IEA 2009
17TH WORLD CONGRESS ON ERGONOMICS AUGUST 9-14 BEIJIN, CHINA

Repetitive movements of upper limbs in agriculture: set up of annual exposure level assessment models starting from OCRA checklist via simple and practical tools

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Risks of upper extremity musculoskeletal disorders are not well investigated in farmers. This study performed risk assessment in some farms in Italy (Tuscany, Piedmont and Marches). To obtain an exposure index, we previously analysed work organization recording all the tasks. Then we performed the analysis using the OCRA checklist. The task analysis showed an intrinsic high risk. Limited to the Tuscany case the workers were submitted to a clinical examination especially finalized to study the spine and upper limb work related musculoskeletal disorders.

The OCRA method is the reference method chosen in ISO (ISO 11228-3) and CEN (EN 1005-5) standards regarding risk assessment and management of upper limbs repetitive movements and exertions. The method consists of two specific tools (OCRA index and OCRA checklist) that will be shortly presented together with definitions, criteria and procedures for assessment of work conditions with biomechanical and physiological overload of upper limbs. Special attention will be devoted to analysis of multiple repetitive tasks.

The aim of this study is to define alternative analytical methods to establish the cumulative exposure level to agricultural work tasks or other works characterized by annual distribution, given that quality and duration of the work depend on the month.

The first survey results, though still preliminary and concerning a small case report, evidenced that one of the alternative analytical methods proposed show a good association between high values of the OCRA check list and the development of musculoskeletal disorders.

The future objective of the research (once more epidemiological data have been obtained) will be to create a simple, practical tool (software) to estimate annual risk exposure using pre-established calculation models. Once the intrinsic values of each task characterising a particular form of agriculture have been precalculated, the annual exposure level can be calculated immediately, simply by asking the worker which tasks are performed, month by month, over the year.

Keywords: "upper extremities musculoskeletal disorders", "annual exposure", "risk assessment tools

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) of upper limbs (UL) and spine, in the last 35 years, have become extremely widespread, reaching epidemic levels, in all advanced industrialised countries [Hagberg et al.1995]. Up to recent times in Italy, no particular attention was paid to these disorders. However some occupational health professionals underline that the first results of the local studies show that the level of the problem is the same as reported in other western countries (Colombini et al, 1996)

For the origin of UL-WMSDs it must be recalled that some organizational and biomechanical factors (frequency and repetitiveness of movements, use of force, type of posture and movements, distribution of recovery periods, duration of exposure) have to be considered. There are other risk factors (additional factors) that might enhance the overall risk.

In International literature the frequency of WMSDs and spinal disorders are not well investigated in farmers. A cross sectional study conducted among 537 workers pruning grapevines in the region of Champagne emphasized a prevalence of nocturnal hand paresthesias and hand wrist pain (37 and 12% respectively). All workers completed a questionnaire about nocturnal hand paresthesias and musculoskeletal pain during a period of 12 months (Roquelaure et al, 2002. The development of hand paresthesias, which affected a third of employees, was different from hand paresthesias observed in industrial workers since most vineyard workers recovered without medical treatment after the pruning season. In a another study (Roquelaure et al, 2002) the same authors evaluated biomechanical strains on the hand-wrist system during grapevine pruning through surface electromyography activity of the right flexor digitorum muscle and wrist posture. In this way the authors emphasized high biomechanical strain with maximal voluntary handgrip contraction of 23,5 %. Numerous cuts required moderate or extreme ulnar deviation.

More recent European statistical data regarding upper limb musculoskeletal disorders (EUROSTAT 2006) show that sectors in leading position (after manufacturing) are construction, fishing and agriculture. In 2004 in the agricultural sector, 51% of all recorded work-related diseases, are upper limb musculoskeletal disorders. In Italy, in 2005, WMSDs (spine and upper limbs) recorded in agriculture, are nearly 60% of all work-related diseases. These data confirm the need to tackle more systematically this issue in the specific sector.

This study performed risk assessment in some farms in Italy (Tuscany, Piedmont and Marches). Limited to the Tuscany case the workers were submitted to a clinical examination especially finalized to study the spine and upper limb work related musculoskeletal disorders. The results were inserted in a dedicated software.

OBJECTIVES

Traditional risk assessment methods for multitask involving upper limbs repetitive movements generally concentrate on typical daily exposure: however, in agriculture, exposure varies in duration and type over the period of one year.

The aim of this study is:

- to define a peculiar procedure for a preliminary analysis of all the manual tasks characterised by one year distribution through the use of a special multitask assessment models to evaluate the cumulative exposure level in agricultural jobs and for all manual jobs having the common characteristic of an annual distribution
- in order to validate those calculation models, they should be compared to the occurrence of UL-WMSDs traced (by an active health surveillance program) in several groups of workers in different agricultural sectors. This will help identify the best predictive model (of health effects) considering the specific combination of exposures over a year range.

Thus, the final objective of the research presented here is to create a simple, practical tool (software) devoted to OSH practitioners by which they can estimate annual risk exposure using pre-established calculation models: in fact once the intrinsic exposure values of each task, characterising a particular form of agriculture, have been pre-calculated, the annual exposure level can be calculated immediately, simply by asking the worker which tasks are performed, month by month, over the year.

These tools can be considered as “good practice” tools, in that they enable occupational safety and health operators, agriculture managers, ergonomists, occupational doctors but also occupational health authorities and insurance institutes to better identify exposure levels for this type of workers and address consequent prevention programs with related priorities.

METHODS

General methods for assessment of exposure levels to works characterised by multi-task turnover

When dealing with an exposure risk assessment (from upper limb biomechanical overloading) to multitask works, it is necessary to go through 3 operating stages:

a) facing a preliminary organizational study to establish cyclic turnover that is the periodicity with which the different tasks to be implemented by the worker (or the homogeneous group of workers employed in the same tasks in the considered period) repeat in time: daily or weekly or monthly or yearly.

b) defining the risk level inherent in each task (intrinsec level), using the OCRA checklist. Intrinsic level means ascribe to the task a net duration of 440 minutes/shift with 2 pauses of 8-10 minutes each and a lunch break of at least 30 minutes.

c) applying specific mathematical models assessing exposure to “multitasks”.

