



ANALYSIS OF MUSCLE FATIGUE IN TRACTOR OPERATORS FROM WESTERN SANTA CATARINA

Jeanquiele Pendon Grando: Unochapecó, discente do curso de Fisioterapia da Unochapecó, Chapecó, SC, Brasil

Kauana Inês Petzen: Unochapecó, discente do curso de Fisioterapia da Unochapecó, Chapecó, SC, Brasil

Tahiana C. Lorenzet Zorzi: Docente do Curso de Fisioterapia, Universidade Comunitária da Região de Chapecó, SC, Brasil; tahiana@unochapeco.edu.br

Josiane S.de Almeida Altamar: Docente do curso de Fisioterapia, Doutora Área de Ciências da Saúde Universidade Comunitária da Região de Chapecó, SC, Brasil

ABSTRACT

The daily work of the agricultural tractor operator causes him/her to remain seated and isolated for a long time, often compromising his/her health, characterizing a stressful profession. *Objective:* to evaluate the subjective perception of muscle fatigue when performing activities by agricultural tractor operators in a small municipality in the State of Santa Catarina. *Methodology:* an observational quantitative cross-sectional study, carried out in the off-season of the corn between April and June 2018, with 15 tractor operators. The instruments used were the Bipolar Questionnaire and the simple identification questionnaire. *Results:* the Bipolar Questionnaire showed that muscle fatigue was high at the end of the work activity of the agricultural tractor operator. *Conclusion:* there is a subjective perception of muscle fatigue during the execution of the agricultural tractor operation, which is more pronounced at the end of the working day.

KEY-WORDS: Muscle fatigue; Operator; Physical therapy.

1. INTRODUCTION

The need for replacing human labor with agricultural machinery due to rural exodus and the constant need for increased food production has led to an extraordinary evolution in the tractor and agricultural equipment industry (ALCÂNTARA et al., 2017).

However, this activity has brought physical and mental overload, as well as occupational hazards such as muscular fatigue, related to equipment vibrations, poor posture, and the work process itself (BARDIERI, 2017).

Operator fatigue is one of the main factors affecting a tractor driver's activity, which impacts their motor and intellectual skills, such as paying less attention to control instruments, reducing gear shifting frequency, and becoming less sensitive to environmental information (BAESSO et al., 2018).

Work-related activities involve physical, cognitive, and psychological loads, indicating that overload can influence or cause suffering and physical fatigue, changes in work execution pace, and cognitive work overload. Physical load is related to muscle effort, cognitive load results from mental effort, and psychological load is associated with the emotional aspects of the task performed (CARDOSO & GOTIMJO, 2012).

Thus, concern for operator comfort and safety has drawn the attention of the physiotherapy field, as it is its role to contribute to the maintenance, well-being, and quality of life of these workers. Additionally, this population is more studied in the fields of agronomy and engineering, but there are few studies in the health sector.

In this context, knowing the fatigue index can be important for identifying intervention strategies in the field of preventing injuries, especially in the predominantly agricultural territory where the research was conducted.

Therefore, this study aimed to evaluate the subjective perception of muscular fatigue in the execution of activities by agricultural tractor operators in a small municipality in western Santa Catarina.

2. MATERIALS AND METHODS

The present study is an observational quantitative cross-sectional study. The selected setting was a small municipality in western Santa Catarina, covering an area of 234.40 square kilometers, divided into 14 neighborhoods and 25 rural communities. The economy of the municipality is driven by a partnership between agriculture and agro-industries, with a significant emphasis on poultry farming, pig farming, grain production, and dairy.

In the municipality, there are five mechanized agricultural patrols involving 168 members. Patrols are groups of farmers from various communities established through federal and municipal government initiatives in 16 communities of the municipality. Each patrol group consists of four tractor operators, one of whom operates the forage harvester during harvesting, while the others provide support in loading and transporting the harvested products.

For the research, operators working with agricultural tractors above 18 years of age, literate, with at least one year of experience operating tractors as part of their work routine, and who agreed to participate voluntarily were selected, totaling 20 individuals. Five participants with confirmed diagnoses of repetitive strain injuries (RSI) or work-related musculoskeletal disorders (WRMD), or those experiencing pain and workers who had returned from vacation in the last three weeks were excluded.

Initially, authorization from the Municipal Department of Agriculture for the research was obtained. After approval by the Human Research Ethics Committee under opinion 2.582.698, data collection began between April and July 2018. A self-developed identification questionnaire was administered to characterize the subjects, including age, weight (kg), Body Mass Index (BMI), height (cm), presence of pain, existing diseases, physical activity practice, tractor work experience, daily tractor usage hours, type of activity performed, breaks, tractor model, and brand of tractor unit.

