Self-reported pain and trunk posture during pruning activity among vineyard workers at the Château Larose-Trintaudon

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Abstract. This paper presents the first stage of our project aiming at preventing work-related musculoskeletal disorders and improving work conditions for the Château Larose-Trintaudon (Saint-Laurent Médoc, France) vineyard workers: an ergonomic assessment of vine pruning activity was conducted. Self-reported musculoskeletal pain increased throughout the working day in the lower back region. Furthermore, video analysis during real working conditions revealed that pruning activity exposed vineyard workers to a high risk of developing WMSD. The vineyard workers frequently adopted trunk-thigh postures considered 'extreme'. The present ergonomic evaluation strongly suggests that back pain is an important health issue among the vineyard worker population.

Keywords. Vineyard worker; grapevine pruning activity; work-related musculoskeletal disorders; self-reported localized musculoskeletal pain assessment; video analysis.

1. Introduction

According to the French National Health Insurance annual report published in 2010, there were 658 000 episodes of absence from work for sick leave in France. A majority of all the days off for illness was due to work-related musculoskeletal disorders (WMSD). In its 2005-09 Health and Security Plan at work, the "Mutuelle Sociale Agricole" (MSA - French agricultural mutual insurance system) reported that WMSD counted for more than 95% of sick leave. Among all the farming sectors, viticulture is the top sector affected by WMSD.

The Château Larose-Trintaudon, St Laurent-Medoc (France) is the largest vineyard in the Médoc with approximately 225 hectares. It produces more than one million bottles of wine per year and is one of the main employers of vineyard workers in the Médoc area (30 permanent vineyard workers).

Despite a will to improve the working conditions by e.g., adapting work shifts, weekly equipment maintenance and professional training for the workers, the Château Larose-Trintaudon is still facing an increasing number of absences for sick leave among its vineyard worker employees (Table 1). Furthermore, most of the workers' complaints

identified during the 2010-2012 period occurred during winter work and, more specifically, during the grapevine pruning activity.

Table 1. Number and percentage of working days lost due to sickness per year for the Larose-Trintaudon vineyard workers between 2010 and 2012.

Years	Number of working days per year	Number of working days lost due to sickness per year	Percentage of working days lost due to sickness per year
2010	7650	723	9.4
2011	7590	995	13.1
2012	7590	1325	17.4

Within this context, taking the high prevalence of WMSD especially in the vineyard workers' lower-back region during vineyard work, we were encouraged to perform an ergonomic assessment during the pruning season.

This paper presents the first stage of an intervention aiming at preventing WMSD and improving work conditions for the Château Larose-Trintaudon vineyard workers.

Our aim was to collect and analyze (1) self-reported musculoskeletal pain ratings among vineyard workers during a working week of pruning activity and (2) video recording of the grapevine pruning activity.

2. Methods

2.1 Study sample

Study participants consisted of a sample of 11 vineyard workers employed at the Chateau Larose-Trintaudon, St Laurent-Medoc, France.

Table 2 presents the characteristics of the 11 participants who voluntarily participated in the present study.

Characteristics	n = 11
Men	6
Women	5
Age (years)	45.4 (6.3)
Height (cm)	166.6 (6.1)
Weight (kg)	72.2 (12.4)
BMI (kg/m²)	25.9 (3.2)
Vineyard experience (years)	18.7 (6.6)

Table 2. Characteristics of the vineyard workers, means (SD).

All 11 participants gave their informed written consent to the experimental procedure as required by the Helsinki declaration and the local Ethics Committee. In addition, all the collected data were managed by the MedSafe technology by the IDS Company (Montceau-les-Mines, France). IDS is an approved hosting provider in personal health data by the French Ministry for Social Affairs and Health.

2.2 Self-reported musculoskeletal pain ratings

The vineyard workers were instructed to indicate their pain ratings in 22 anatomical regions of the body on an adapted body map using a 0-10 numeric pain rating scale (0: 'No pain'; 10: 'Worst possible pain'), twice a day (before the start and after the end of the

working day of grapevine pruning) during five consecutive working days of grapevine pruning (from Monday to Friday) at the beginning of January, 2014.