As to calculation procedures, the 3 stages will be tackled for yearly cycle multitasks.

Cyclical turnover and organizational studies on exposure to yearly multitasks.

While in the industry turnover periodicity is typically daily, in other productive sectors this periodicity is longer: for example in agriculture it is typically yearly. Each month of the year is characterized by different processing, each including different tasks. Priority objective to this organizational study stage is identification of workers’ homogeneous group carrying out the same tasks over the year: which and how many workers are involved and which tasks they carry out.

Two solutions are proposed for studying the exposure duration to developed tasks: (a) a semi-qualitative option, which is simpler, when only few information are available (e.g. from worker(s)’ interviews) and (b) the quantitative option based on knowledge of hours actually worked in the month per each task.

(a) Simplified organizational study (SEMI-QUALITATIVE MODEL)

Table 1 shows a preliminary example of simple identification of the different tasks carried out by the same workers’ group (homogeneous group by job) over one year.

It preliminarily reports:

- the nome of the different tasks carried-out in the year (A, B, C,…)
- the number of days actually worked in the month
- the processing carried out in that month (marked by 1)

These simple data already provide useful information through calculation of percentage using exposure constants. These constants are: 20 days of work a month over 11 months a year.

The first calibration procedure, through time constants, is carried out to calculate in percentage the exposure days per month: when the percentage exceeds 100, it means that the worker that month has worked more than 20 days.

This first percentage ascribes a semi-qualitative duration value to the tasks developed in the month and above marked by 1 (Table 1). In the example reported in Table 2, if in one month two tasks are carried out (see February with a 100% value: he/she has worked for 20 days), each task is ascribed the half-month duration (0.5). If on the contrary in one month 2 tasks are carried out (see July with a 113% value, i.e. he/she worked over 20 days), each task is ascribed 0.6 proportional duration (a little more than half a month).

Then such numbers are summed up in horizontal, deriving the number of “fictitious” months worked for each task in the year. Such data will allow to derive the “assessed” percentages corresponding to each task in the year (% of fictitious months worked as calibrated on the 11-month constant).

(b) Quantitative organizational study (ANALYTICAL MODEL)

Sometimes it is not so difficult to obtain more accurate exposure data (per month) such as detail of worked hours: actually these data are available in agricultural business being the basis for workers' salary (Table 3).

With these data the proportional distribution among tasks over the year can be easily obtained being derived for each task as a percentage on the total of hours worked in the year (Table 4).

The obtained percentages outline the intrinsic time distribution present among developed tasks

In addition to describes the intrinsic time distribution of the tasks presented in Table 4, it is necessary to reassess the proportion by weighting them on "worked time constants". Table 5 shows the generic working duration constants expressed in hours/month (160), days/month (20), days/year (220), months work/year (11), worked hours/year (1760)

Starting from the constants reported in Table 5, we can calculate the weighted proportional distribution among the tasks developed in the year.

Worked hours/month constant	**160**	Working month constant	**11**
Worked days/month constant	**20.0**	Working hour/year constant	**1760**
Worked days/year constant	**220**		

Table 5 – Duration constants of generic working activity to be used to weight exposure duration.

The example reported in Table 6 evidences that the total of worked hours/year is 1680: considering that the constant used is equal to 1760 hours, there is a 0.5% reduction of working activity. The result is that the percentages reported in the column of weighted proportional distribution are lower that those of intrinsic proportional distribution. If by contrast, the total of worked hours exceeds the constant, the % reported in the column of calibrated proportional distribution will be higher.

OCRA checklist for assessment of risk intrinsic level

The OCRA method (Colombini et al. 1996, 2005), now ISO (ISO 22228-3) and CEN (EN1005-5) standards always was developed accounted for, in its assessment criteria, the orientations of the scientific literature available on this topic. For the assessment of the work involving a potential biomechanical overload of upper limbs, it suggests to identify and quantify the following main risk factors which characterise a work-related exposure to repetitive tasks. They are: frequency of high action, excessive use of force, awkward and/or stereotyped upper limb movements and postures, lack of appropriate recovery periods, complementary risk factors, net duration of the repetitive task(s).

The OCRA method proposes two risk analysis tools: OCRA index and OCRA checklist.

OCRA checklist, is the priority analytical model both during the first risk assessment stage in a given working situation (mapping stage). Like OCRA index, the OCRA checklist consists of 5 parts dedicated to the study of the four main risk factors (lack of recovery periods, frequency, force, awkward postures) and complementary factors (vibrations, cold temperatures, accurate works, counterblows, etc.).

The analytical scheme proposed by OCRA checklist identifies pre-established numerical values (increasing versus risk increase) for each of the 4 main risk factors and for each complementary factor.

The sum of the obtained partial values produces a numerical figure allowing to assess the exposure level through a relationship with OCRA index values in a variety of ranges (green, yellow, red, purple), as described in Table 7.

After tackling the first organizational study stage (identification of developed tasks and turnover times, time proportion in the final cyclic period, shift net duration and break distribution), the study aimed at obtaining final exposure levels needs research of intrinsic OCRA checklist final value of each identified task.

When speaking of intrinsic value, we mean assessing each task as if it were the only task developed along the whole shift (approx 440 net minutes of repetitive value with a lunch break of at least 30 minutes and two breaks of minimum 8 minutes).

Table 8 reports the examples of risk assessment with checklist on a group of processing developed in one year. Assessments are to be referred to one limb (in this case the right one) maintaining the score of each risk factor. The final score expresses the value of intrinsic index

b) rotation occurs less than once per hour: when the rotation occurs less than once per hour, we cannot use the formula of weighted average that would tend to under-evaluate exposure.

