is pain, which becomes the main limitation to the accomplishment of tasks[21]. Posture is also a significant element, and might be influenced by several injuries of the musculoskeletal system of the spine. Working in standing position might be tiresome, because it demands continuous contraction of muscle groups to oppose gravity. Thus it might increase discomfort and pain, in addition to inducing early activation of the mechanism of muscle fatigue[22,23]. Poor body posture and manual work are the factors that most harm the joints and health of this population of workers[24].

The aim of the present study was to investigate musculoskeletal symptoms, spine and upper limb function and quality of life among ceramic industry workers.

METHODS

The present cross-sectional and quantitative study was conducted at two ceramic manufacturing companies in the Criciúma Carboniferous Area, Santa Catarina, Brazil, in September and October 2015. The sample was composed of employees from these two companies. The study was approved by the ethics committee of University of the Southern Extreme of Santa Catarina (Universidade do Extremo Sul Catarinense – UNESC) ruling no. 1,158,482/15.

The sample size was calculated using the equation formulated by Medronho (2009)[25]. According to data provided by Criciúma's Reference Center of Workers' Health (Centro de Referência em Saúde do Trabalhador - Cerest) 370 employees worked in the production area of the two analyzed companies, who thus represented the study population. The target-result was set to 189 workers allocated to the production area of the two companies, therefore corresponding to the number of participants to be recruited by means of simple random probabilistic sampling. Recruitment considered a minimum of six uninterrupted months of work in the production area, the contribution of data from the work safety and health department to orient the selection of groups, and signature of an informed consent form upon being invited to participate in the study. All the participants were male.

For assessment of the participants' quality of life, questionnaire WHOQOL-Bref, which investigates four quality of life domains, was self-responded as per the manual of instructions. The Nordic Questionnaire of Musculoskeletal Symptoms (NQMS) was used to collect data on WMSD symptoms among all the workers[26] through simple and direct questions, the results of which were indicated on the human figure included in the instrument[27-29].

The intensity of pain was quantified by means of a visual analogue scale (VAS) with different colors and faces representing the range from no pain to maximum pain.

Muscle strength was assessed by means of lumbar, scapular and handgrip dynamometry. Low back muscle strength was evaluated with Takei® back muscle dynamometer with 0-200 kgf measuring range (Takei Scientific Instruments Co., Tokyo, Japan). For measurement, the participants were oriented to stand on the dynamometer's platform, with the knees in 30º semi-flexion and to hold the handle. Then they were requested to perform maximum effort to pull the handle with the following verbal commands: "Hold fast, pull, pull, pull." Finally, the strength developed was measured.

Scapular muscle strength was assessed with Crown scapular dynamometer (São Paulo, SP, Brazil) with 0-50 kgf measuring range. For measurement, the participants were oriented to stand up with the feet apart at about the shoulders' length with the knees in slight flexion to adjust the body posture to the task, to place the dynamometer at the chest level and pull the handles apart. The verbal commands were the same as for low back muscle strength.

Handgrip strength was assessed with Saehan® (South Korea) dynamometer with 0-100 kgf measuring range. For measurement, the participants were oriented to sit down, place the forearm on a support leaving the hand free and with slight 20º ulnar deviation. Next they were requested to make maximum handgrip effort through verbal command "Hold fast. Ready! Press, press, press." Finally, the strength developed was measured.

All dynamometers had calibration certificates. In all three tests, three measurements were performed for all the participants and the highest one was selected for analysis.

The Oswestry Low Back Pain Disability Questionnaire (ODQ 2.0) was used to assess low back disability for performance of activities of daily living as a function of pain. ODQ comprises 10 items that assess low back pain during various functional tasks. Each item is scored from 0 to 5, the higher the score, the greater the disability. The final score is obtained by adding the individual item's score and expressed as percentage[30].

Questionnaire Disabilities of the Arm, Shoulder and Hand (DASH) comprises 30 questions that investigate functional ability and physical symptoms. Among the items, two investigate physical function, six symptoms and three social functions. The score is obtained through two equations, one for the first 30 items, and the other for the optional modules.

Data analysis was performed with software IBM Statistical Package for the Social Sciences (SPSS) version 22.0. Quantitative variables were expressed as mean, standard deviation and standard error.