The 22 anatomical regions were selected using a modified French version of the standardized Nordic Questionnaire (Kuorinka et al., 1987): neck, lower back, right and left shoulders, right and left elbows, right and left wrists, right and left triceps, right and left forearms, right and left thighs, right and left knees, right and left ankles, right and left calves, right and left heels.

2.3 Video-based analysis of the grapevine pruning activity

The 11 winegrowers were video recorded *in situ* in the Château Larose-Trintaudon vineyard during 12 minutes of pruning activity. The pruning activity consists in selecting two branches from the grapevine, which will bear grapes. In order to select these 2 branches, the vineyard workers have to bend their trunk over and then cut all the others branches using manual or electric shears.

In the present study (based on the prevalence of WMSD in vineyard workers at the Château Larose-Trintaudon vineyard and on the results from the self-reported musculoskeletal pain rating assessment), we focused on the biomechanical assessment of the lower back region. More precisely, we assessed trunk-thigh angle during the performance of pruning activity. To do so, the observer first recorded the pruning activity perpendicularly to the vineyard worker. Video analysis started at the moment when the vineyard worker cut the first branch. Using the Kinovea software (http://www.kinovea.org/), on each video, we placed 3 notable anatomic landmark points on each vineyard worker, (1) shoulder, (2) pelvis and (3) knee (Figure 1). For each video, we were then able to calculate trunk-thigh angles and the time the vineyard workers maintained trunk-thigh angle in the following 10 intervals : Inferior to 90°, [91°-100°], [99°-110°], [111°-120°], [121°-130°], [131°-140°], [141°-150°], [151°-160°], [161°-170°] and [171°-180°]).

Figure 1. Assessment of trunk-thigh angle during the pruning activity.
The 3 notable anatomic landmarks (shoulder, pelvis and knee) used to calculate trunk-thigh angle are represented by three crosses.

2.4 Statistical analysis

Self-reported musculoskeletal pain assessment

A three-way analysis of variance (ANOVA) with 5 Days (Monday *vs.* Tuesday *vs.* Wednesday *vs.* Thursday *vs.* Friday), 2 Periods (Before the start of the working day of grapevine pruning *vs.* After the end of the working day of grapevine pruning) and 22 Anatomical regions (Neck *vs.* Right shoulder *vs.* Left shoulder *vs.* Right elbow *vs.* Left elbow *vs.* Right wrist *vs.* Left wrist *vs.* Right triceps *vs.* Left triceps *vs.* Right forearm *vs.* Left forearm *vs.* Lower back *vs.* Right thigh *vs.* Left thigh *vs.* Right knee *vs.* Left knee *vs.* Right ankle *vs.* Left ankle *vs.* Right calf *vs.* Left calf *vs.* Right heel *vs.* Left heel) as

independent factors was applied to the data.

Video-based analysis of trunk-thigh angle during grapevine pruning

A one-way ANOVA with Trunk-Thigh angles intervals (Inferior to 90° *vs.* [91°-100°] *vs.* [99°-110°] *vs.* [111°-120°] *vs.* [121°-130°] *vs.* [131°-140°] *vs.* [141°-150°] *vs.* [151°-160°] *vs.* [161°-170°] *vs.* [171°-180°]) as independent factor was applied to the data. Post-hoc analyses were used whenever necessary. Level of significance was set at 0.05.

3. Results

3.1 Self-reported musculoskeletal pain ratings

The statistical analysis detected two significant main effects: Period ($F(1,10)=8.52$, $P<0.05$) and Anatomical region ($F(21,210)=8.23$, $P<0.0001$), as well as a significant two-way interaction Period × Anatomical region ($F(21,210)=4.06$, $P<0.0001$).

Figure 2 illustrates this two-way interaction and presents the mean + SD of the self-reported musculoskeletal pain ratings obtained before the start and at the end of the working day of grapevine pruning obtained for each of the 22 anatomical regions.