In this case the mathematical model uses the "worst working situation" (the task most at risk recalculated in relation with its real duration as well as with the total duration of all repetitive tasks in the shift): this first estimation is to be weighted with the values and durations of all the other repetitive tasks present in the shift. The complex formula used is the following

The OCRA checklist: summary of calculation models for daily rotation multitask exposure.

When the repetitive task turnover is daily, 2 events may occur:

a) rotation occurs at least every hour: in the former case, for exposure calculation, the time weighted average of final intrinsic risk indices of each task is calculated using the following formula:

$$[(pA \times \%\, tA) + (pB \times \%\, tB) + \ldots + (i..pN \times \%\, tN)] \times Md \quad (1)$$

where

- "pA", "pB", etc. are the checklist intrinsic scores of each task and %tA, %tB etc. represent the corresponding duration proportions (in %) in relation to the total duration of repetitive tasks developed in one shift (100% in all cases)

Md = duration multiplier considering the total net duration of repetitive tasks in the shift that is the sum of each repetitive task duration (Table 9)

b) rotation occurs less than once per hour: when the rotation occurs less than once per hour, we cannot use the formula of weighted average that would tend to under-evaluate exposure.

In this case the mathematical model uses the "worst working situation" (the task most at risk recalculated in

relation with its real duration as well as with the total duration of all repetitive tasks in the shift): this first estimation is to be weighted with the values and durations of all the other repetitive tasks present in the shift. The complex formula used is the following

(2) complex Checklist final score = $score_{1(Dm1)} + (\Delta score_1 \times K)$

where

1,2,3,…,N = repetitive tasks ordered according to checklist score values (1= highest; N = lowest) calculated considering the actual duration respective multiplier (Dm_i)

$score_1$ = score of task $_1$ considering Dm_1

Dm_i = duration multiplier according to actual duration of task

Dm_{tot} = duration multiplier for total duration of all repetitive tasks

$\Delta score_1$ = highest score considering Dm_{tot} (selected among N tasks) - score of task $_1$ considering Dm_1

where

$$K = \frac{(score_{1\,max} * FT_1) + (score_{2\,max} * FT_2) + \ldots + (score_N * FT_N)}{(score_{i\,max})}$$

$score_{i\,max}$ = score of $task_i$ considering Dm_{tot}

FT_i = Time fraction (values between 0 and 1) of task, as compared with repetitive total time.

OCRA checklist: assumptions of calculation models for yearly rotation multitask exposure.

It has been already emphasized that the traditional exposure calculation models proposed by the OCRA method were focused on daily exposure study.

Always starting from OCRA method theoretical grounds, we are now testing a variety of assumptions of mathematical models allowing to calculate in the near future the cumulative exposure level also for multitask exposures in these non-daily cycle time ranges.

Starting from the data derived from the two (semi-qualitative and analytical) organizational data collections, three calculation models were assumed: a) the traditional weighted average for exposure time; b) the traditional weighted average but redefined on time constants; c) complex multitask formula for OCRA.

a) Calculation of average index weighted by exposure time

It is the same as above reported when repetitive task rotation occurs at least every hour (formula 1).

As regards this calculation hypothesis, it will tend from time to time to under evaluate or over evaluate exposure since it is not able to take into due account the monthly exposure duration likely to vary during the year.

Before calculating the weighted average, it will be necessary to evaluate:

- duration and distribution of breaks and non repetitive tasks
- the net duration of repetitive tasks in a typical day of the year (ea: in the specific case of 380 minutes with the corresponding duration multiplying will be factor 0.95)
- the OCRA checklist intrinsic values of each task re-evaluated considering the actual, above reported, organi-zational factors present in a typical shift.

Table 10 shows the whole procedure and final values calculated using formula (1).

b) Calculation of weighted average index on exposure constants

Recalling the concept of time constants presented in Table 5, time proportions re-weighted for indicated constants will be used to make the calculation of weighted average. An example of final evaluation (data by Table 6). is given in Table 11.

The example reported in Table 11 clearly shows that the exposed staff works in the year for a time slightly lower than identified time constants (5% less). Even the exposure proportions of tasks appear to decrease as compared with those indicated for the previous calculation method, hence the final index is lower than the one obtained calculating the classical weighted average (Table 10). The opposite would occur for exposure times exceeding the constants.

c) Calculation of exposure index with the OCRA Multitask Complex model

The calculation assumes application of Multitask Complex Model already presented for assessment of daily exposure to several tasks with rotation exceeding one hour (formula 2):

To be able to calculate Dum_i (duration multiplier of each task in the year), it was devised to:

- reduce the exposure period to a fictitious working shift
- transform the yearly exposure proportion (those re-weighted considering duration constant) into fictitious shift minutes (Table 12).

This allows to obtain exposure multipliers regarding the real duration of each task needed to apply this calculation model.The formula used to calculate such fictitious minutes is the following:

(3) %Task duration (weighted on time constants) x total net duration of shift repetitive works

Then, always for each upper limbs, we will assess two values of OCRA checklist for each task (Table 13)

- considering the total exposure time to shift repetitive tasks (INDEX MAX)
- using partial times (PARTIAL TIME INDEX).

The checklist values thus obtained are ordered by severity.

Once the K factor has been obtained, it will be possible to proceed to calculate final exposure values for the Multitask Complex OCRA (Table 13).

By comparing now the results obtained with the 3 different proposed calculation models, some differences are visible: in this case the classical weighted average over-estimates the weighted average over exposure constants. The Multitask Complex model, though being based on exposure constants, is the highest (Table 14).

Obviously according to whether input data are derived from the SEMIQUALITATIVE or ANALYTICAL organizational data collection model, results may vary because of the different degree of accuracy of obtained information.

RESULTS

Results of the evaluation of exposure index (checklist score) in different kinds of cultivations.