Following the initial interview, a day was scheduled to administer the Bipolar Questionnaire, which evaluates the subjective sensation of muscle fatigue of workers referring to the individual's sensation at that moment of work. The questionnaire consists of 14 questions with two extremes for each question from 1 to 7 for quantification of the situation, where closer to 1 indicates lower fatigue, and closer to 7 indicates higher fatigue. Participants choose a number according to their perception at that moment, in three stages: at the beginning, middle, and end of the work shift. All stages of the research were conducted at the participants' workplaces.

Lastly, a non-participant observational analysis of the operational environment was conducted for a better understanding of the work routine and ambiance. The research followed the guidelines and criteria established in Resolution 466/12 of the National Health Council (NHC), ensuring the legitimacy, privacy, and confidentiality of information, and all participants signed the Informed Consent Form and authorization for image use.

For preliminary data exploration, descriptive frequency analysis was conducted using Microsoft Excel Office 2010 spreadsheet. Normality tests (Shapiro-Wilk) were performed to analyze possible differences between samples. Spearman's correlation analysis was used to evaluate the relationship between the daily number of hours worked and the chronicity of fatigue (Borg Scale at the beginning of activities). The same analysis was used to compare the

homogeneity of fatigue outcomes at three moments: beginning, middle, and end of the work shift.

To compare Borg Scale results before, during, and after, the Kruskal-Wallis test was used. Pairwise differences were tested using Tukey's post-test. For the bipolar questionnaire, descriptive frequency analysis was conducted using Microsoft Excel Office 2010 spreadsheet.

3. RESULTS

Regarding gender, all participants were men with an average age of 40 years \pm 14.5, ranging from 18 to 60 years, a result similar to that found in the study by SANTOS (2014). This is mainly due to the productive age range in Brazil, where people are most active in their work activities. Additionally, as the researched region is small, a large portion of the population working in the field also lives there, and children often continue working on their parents' property, reflecting the characteristics of family farming. Family farming is characterized by labor within the family group, distinguished by production for self-consumption and daily consumption by the city's population.

Regarding body mass index (BMI), 7 operators (47%) were within normal ranges, indicating low risk for cardiovascular diseases, 6 (40%) were overweight, indicating a risk factor for cardiovascular diseases, and 2 (13.3%) were obese, indicating a high risk for cardiovascular diseases. These data are consistent with the study by ZIANET (2016), in which 46.09% of the workers in the study were overweight, indicating a risk for cardiovascular diseases.

Regarding the hours worked during the harvest period, it was 9.45 ± 1.18 , more than eight hours per day. CAFFAROA et al. (2017) establish the relationship that when an operator works many hours per day, fatigue increases, reducing their alertness, which may lead to a work accident. Table 1 shows the fatigue perception index at three moments, indicating that at the beginning of the work shift, 7 (46.67%) operators experienced moderate fatigue, which persisted throughout the middle and end of the shift.

Table 1 - Classification of the subjective perception index of fatigue at three moments of work activity.

| FATIGUE PERCEPTION | n(%) |
|---------------------------|-------------|
| BEGINNING OF SHIFT | |
| No fatigue | 7(46,67%) |
| Very weak fatigue | 1(6,67%) |
| Moderate fatigue | 7(46,67%) |
| MID-SHIFT | |
| No fatigue | 1(6,67%) |
| Very weak | 1(6,67%) |
| Weak | 2(13,33%) |
| Moderate | 6(40,00%) |
| Strong/Intense | 5(33%) |
| END OF SHIFT | |
| Moderate | 7(47%) |
| Strong/Intense | 2(13%) |
| Very strong/intense | 4(27%) |
| Almost maximum | 2(13%) |

Source: Authors

In Table 2, the subjective fatigue perception index of muscular fatigue at three moments of the work shift is displayed, revealing critical points of moderate fatigue in the lower back, back, left arm, wrist, or hand. The mid-shift fatigue was also evaluated, indicating critical points of intense fatigue in the left arm, hand, or wrist. In the final questionnaire of the work shift, critical points of intense fatigue were observed in the head, lower back, back, thighs, legs, left arm, wrist or hand, neck, shoulders, calmness, tiredness, and compromised productivity.