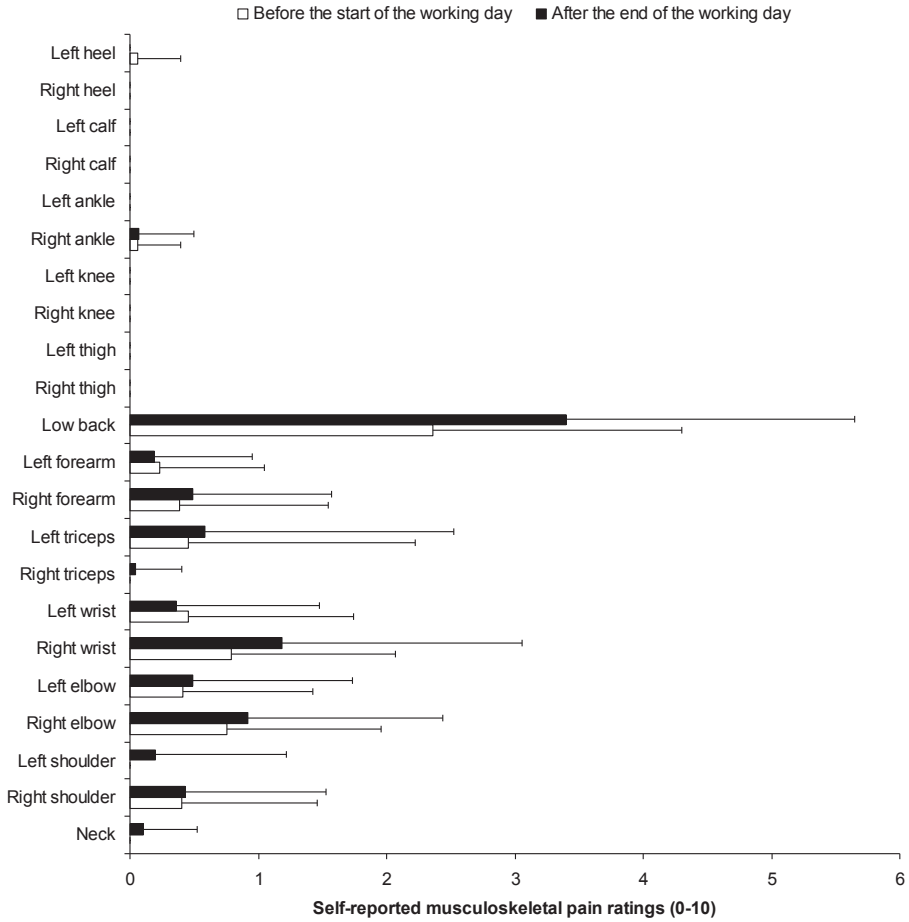

Figure 2. Mean + SD of the self-reported musculoskeletal pain ratings before the start of the working day of grapevine pruning and at the end of the working day of grapevine pruning obtained for the 22 anatomical regions.

The decomposition of this two-way interaction into its simple main effects indicated significantly higher pain rating in the lower back region compared with the other anatomical regions ($P<0.0001$). Furthermore, the pain rating in the lower back region was

significantly higher at the end of the working day compared with the start of the working day of grapevine pruning (P<0.0001).

3.2 Video analysis of trunk-thigh angle during grapevine pruning

Figure 3 presents the percentages + SD of work time spent by the vineyard workers in the 10 Trunk-Thigh angles intervals during a 12-min grapevine pruning activity.