Table 15 shows the results of the OCRA checklist score (and their determinants) obtained in several vine-growing tasks as recorded in a sample of farms in different Italian regions. The results show that most analyzed tasks, if individually considered as performed all the time, are included in the red/violet area of exposure. This means, in general, a high risk of biomechanical overload of the upper extremities. On the other side, the table shows which kind of analytical output should be derived for each agricultural kind of cultivation to help practitioners fill in data on yearly exposure to the different tasks. Table 16 shows similar data for peach cultivations: also for this kind of cultivation, most of the analyzed tasks are included in the red-violet band of OCRA check list.

Results of preliminary epidemiological studies and predictivity assessment of annual exposure complex models

The percentages of the pathologies were estimated on the total number of the exposed workers at the beginning of the clinical examination (no= 125) even if it was not possible to visit all the workers. Only 42 of 125 exposed workers were allowed to submit to a clinical examination by a specialist in rheumatology. The medical doctor did only clinical diagnosis (without instrumental clinical tests) deriving the information in table 13. In the future the clinical diagnosis will be completed by means of more objective and specific instrumental tests.

This work hypothesized 3 new calculations of final exposure level, each leading to different final exposure results. Now the point is to define which is the best exposure estimator, that is in other terms, the best “predictor” of upper limb WMSDs reported in a population of exposed subjects. This can be checked considering the already known OCRA method association (predictivity) with the prevalence of exposed workers (% PA) affected by one or more UL WMSDs. This association is expressed by the following linear equations

(4) %PA (Pathological subjects) = 2.39 (± 0,14) x OCRA index
$\%PA=(\text{OCRA checklist})^{1,004}$

Owing to the strong association, it is also possible to identify the best OCRA checklist score, PA % being known through formula:

(5) OCRA checklist = $\%PA^{(1/1,004)}$

This methodological approach, beyond some theoretical limits, will be very useful practically speaking, as clinical data from workers exposed to different manual tasks along one-year period become available. In fact they will allow to establish with increasing certainty the mathematical models better associating with traced prevalence of pathological subjects (%PA). This check has been possible for the time being only over a very small set of (exposure and disease) data collected in two small farms. All the calculation models presented in this study were tested with such data. The results are reported in Table 17: column 3 reports PA% values traced in all farms. Column 4 reports the value of OCRA checklist expected starting from actually present PA% (column 3). In the subsequent columns, for each calculation model proposed, the actually calculated exposure value and corresponding error % as to expected value are expressed.. Notice that the exposure assessment traditional method for study of daily shifts tends to underestimate the risk (column 5), while the proposed method in column 8 (OCRA Multitask Complex analysis model) seem to provide a good predictivity of actually traced PA%. It is noteworthy that the results of such reliability checks of proposed calculation models are still hypothetical because of the small number of cases considered.

The total exposed population was composed by 125 workers: 82 males and 43 females: they operated in 4 farms in Tuscany. Only 42 of them were allowed to submit to a clinical examination by a specialist in rheumatology: 22 males and 20 female. The average age of the group is 49 (range 23-77) for males and 44 for females (range 27-59); the average working time in pruning is 10 years (range 1-42) for males and 5 years (range 0,5-15) for females. In Table 18 and 19 the percentage of the affected workers are reported.

In Figure 1 the different distributions for joint of the UL-WMSDs and Figure 2 the prevalence of UL-WMSDs for number of pathologies/person are reported for males and females. In the diagrams the presence of high percentages of right wrist tendinytis and Carpal Tunnel Syndrome is evident both in males and females.

CONCLUSIONS

In view of upper limb biomechanical overload risk assessment in works varying in the different months of the year, typically in agriculture, a methodology is presented including:

- pre-assessment with accredited traditional methods such as OCRA method (OCRA checklist) of each manual tasks typical of a given job or cultivation.
- set up of anamnestic schemes of more or less detailed information collection on times and ways of different task performance during the year by one or more workers.
- use of mathematical models (still to be validated) to assess annual cumulative exposure given the type of works and related performance times.

As regards the latter, a methodology has been set up to identify the “most reliable” ones in relation to the well known trend of associations between exposure indicators and illness (collective) indicators. Completion of the first presented studies, together with the collection of more numerous clinical data together with exposure ones, will allow to set up exposure assessment methods easily applicable not only to agriculture but also to all working activities with rather long periodicities (months), to activities with year fractions (task rotations in the year) and more generally to all situations involving cyclic rotation of workers on working tasks not only on a daily basis. As already said, the final objective of this work is to create a simple, practical tool (applicable by a simple and free software) to estimate annual risk exposure using predetermined calculation models. Once the intrinsic values of each task characterising a particular form of agriculture have been pre-calculated, the annual exposure level can be calculated immediately, simply by asking the worker which tasks are performed, month by month, over the year.

Clinical evaluation, even if preliminary, indicates that this specific working population, spending many months a year in pruning vine, show a specific occupational musculoskeletal and disease that we can perhaps call “*the pruning hand*” characterised by myofascial opponens right pollicis, myofascial brachioradialis syndrome, carpal tunnel syndrome, myofascial flexor and extensor carpi radialis syndrome.

Instrumental clinical tests will be carried in the future out the get a further confirmation of the preliminary clinical examination.

REFERENCES

Colombini D, Grieco A, Occhpinti E (1996) Occupational muscolo-skeletal disorders of the upper limbs due to mechanical overload: methods, researches, experiences, criteria for prevention. Med Lav vol. 87 n. 6

Colombini D, Occhipinti E, Grieco A. (2002). Risk assessment and management of repetitive movements and exertions of upper limbs, Elsevier Science, Amsterdam.

Colombini D, Occhipinti E, Fanti M. (2005). Il metodo OCRA per l’analisi e la prevenzione del rischio da movimenti ripetuti, Franco Angeli, Milano.

ISO, (2007). ISO 11228-3. Manual handling. Part 3: Handling of low loads at high frequency.