Table 2 - demonstrates the level of subjective muscular fatigue perception at the beginning, middle, and end of the work shift concerning anatomical points.

| | ABSENT | | MODERATE | | INTENSE | |
|--------------------------|--------|-------|----------|-------|---------|-------|
| | N | Media | N | Media | N | Media |
| INITIAL BIPOLAR | | | | | | |
| Lower Back | 14 | 1,50 | 1 | 5 | - | - |
| Back | 14 | 1,50 | 1 | 5 | - | - |
| Arm, wrist, and hand L | 14 | 1,50 | 1 | 5 | - | - |
| Neck and shoulders | 13 | 1,15 | 2 | 4 | - | - |
| Calm | 14 | 1,5 | 1 | 5 | - | - |
| MID-SHIFT BIPOLAR | | | | | | |
| Lower Back | 12 | 1,17 | 3 | 4,33 | - | - |
| Back | 13 | 1,15 | 2 | 4 | - | - |
| Thighs | 14 | 1,50 | 1 | 5 | - | - |
| Legs | 14 | 1,50 | 1 | 5 | - | - |
| Arm, wrist, and hand L | 14 | 1,50 | 1 | 5 | - | - |
| Neck and shoulders | 11 | 1,55 | 4 | 4,25 | - | - |
| Tired | 13 | 1,25 | 1 | 4 | 1 | 6 |
| Visual disturbance | 14 | 1,50 | 1 | 4 | - | - |
| FINAL BIPOLAR | | | | | | |
| Head | 14 | 1,50 | - | - | 1 | 5 |
| Lower Back | 10 | 1,63 | 2 | 4 | 3 | 6,33 |
| Back | 12 | 1,42 | - | - | 3 | 4,33 |
| Thighs | 14 | 1,50 | - | - | 1 | 5 |
| Legs | 13 | 1,15 | 1 | 4 | 1 | 6 |
| Arm, wrist, and hand L | 10 | 1,50 | 5 | 4,80 | - | - |
| Arm, wrist, and hand R | 9 | 1,44 | 5 | 4,80 | 1 | 6,50 |
| Feet | 15 | 1,07 | - | - | - | - |
| Neck and shoulders | 10 | 1,90 | 3 | 4,33 | 2 | 6,50 |
| Concentration | 12 | 1,46 | 3 | 4,33 | - | - |
| Calm | 13 | 1,38 | - | - | 2 | 6,50 |
| Cansado | 4 | 2,25 | 2,25 | 6 | 5 | 6,40 |

| | | | | | | |
|--------------------|----|------|------|---|---|---|
| Desc. visualmente | 14 | 1,50 | 1,50 | 1 | - | - |
| Prod. comprometida | 13 | 1,31 | 1,31 | 1 | 1 | 6 |

Source: Authors

Another important factor was that all tractors used did not have enclosed cabins. Studies show that the lack of protective cabins can lead to work accidents, as the operator is susceptible to extreme weather conditions and unfavorable sound effects.

Stress among the operators was observed, reflecting in subjective fatigue, as during the harvesting process, episodes occurred where the forage harvester machine broke down or became clogged with the corn being ground; thus, the operators had to stop the harvest and descend to fix the machine to continue the process. If they couldn't fix it themselves, they needed to call a mechanic for assistance to complete the process.

Through the operators' reports at the time of the machine breakdown, it was evident that having to leave their workstation and often take on a task that is not theirs – such as fixing the machine – resulted in lost time in harvesting and generated a high level of stress, as the time the tractor was stopped for repair reflected in a later harvest.

During the collection period, the region's climate was a limiting factor, as the operators did not work on rainy days. Due to the collection being in the off-season (April to July), the sample size was small. It is suggested that the research be conducted during the corn harvest season (November to January) because the work shift is longer due to daylight saving time, and there are other weather conditions, which probably predispose operators to greater fatigue and tiredness.

OLIVEIRA et al. (2013) used the Bipolar Questionnaire for subjective assessment of work fatigue in the rural population and highlighted that work fatigue is present in the population mainly at the end of the work shift, with complaints of leg, back, and lower back pain. The study covered various work activities performed by this class of workers, such as the use of different tools, handling of machinery, chainsaws, sickles, machetes, and manual work in general.

The author also mentions in the study that special attention must be paid to preventive measures regarding the health of these workers, as they are constantly exposed to unfavorable weather conditions, physical and nervous exhaustion, leading to a decrease in work performance and an increase in the risk of accidents during the execution of their activities.

4. CONCLUSION

Through this research, it was possible to confirm that there is muscular fatigue during the operation of agricultural tractors, especially towards the end of the work shift.

It is suggested to pay closer attention to prevention and health promotion for these workers and the rural population in general. Furthermore, new research during peak harvest times is recommended since agricultural activities are still relatively understudied.