RESULTS

The sample was composed of 189 men, with average age 40.72 (±8.31) years old. On VAS assessment, 62 (32.8%)

participants reported presence of pain, and 127 (67.2%) no pain at all. As to the intensity of pain as also assessed by VAS, among the participants who reported pain, 13 (6.9%) had mild pain, 44 (23.3%) moderate and 5 (2.6%) severe (Table 1).

NQMS was used to assess musculoskeletal symptoms in the various body segments. The lumbar spine was the segment most frequently mentioned as location of pain: 68 (36.0%) participants reported having had low back pain in the past 12 months, 38 (20.1%) in the past 7 days and 27 (14.3%) had been forced to avoid some activities due to pain. The knees were the second most frequent location of pain; 46 (24.3%) participants reported knee pain in the past 12 months, 26 (13.8%) in the past 7 seven days and 23 (12.2%) had been forced to avoid some activities. The upper limbs (shoulders) were the third most frequent location of pain; 36 (19.4%) participants reported occurrence of pain the past 12 months, 23 (12.2%) in the past 7 days and 5 (2.6%) were forced to avoid some activities Table 2). On assessment of muscle strength by means of dynamometry and relative to four segments, 82 (43.4%) participants exhibited reduced and 107 (56.6%) normal low back muscle strength. Fifty-six (29.6%) participants exhibited reduced and 133 (70.4%) normal scapular muscle strength. On the handgrip strength test, 117 (61.9%) participants exhibited reduced and 72 (38.1%) normal muscle strength in the right hand, while 107 (56.6%) exhibited weakness and 92 (43.4%) normal muscle strength in the left hand (Table 3).

Table 1. Characterization of ceramic industry workers and categorization of pain according to the visual analogue scale (VAS) results, Criciúma, 2015 (n=189).

Variable	Mean±Standard deviation, n (%)
Age (years)	40.72 ± 8.31
Pain (n=189)	
Yes	62 (32.80)
No	127 (67.20)
VAS (n=62)	
Mild	13 (6.90)
Moderate	44 (23.30)
Severe	5 (2.60)

Workers' age, pain and its intensity. The results relative to variable age are expressed as mean and standard deviation. The other parameters are expressed as absolute and relative frequencies.

Based on the WHOQOL-Bref results, 115 (60.8%) participants rated their quality of life average, 73 (38.6%) good and one (0.5%) poor; none described his quality

Table 2. Distribution of musculoskeletal symptoms according to the Nordic questionnaire, Criciúma, 2015 (n=189).

Variable	n (%)		
	Pain in the past 12 months	Pain in the past 7 days	Avoided activities in the past 12 months due to pain
Neck	31 (16.4)	18 (9.5)	5 (2.6)
Shoulders	36 (19.4)	23 (12.2)	13 (6.9)
Right	14 (38.9)	11 (47.8)	7 (53.8)
Left	8 (22.2)	5 (21.7)	1 (7.7)
Both	14 (38.9)	7 (30.4)	5 (38.5)
Elbows	9 (4.8)	7 (3.7)	4 (2.1)
Right	4 (44.4)	3 (42.9)	2 (50.0)
Left	1 (11.1)	1 (14.3)	0 (0.0)
Both	4 (44.4)	3 (42.9)	2 (50.0)
Forearms	10 (5.3)	5 (2.6)	5 (2.6)
Right	1 (10.0)	2 (40.0)	3 (60.0)
Left	1 (10.0)	1 (20.0)	0 (0.0)
Both	8 (80.0)	2 (40.0)	2 (40.0)
Wrists, hands, fingers	32 (16.9)	24 (12.7)	9 (4.8)
Right	11 (34.4)	6 (25.0)	2 (22.2)
Left	8 (25.0)	9 (37.5)	2 (22.2)
Both	13 (40.6)	9 (37.5)	5 (55.6)
Back	29 (15.3)	16 (8.5)	11 (5.8)
Low back	68 (36.0)	38 (20.1)	27 (14.3)
Hips and thighs	15 (7.9)	10 (5.3)	11 (5.8)
Knees	46 (24.3)	26 (13.8)	23 (12.2)
Ankles and feet	30 (15.0)	28 (14.8)	17 (9.0)

Musculoskeletal symptoms among ceramic industry workers. The results are expressed as absolute and relative frequencies. Column 2: workers who had pain in the past 12 months; column 3: workers who had pain in the past 7 days; column 4: workers who were compelled to avoid activities of daily living in the past 12 months due to pain.

of life as very good. On analysis per domain, the poorest results corresponded to domain environment. A total of 135 (72.4%) participants described their environment as average, 10 (5.3%) as poor and only 44 (23.3%) as good. In turn, social relationships was the domain with the most favorable results: 137 (72.5%) participants rated them good, 27 (14.3%) average and 3 (1.6%) poor (Table 4).