Hagberg M, Silverstein B, Wells R, Smith MS., Hendrich HW, Carayon P, Perusse M. (1995). Work-related musculoskeletal disorders: a reference book for prevention. Taylor and Francis, London.

Occhipinti E., Colombini D. (2007) Updating reference values and predictive models of the OCRA method in the risk assessment of work related musculoskeletal disorders of the upper limbs (UL-WMSDs). Ergonomics (in press)

Roquelaure, Y., Gabignon, J.C., Delaliux, P., Ferrari, C., Mea, M., Fanello, S., Penneau-Fontbonne, D., (2001) Transient hand paresthesias in Champagne vineyard workers. Am J Ind Med 40(6): 639-645.

Roquelaure, Y., Dano, C., Dusolier, G., Fanello, S., Penneau-Fontbonne, D., (2002) Biomechanical strains on the hand-wrist system durino grapevine pruning. Int Arch Occup Enviorn Heallth 75: 591-595.

WORKING TASKS	QUALITATTIVE DESCRIPTION OF THE MONTHS WORKED/YEARS												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAYS WORKED FOR YEAR
DAYS WORKED/MONTH	20	20	20	20	25	20	23	0	25	13	25	0	210,00
DRY PRUNING GRAPEVINE		1	1							1			
GREEN PRUNING GRAPEVINE				1	1	1							
GRAPE HARVEST									1				
COLLECTION OLIVE TREE											1		
PRUNING OLIVE TREE	1	1											
COLLECTION STRAWBERRIES						1	1						
COLLECTION PEACHES							1						

Table 1 – Example of simplified (semi-qualitative) description of the different tasks carried out by a homogenous group of workers over one year.

TASKS	**QUALITATIVE DESCRIPTION OF WORKED MONTH/YEAR:** percentage results weighted on 20 day/month constant													
	JAN	FEB	MAR	APR	MAY	JUN	LJUL	AUG	SEP	OCT	NOV	DEC	TOTAL IN FICTITIOUS MONTHS	% FICTITIOUS MONTHS WORKET ON 11 MONTHS CONSTANT
% OF DAYS/MONTHG WORKED ON CONSTANT	100%	100%	100%	100%	125%	100%	113%	0%	125%	63%	125%	0%		
DRY PRUNING GRAPEVINE		0,5	1,0							0,6			**2,1**	**19,3%**
GREEN PRUNING GRAPEVINE				1,0	1,3	0,5							**2,8**	**25,0%**
GRAPE HARVEST									1,3				**1,3**	**11,4%**
COLLECTION OLIVE TREE											1,3		**1,3**	**11,4%**
PRUNING OLIVE TREE	1,0	0,5											**1,5**	**13,6%**
COLLECTION STRAWBERRIES						0,5	0,6						**1,1**	**9,7%**
COLLECTION PEACHES						0	0,6						**0,6**	**5,1%**

Table 2 – Processing of organizational data collected with simplified (semi-qualitative) description of the tasks carried out by a homogeneous group of workers over one year.

TYPE OF WORKING TASKS	DESCRIPTION OF WORKED HOURS/MONTH FOR EACH TASK												
	JAN	FEB	MAR	APR	MAY	JUNE	LJUL	AUG	SEP	OCT	NOV	DEC	TOTAL HOURS
DRY PRUNING GRAPEVINE		80	160							100			340.00
GREEN PRUNING GRAPEVINE				160	200	80							440.00
GRAPE HARVEST									200				200.00
COLLECTION OLIVE TREE											200		200.00
PRUNING OLIVE TREE	160	80											240.00
COLLECTION STRAWBERRIES						80	80						160.00
COLLECTION PEACHES							100						100.00
	160	**160**	**160**	**160**	**200**	**160**	**180**		**200**	**100**	**200**	**0**	***1680***

Table 3 – Example of duration of different tasks carried out by a homogenous group of workers over one year analytically expressed in hours/month (analytical model)

	ESTIMATE OF PERCENTAGES STARTING FROM WORKED HOURS/MONTH FOR EACH TASK												
	JAN	FEB	MAR	APR	MAY	JUNE	LJULY	AUGU	SEPT	OCT	NOV	DEC	Proportional distribution of tasks
DRY PRUNING GRAPEVINE		50%	100%							100%			20,2%
GREEN PRUNING GRAPEVINE				100%	100%	50%							26,2%
GRAPE HARVEST									100%				11,9%
COLLECTION OLIVE TREE											100%		11,9%
PRUNING OLIVE TREE	100%	50%											14,3%
COLLECTION STRAWBERRIES						50%	44%						9,5%
COLLECTION PEACHES							56%						6,0%
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**0%**	**100%**	**100%**	**100%**	**0%**	**100% (su 1680 ore)**

Table 4 – Example of different processing and tasks carried out by a homogeneous group of workers over one year expressed in % on the total of hours worked in the year (intrinsic proportional distribution among the tasks developed in the ear: worked out from Table 3).

WORKING TASKS	GEN	FEB	MAR	APR	MAY	JUNE	LJULY	AUGU	SEPT	OCT	NOV	DEC	TOT. WORKED HOURS	INTRINSIC %	CONSTANT WEIGHTED %
													1680	100,0%	95,5%
DRY PRUNING GRAPEVINE		**50%**	**100%**							**100%**			340	20,2%	19,3%
GREEN PRUNING GRAPEVINE				**100%**	**100%**	**50%**							440	26,2%	25,0%
GRAPE HARVEST									**100%**				200	11,9%	11,4%
COLLECTION OLIVE											**100%**		200	11,9%	11,4%
PRUNING OLIVE TREE	**100%**	**50%**											240	14,3%	13,6%
COLLECTION STRAWBERRIES						**50%**	**44%**						160	9,5%	9,1%
OLLECTION PEACHES							**56%**	**100%**					100	6,0%	5,7%

Table 6 Example of calculation of calibrated proportional distribution among the tasks carried out in the year and as compared with intrinsic proportional distribution (worked out from Table 3).