REFERENCES

ALCÂNTARA, M.P; NASCIMENTO, R. C; ALENCAR, R. P; PIMENTEL, D. JA.; PINTO, A. V. F. Avaliação dos riscos de acidentes no uso de tratores agrícolas, em uma usina no estado de Alagoas. South American Journal of Basic Education, Technical and Technological. 2017;4(1):2446-4821.

BAESSO, M. M. ; MODOLO, A. J. ; BAESSO, R. C. E.; TROGELLO, E. Segurança no uso de máquinas agrícolas: avaliação de riscos de acidentes no trabalho rural. Brazilian Journal of Biosystems Engineering v. 12(1): 101-109, 2018

BARDIERI, Juan Paulo. Atendimento as normas de segurança e ergonomia nos postos de operação de tratores agrícolas. Dissertação (Mestrado) 129f. UFSM, Santa Maria/RS. 2017

BRASIL. Prefeitura Municipal De Coronel Freitas. Localização. Disponível em: <www.coronelfreitas.sc.gov.br> Acesso em 05 dez 2017

CAFFAROA, F.; CREMASCIOB, M. M.; ROCCATOC, M.; CAVALLOA, E. It does not occur by chance: a mediation model of the influence of workers' characteristics, work environment factors, and near misses on agricultural machinery-related accidents. *International Journal of Occupational and Environmental Health*, VOL. 23, NO. 1, 52–59 [10.1080/10773525.2017.1404220](https://doi.org/10.1080/10773525.2017.1404220). 2017

CARDOSO, M. S; GONTIJO, L. A. Avaliação da carga mental de trabalho e do desempenho de medidas de mensuração: NASA TLX e SWAT. *Gestão & Produção*, 2012. 19(4), 873-884. Acesso em jun 2017

COUTO, H. A. *Ergonomia Aplicada ao Trabalho: Manual técnico da Máquina Humana*. Belo Horizonte: Ergo Editora; 1996.

DEFANILG C.J; XAVIER, A. A.; Fadiga no Trabalho: estudo de caso na agroindústria. XIII SIMPEP - Bauru, São Paulo, Brasil, 6 a 8 de Novembro de 2006

DE SOUZA OLIVEIRA et al. Fadiga Empregados Em Trabalhadores Rurais. *Revista da Rede de Enfermagem do Nordeste* 2013. Acesso em 17 de dez 2018

FERNANDES, H. C; FILHO P. F. S; QUEIROS, D. M; CAMILO, A. J; REIS, E. F. Vibração em tratores agrícolas: caracterização das faixas de frequência no assento do operador. Dissertação. Viçosa/ MG: – DEA/UFV Engenharia na Agricultura; 2003 acesso em set 2017.

IIDA, I; BUARQUE, L. *ERGONOMIA: Projeto e Produção*. 3ª edição revisada 2016 p 134, 607, 608, 739, 742, 743.

MARCON, L. C. Análise Ergonômica Das Condições Do Trabalho De Operação De Tratores Agrícolas.2013. 81f. Monografia de Curso de Pós-graduação Lato Sensu UNESC. Criciúma. Acesso em: 23 set. 2017

Martins AJ, Ferreira NS. A Ergonomia no Trabalho Rural. Rev. Eletrônica. Atualiza Saúde,[internet]. 2015. Acesso em set 2017

PASTÓRIO, I.T; ROESLER, M. R; PLEIN, L. Condições de trabalho e saúde mental do/aTrabalhador/a rural: desafios e perspectivas no desenvolvimento rural. Revista Geo Pantana (24): 129-146. 2018.

PIERONI, G. B. Análise ergonômica do trabalho florestal em uma empresa de produção de madeira em toras. Monografia Especialização de Engenharia da Produção 65 f. PATO BRANCO - PR 2014

SANTOS, V. C.; MONTEIRO, L. A.; MACEDO, D. X. S.; CHIODEROLI, C. A.;ALBIERO, D.; avaliação antropométrica do operador de tratores agrícolas da região do litoral leste do ceará. XLIII Congresso Brasileiro de Engenharia Agrícola – CONBEA. Centro de Convenções “Arquiteto Rubens Gil de Camillo”- Campo Grande -MS 2014

ZIANIET, F. C.; ADAMI, F. S; FASSINA, P. Avaliação do risco cardiovascular de adultos atendidos em unidade básica de saúde. Revista UNINGÁ Review.Vol.26,n.1,pp.23-29. Rio Grande do Sul. 2016