Table 5 describes the results of ODQ (low back disability) and DASH. A total of 188 (99.5%) participants reported minimal disability to perform activities of daily living and one (0.5%) moderate disability. DASH assesses upper limb disability; the higher the score (i.e., the closer to 100) the poorer the degree of disability. In the present study the mean score was 5.12±0.53, which shows that no participant had upper limb disability.

Table 3. Distribution of low back, scapular and hand strength values (kgf), Criciúma, 2015 (n=189).

Variable	Mean±Standard deviation, n (%)
Low back muscle strength	139.02±35.92
Normal	107 (56.60)
Weakness	82 (43.40)
Scapular muscle strength	33.37±7.75
Normal	133 (70.40)
Weakness	56 (29.60)
Right hand muscle strength	48.89±9.58
Normal	72 (38.10)
Weakness	117 (61.90)
Left hand muscle strength	46.67±9.33
Normal	82 (43.40)
Weakness	107 (56.60)

Ceramic industry workers' muscle strength. The results are expressed as mean and standard deviation or absolute and relative frequencies. Muscle strength was considered normal when equal to or higher than the reference values for age and sex. Muscle weakness was defined as strength below the reference values for age and sex. Reference values for low back dynamometry according to Elchinger et al.[49]: values 114 kgf and higher were considered normal strength and lower values weakness. Reference value for scapular dynamometry according to Trotta[50]: 30 kgf. Reference values for handgrip dynamometry with Saehan dynamometer 41.39 kgf for the right hand and 39.02 kgf for the left hand according to Reis and Arantes[51].

DISCUSSION

Data analysis showed that the perceived quality of life of the sample of ceramic industry workers was average to good, the highest scores corresponding to domain social relationships and the poorest ones to domain environment. Most of the scores fell within categories average to poor, representing 77.7% of the participants.

Quality of life involves the creation, maintenance and improvement of the work environment in regard to satisfactory physical conditions of hygiene and safety, as well as to psychological and social conditions. The result is a pleasant and friendly work environment, which substantially improves the quality of life of people at organizations[31].

Ceramic industry workers are exposed to several occupational hazards, a part of them inherent of the physical work environment. As a function of their nature, concentration and length of exposure, such hazards might be harmful to the health, and consequently also the quality of life of workers[32].

A study that assessed the quality of life of ceramic industry workers in the state of Paraná, Brazil, found that the factors related to the work environment were seen as the most negative by the participants[33]. Another study performed with ceramic industry workers in the Bahian Sertão applied WHOQOL, as in the present study, and also found similar results: negative self-perceived quality of life mainly as a function of domain environment[34].

The lumbar spine was the body segment most frequently mentioned as location of pain; 36% of the participants reported low back pain in the past 12 months. The fact that low back pain compelled 14% of the sample to avoid some activities and movements is noteworthy, as also is the frequency of acute pain, as 20.1% of the participants reported occurrence of low back pain in the past 7 days.

In a study conducted in Pedreiras county, São Paulo, Brazil, with 235 ceramic industry workers[35], the rate of pain complaints in general in the past 12 months was 38%, which is very close to the one found in the present study (33%). Another aspect of convergence between these two studies is the higher frequency of low back and knee complaints.

The following were described as causes of musculoskeletal disorders among ceramic industry workers: repetitive movements, use of inadequate tools, lack of control on staff decisions, concerns with the job demands, job dissatisfaction,

Table 4. Distribution of quality of life (WHOQOL-Bref) scores among ceramic industry workers, Criciúma, 2015 (n=189).

Variable	Physical health	Psychological	Social relationships	Environment	Global
Poor	2 (1.1%)	1 (0.5%)	3 (1.6%)	10 (5.3%)	1 (0.5%)
Average	67 (35.4%)	80 (42.3%)	27 (14.3%)	135 (72.4%)	115 (60.8%)
Good	115 (60.8%)	106 (56.1%)	137 (72.5%)	44 (23.3%)	73 (38.6%)
Very good	5 (2.6%)	2 (1.1%)	22 (11.6%)	0 (0.0%)	0 (0.0%)

Table 5. Distribution of scores on the Oswestry Low Back Pain Disability Questionnaire (ODQ – low back disability) and Disabilities of the Arm, Shoulder and Hand (DASH) (upper limb disability) among ceramic industry workers, Criciúma, 2015 (n=189).