OCRA checklist score	**OCRA index** score	Exposure levels	
Up to 7.5	2.2	GREEN	= No risk
7.6 – 11.0	2.3 – 3.5	YELLOW	= borderline
11.1 – 14.0	3.6 – 4.5	RED LIGHT	= light risk
14.1 – 22.5	4.6 – 9.0	RED MEDIUM	= medium risk
≥ 22.6	≥ 9.1	RED HIGH	= high risk

Table 7- The final score of OCRA checklist matched with OCRA index score and related risk ranges.

TYPE OF WORKING TASKS	**recovery**	**freq.**	**force**	side	shoulder	wrist	elbow	hand	stereotypy	**Tot posture**	**additional**	**INTRINSIC checkline value (**duraion 8 hours incl canteen and two breaks 10 minutes each)
DRY PRUNING GRAPEVINE	4	7	2	RG	10	2	3	2	1.5	11.5		**24.5**
GREEN PRUNING GRAPEVINE	4	7	2	RG	8	2	3	2	1.5	9.5		**22.5**
GRAPE HARVEST	4	7	1	RG	2	2	2	2	1.5	3.5		**15.5**
COLLECTION OLIVE	4	9	0	RG	8	2	2	8	1.5	9.5		**22.5**
PRUNING OLIVE TREE	4	8	3	RG	8	2	3	2	1.5	9.5		**24.5**
COLLECTION STRAWBERRIES	4	5	0	RG	1	2	2	8	1.5	9.5		**18.5**
OLLECTION PEACHES	4	5	2	RG	6	2	2	8	1.5	9.5		**20.5**

Table 8 – Examples of risk assessments with OCRA checklist on a group of processing developed in one year. Assessments are to be referred to the right limb, The score of each risk factor is reported. The final score expresses the value of intrinsic index.

60-120 min : Multiplying factor = 0.5 121-180 min: Multiplying factor = 0,65 81-240 min: Multiplying factor = 0.75	241-300 min: Fattore moltiplicativo= 0,85 301-360 min: Fattore moltiplicativo= 0,925 361-420 min: Fattore moltiplicativo= 0,95	421-480 min: Fattore moltiplicativo= 1 Exceed .480 min: Fattore moltiplicativo= 1,5

Table 9- Hypotheses of elements for calculation of duration multiplier (Du_M) referred to exposure months/year.

Intrinsic OCRA checklist values (duration 8 hours incl lunch break and 2 breaks 10 minutes each)		INTRINSIC OCRA check list values amended for actual net duration in shift and break distribution			**AVERAGE INDEX, WEIGHTED FOR EXPOSURE TIME** (calculated with INTRINSIC OCRA checklist values amended for actual net duration in shift and breaks distribution)		
RG	**LF**	**RG**	**LF**		Intrinsic %	Partial Weighted RG limb	Partial weighted LF limb
24.5	11,0	23.3	10,5	A	20,2%	**4.2**	**3.7**
22.5	18,0	21.4	17,1	B	26,2%	**5.0**	**4.3**
15.5	4,0	14.7	3,8	C	11,9%	**1.6**	**1.5**
22.5	23,0	21.4	21,9	D	11,9%	**2.3**	**2.3**
24.5	13,0	23.3	12,4	E	14,3%	**3.0**	**2.4**
18.5	6,0	17.6	5,7	F	9,5%	**1.5**	**1.3**
20.5	16,0	19.5	15,2	G	6,0%	**3.1**	**2.8**
					100%	**20,8**	**12,9**

Table 10 - Example of calculation of weighted average index (data from Table 4)

Intrinsic OCRA checklist values (duration 8 hours incl lunch break and 2 breaks 10 minutes each)		INTRINSIC OCRA check list values amended for actual net duration in shift and break distribution			AVERAGE INDEX WEIGHTED FOR EXPOSURE CONSTANT (calculated with INTRINSIC OCRA checklist values amended for actual net duration in shift and breaks distribution)		
RG	**LF**	**RG**	**LF**		CONSTANT WEIGHTED %	Partial Weighted RG limb	Partial weighted LF limb
24.5	11,0	23.3	10,5	A	19,3%	**4,5**	**2,0**
22.5	18,0	21.4	17,1	B	25,0%	**5,3**	**4,3**
15.5	4,0	14.7	3,8	C	11,4%	**1,7**	**0,4**
22.5	23,0	21.4	21,9	D	11,4%	**2,4**	**2,5**
24.5	13,0	23.3	12,4	E	13,6%	**3,2**	**1,7**
18.5	6,0	17.6	5,7	F	9,1%	**1,6**	**0,5**
20.5	16,0	19.5	15,2	G	5,7%	**1,1**	**0,9**
					95%	**19,8**	**12,3**

Table 11 –Example of calculation of the average index weighed over time constants (data by Table 6)..

Intrinsic OCRA checklist values (duration 8 hours incl lunch break and 2 breaks 10 minutes each)		INTRINSIC OCRA check list values amended for actual net duration in shift and break distribution			FICTITIOUS MINUTES/TURN OVER
RG	**LF**	**RG**	**LF**	**eV**	**363**
24.5	11,0	23.3	10,5	A	73
22.5	18,0	21.4	17,1	B	95
15.5	4,0	14.7	3,8	C	43
22.5	23,0	21.4	21,9	D	43
24.5	13,0	23.3	12,4	E	52
18.5	6,0	17.6	5,7	F	35
20.5	16,0	19.5	15,2	C	22

Table 12 -.Evaluation of the fictitious exposure minutes of different tasks, weighted for exposure constants