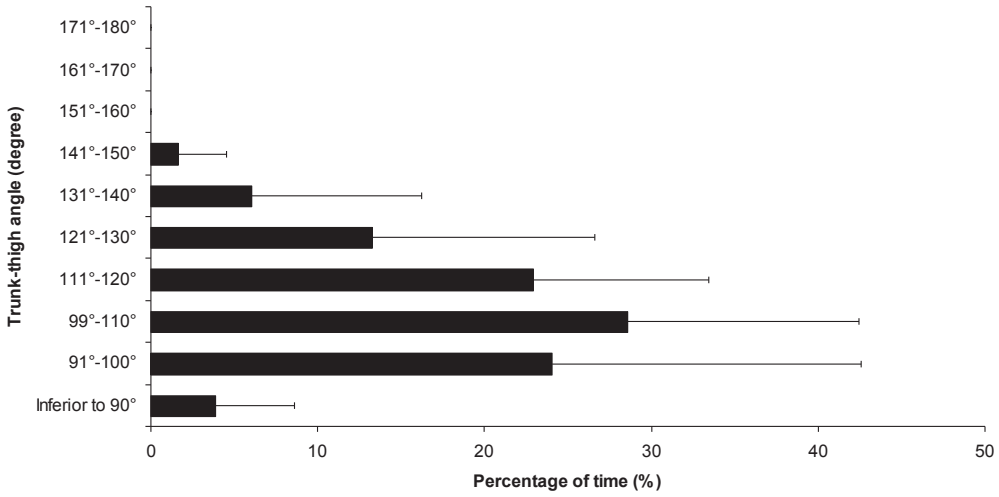

Figure 3. Mean + SD of the percentages the winegrowers spent in different Trunk-Thigh angles intervals during the 12-min grapevine pruning activity.

The statistical analysis showed a significant main effect of Trunk-Thigh angle interval (F(9,90)=13.8, P<0.0001). The post-hoc analysis further indicated that the percentages of pruning working time spent with the trunk-thigh angles comprised in the three intervals of [91°-100°], [99°-110°], and [111°-120°] were significantly larger than those spent in the seven other intervals (P<0.05).

The descriptive analysis further showed that the vineyard workers never maintained a trunk-thigh angle greater than 150° during the grapevine pruning activity. The vineyard workers spent 100% of their working time with trunk-thigh angle less than 150° and 79% of their working time with trunk-thigh angle less than 120°.

4. Discussion and Conclusion

The results of the self-reported pain ratings indicated that the most painful region among vineyard workers was the lower back area (Figure 1). Our observation is in accordance with two recent studies that have concluded that the back is the anatomical region with the highest prevalence of musculoskeletal pain in vineyard workers (Bernard et al., 2011; Brumitt et al., 2011). More originally, our results further revealed that self-reported pain from the lower back significantly increased throughout the working day of vine pruning. This suggests that the pruning task *per se* could increase the risk of chronic or recurrent musculoskeletal lower back disorders in vineyard workers. Meyers et al. (2004) have indicated that the most prominent risk factors for back injury in vineyard work include repetitive lifting/carrying of heavy loads, repetitive exertion of force by the trunk and upper extremities, tractor driving and more notably repetitive or sustained awkward postures of the trunk.

Considering the biomechanical characteristics of the pruning task, we carried out a 2D kinematic analysis of vineyard workers performing daily pruning work to estimate the

biomechanical exposure of the back. The present field study was conducted in real working conditions. Thus, the work organization (e.g. piece-rate), incentive schemes and the physical environment of the work place (e.g. temperature, humidity and tool quality) were considered. The present study presents some limitations in terms of its duration and size of the population investigated. However, this study provides new genuine information related to the biomechanics of vine pruning. The kinematic analysis showed that the vineyard workers spent 100% of their working time with a trunk-thigh angle less than 150° and 79% of their working time with a trunk-thigh angle less than 120° (Figure 3) during grapevine pruning. These results suggest that the pruning activity is associated with a high risk of developing WMSD in the lower back. The adoption of frequent and continuous trunk-thigh postures can be considered as 'extreme'. These analyzes suggest a link between the pain ratings in the lower back and the postural constraints associated with this task (Bernard et al., 2011). As such, the reported complaints are closely linked to the adopted posture at work (Madeleine and Madsen, 2009). Moreover, the kinematics data can be used in a participatory ergonomic approach (Hanse and Forsman, 2001) to provide the workers with interactive information about awkward postures. Thanks to this field ergonomic evaluation among vineyard workers at the Château Larose-Trintaudon during the vine pruning activity, the AGIM Univ. Grenoble-Alpes members in close collaboration with the Center for Sensory-Motor Interaction (SMI) at Aalborg University are now developing a project based on a physical activity program aiming at reducing pain in the lower back region and preventing WMSD among vineyard workers.

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