Variable (ODQ)	n (%)
Minimal	188 (99.50)
Moderate	1 (0.50)
Severe	0 (0.00)
Variable (DASH)	**Mean±Standard deviation. n (%)**
Upper limb disability	5.12±0.53

interpersonal conflict and desire to change the job position, among others[35].

Low back pain mainly affects workers who perform mechanical tasks, and is also associated with factors such as work overload, remaining in standing position for a long period of time and repeated movements[36]. High work-related physical demands and poor ergonomic conditions might result in considerable stress and psycho-physiological fatigue, and thus contribute to the development of low back pain[36,37].

In its International Classification of Impairments, Disabilities and Handicaps (ICIDH), the World Health Organization (WHO) considers low back pain as an impairment that reflects structural loss or abnormality of the lumbar spine of psychological, physiological or anatomical etiology, and also as a disability that translates as a handicap inasmuch as it restricts the ability to perform physical activities. From this perspective, low back pain might evidence a overuse syndrome, compression or postural disorders associated with muscle imbalance, muscle weakness, reduction of the range or coordination of motion, increased fatigue and trunk instability[38].

It is worth stressing that, the considerable rate of low back pain found in the present study notwithstanding, most participants exhibited minimum low back disability for performance of tasks. These findings agree with a relatively new perspective, according to which pain is not a direct determinant of disability. The comprehension of disability is much more complex than the mere occurrence of pain in the lumbar spine[39-42].

To make a parallel with another professional category, one study assessed the relationship between low back pain and disability among 40 coal miners from Treviso, Santa Catarina, Brazil; the results showed that the overall functional capacity, as assessed by means of ODQ, was good. About 97.5% of the sample exhibited minimal disability, while there was one single case of moderate disability (2.5%) even though the rate of chronic low back pain was 25% for the full sample[39].

Reduction of the trunk muscle strength and resistance contributes to the genesis and chronic progression of low back pain[43]. In the present study, 43.4% of the participants exhibited low back muscle weakness. According to some studies, low back muscle weakness and several other physical and biopsychosocial factors are associated to low back pain[44-46].

The size of workstations might compel workers to adopt definite body postures, adjust to certain loads and to behave in a way that causes or aggravates musculoskeletal disorders, thus contributing to the development of secondary muscle weakness[38]. In the present study, dynamometry showed that more than half of the sample had upper limb muscle weakness. It is also noteworthy that the upper limbs were the third more frequently mentioned location of pain. Pain might restrict the performance of movements, and thus lead to loss of the muscle strength, even though the participants did not report disability to perform activities involving this part of the body.

A good state of health is critical for workers, and thus all factors likely to have impact on it should be taken into consideration[47]. Organizations should see their human resources as their most important asset. In turn, functional capacity

is the greatest asset of workers. The functional capacity for work and related factors deserve greater attention in Brazil, as a recent systematic review showed[48].

The present study brings data, such as the ones on the muscle strength and functional capacity of ceramic industry workers, which might contribute to comparisons with other surveys on functional health, as well as information on the quality of life of this population of workers. As limitations, we might mention that the study was conducted at only two, albeit large ceramic manufacturing companies; while the number of participants is representative, there are many other similar companies in the south of the state of Santa Catarina.

CONCLUSION

The prevalence of pain was significant compared to other professional categories involved in industrial production. The results did not point to disabilities among the analyzed population, despite the occurrence of muscle weakness, mainly affecting the upper limbs, and the self-perception of the workers' quality of life as average. These findings show that the state of health of a part of the participants was partially impaired, being perceived as having impact in their personal and professional lives. These data indicate that health promotion and prevention measures targeting this population of workers need to the implemented and continuously monitored.

ACKNOWLEDGMENTS

The authors thank CEREST-Criciúma, the Unit of Workers' Health Promotion and Clinical Care (Núcleo de Promoção e Atenção Clínica à Saúde do Trabalhador (NUPAC-ST), UNESC and the Labor Public Prosecutor Office, Criciúma and Santa Catarina.

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