FICTITITOUS SHIFT MINUTES WEIGHTED BY CONSTANT	CONSTANT WEIGHTED %	OCRA INDEX MAX RG (total time)	OCRA INDEX PARTIAL RG (partial time)	OCRA INDEX MAX LF (total time)	OCRA INDEX PARTIAL LF (partial time)
73	19,3%	23,3	12,3	21,9	11,5
95	25,0%	23,3	12,3	17,1	9,0
43	11,4%	21,4	11,3	15,2	8,0
43	11,4%	21,4	11,3	12,4	6,5
52	13,6%	19,5	10,3	10,5	5,5
35	9,1%	17,6	9,3	5,7	3,0
22	5,7%	14,7	7,8	3,8	2,0
363	**95%**	**21,6**		**12,7**	

Table.13 – Calculation of exposure with *Multitask Complex* OCRA model: OCRA checklist values of single tasks are ordered by severity. For each limb, we report the values calculated for total exposure time to shift repetitive tasks (MAX INDEX) and those recalculated using partial times (PARTIAL TIME INDEX).

	a) WEIGHTED AVERAGE INDEX FOR EXPOSURE TIME	b) WEIGHTED AVERAGE INDEX FOR EXPOSITION CONSTANTS	d) MULTITASK COMPLEX MODEL
RG	**20.8**	**19,8**	**21.6**
LF	**12,9**	**12,3**	**12,7**

Table.14 – Comparison with final exposure values obtained with the 3 calculation model assumptions.

WORKING TASKSI Agricultural Cooperative – women –right arm		CHECKLIST OCRA intrinsic value (CK)
a	pruning	**37.1**
b	Fruit thining	**26.6**
c	Harvest (women)	**12.8**

WORKING TASKSI Agricultural Cooperative – women –right arm		CHECKLIST OCRA intrinsic value (CK)
d	Emptying of bins	**16.6**
e	Fruit selection	**21.9**
f	Grape harvest	**23.0**

Table 16: Results of OCRA Checklist for each working task analysed in peach cultivations (right arm)

n°	1.Farm	3%PA	4. EXPECTED OCRA CHECKLIST INDEX	5. (AVERAGE CLASSICAL DAILY EVALUATION)		6. QUALITATIVE AVERAGE WEIGHED INDEX		7. QUANTITATIVE WIEIGHED AVERAGE INDEX		8. MULTITASK COMPLEX MODEL	
				value	Error%	Value	Error%	value	Error%	value	Error%
1	Global Agric. Cooper. (TOT=13, PA=4)	30.8%	**30.4**	**24.1**	20.6%	**23.8**	21.7%	**23.0**	24.3%	**31.7**	-4.4%
2	Agricu. Enter. -men - (TOT=6, PA=1)	16.7%	**16.5**	**12.5**	24.2%	**17.0**	-3.1%	**12.4**	24.9%	**17.5**	-6.2%

Table 17: Comparison of results of the calculation models and their predictive errors in two farms.

WORKING TASKS	Side	Recovery	Frequency	Force	Total of posture	Additional factors	Value of OCRA Check list
Mother vine	dx	4	9	7	9,5	2	**31,5**
Mother vine	sx	4	3	7	9,5	2	**25,5**
Vine plantation	dx	4	4,5	0	5	0	**13,5**
Vine plantation	sx	4	2	0	9	0	**15**
Manual “tirafili”	dx	4	8	11	10	2	**35**
Manual “tirafili”	sx	4	6	11	10	2	**33**
“Tirafili” with tool	dx	4	5	2	7	2	**20**
“Tirafili” with tool	sx	4	5	2	7	2	**20**
Pruning (dry part) - Tuscany	dx	4	7	2	7	2	**22**
Pruning (dry part) - Tuscany	sx	4	1	1	5,5	2	**13,5**
Pruning (dry part) - Piedmont	dx	4	7	2	13	2	**28**
Pruning (dry part) - Piedmont	sx	4	1	1	13	2	**21**
Pruning (dry part) - Marches	dx	4	7	3	17	2	**33**
Pruning (dry part) - Marches	sx	4	7	1	17	2	**31**
Green pruning - polling	dx	4	1	1	3,5	0	**9,5**
Green pruning - polling	sx	4	8	2	5,5	0	**19,5**
Green pruning – pinching out	dx	4	8	6	9	0	**27**
Green pruning – pinching out	sx	4	0	0	1	0	**5**
Green pruning – stripping of leaves	dx	4	5	2	3,5	0	**14,5**
Green pruning – stripping of leaves	sx	4	2	2	3	0	**11**
Grape harvest - Tuscany	dx	4	3	1	6	0	**14**
Grape harvest - Tuscany	sx	4	6	1	6	0	**17**
Grape harvest - Piedmont	dx	4	3	1	6	0	**14**
Grape harvest - Piedmont	sx	4	6	1	6	0	**17**
Grape harvest - Marches	dx	4	3	1	9	0	**17**
Grape harvest - Marches	sx	4	6	1	9	0	**20**

Table 15: Results of OCRA Checklist for each working task analysed in grape growing

	MALES		FEMALES	
List of main clinical musculoskeletal disorders	N.	%	N.	%
Myofascial opponens right pollicis syndrome	9	15.8	18	20.7
Myofascial brachioradialis syndrome	8	14.0	14	16.1
Carpal tunnel syndrome	2	3.5	12	13.8
Myofascial flexor carpi radialis syndrome-enthesitis	2	3.5	11	12.6
Myofascial extensor carpi radialis syndrome	6	10.5	9	10.3
Metacarpophalangeals synovitis (hypertrophy of Metacarpophalangeals synovitis)	7	12.3	7	8.0
Flexor 3 and/or 4 digitorum tenosynovitis	2	3.5	6	6.9
Proximal and/or distal interphalangeal arthrosis	3	5.3	3	3.4
Caput longum musculi bicipitis tenosynovitis	2	3.5	0	0.0
Acromiohumeral conflict syndrome	2	3.5	2	2.3
Vagina tendinum musculi flexori hypertrophy	1	1.8	0	0.0
Thenar eminence hypotrophy	2	3.5	0	0.0
Dupuytren syndrome	3	5.3	0	0.0
Trigger finger	1	1.8	0	0.0
Guyon’s syndrome	0	0.0	1	1.1
Subacromial bursitis	1	1.8	0	0.0
Metacarpophalangeals arthrosis	1	1.8	0	0.0
Trapeziometacarpal arthrosis (rhizoarthrosis)	1	1.8	1	1.1
Epicondylitis	2	3.5	0	0.0
Abductor right pollicis Myofascial syndrome	2	3.5	0	0.0
De Quervain	0	0.0	1	1.1
M. of Duplay	0	0.0	1	1.1
Compression of nervus ulnaris in elbow	0	0.0	1	1.1
TOTAL	**57**		**87**	

Table 18: List of clinical terminology used to define the musculoskeletal disorders showed by “pruning workers”.

	% UL -WMSDs		
FARMS	**MALES**	**FEMALES**	**TOTAL**
A	25,0%	55,0%	33,8%
B	28,6%	44,4%	34,8%
C	25,0%	0,0%	18,2%
D	33,3%	45,5%	39,1%
TOTAL	26,8%	46,5%	33,6%

Table 19: Percentage of workers affected by UL-WMSDs for gender.

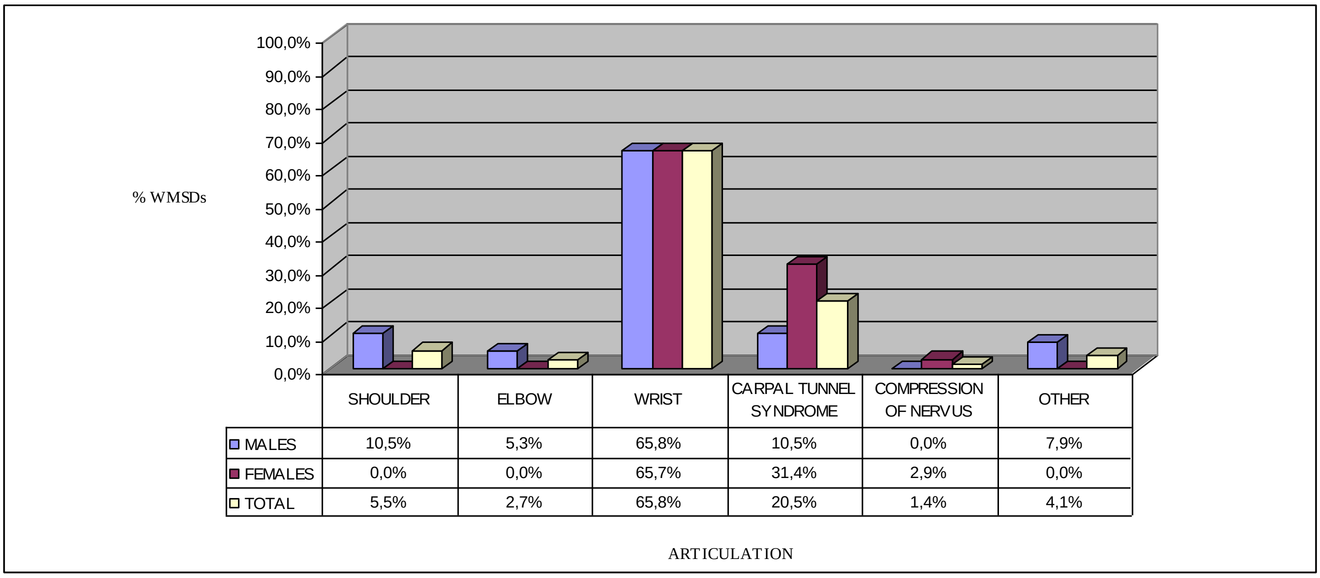

Figure 1: Distribution of the different UL-WMSDs for each articulation and for gender

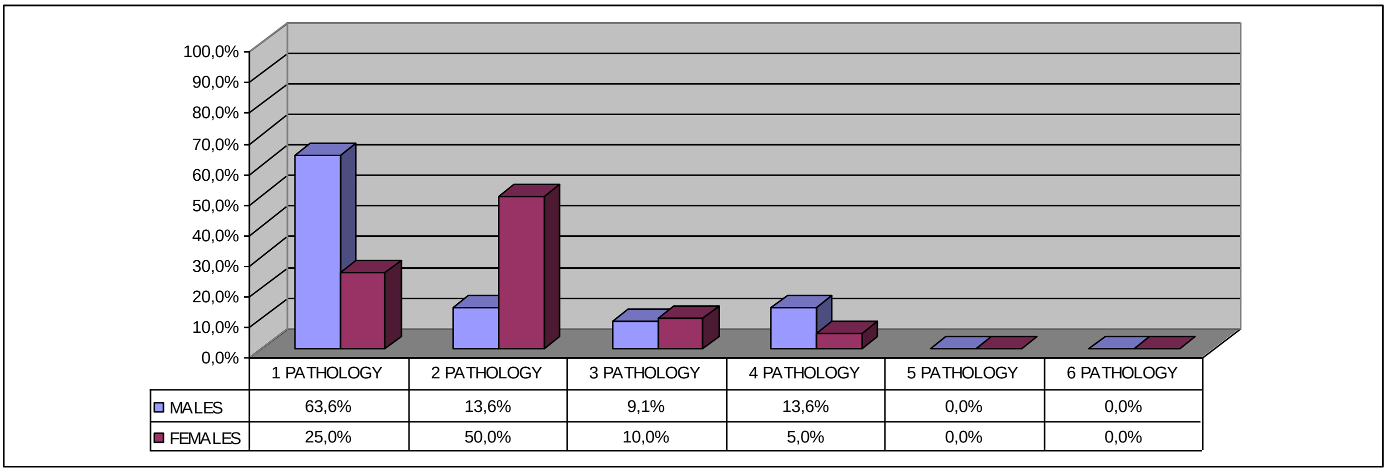

Figure 2: Prevalence of UL-WMSDs for number of pathologies/person for males and females