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Ocra method: a new procedure for analysing multiple repetitive tasks

E. Occhipinti , D. Colombini

Research Unit Ergonomics of Posture and Movement (EPM),
Foundation Don Gnocchi Onlus Milan –Italy

Work-related musculoskeletal disorders of upper limbs (UL-WMSDs) and spine have an enormously spread out, achieving nearly epidemical level in all industrialized countries. As to the origin of such alterations, it is to be underlined that all together organizational and biomechanical factors (frequency of technical actions, stereotypy of movements, use of force, awkward postures and movements, lack of recovery times, actual duration of exposure to repetitive tasks, additional factors such as vibrations, cold, hits, etc) are to be considered as a major determinant of risk presence. The European data concerning UL-WMSDs (Eurostat 2006) evidence that productive sectors more affected by such diseases (after manufacturing) are construction, fishing and agriculture.
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).
The traditional risk analysis methods on subjects exposed to one or several repetitive tasks are generally focused on typically "daily" exposure studies. In many working sectors however (i.e. in agriculture) exposure may vary in duration and type over a longer period (one week; one month; one year). In this paper a special attention will be devoted to present not only the OCRA method but also the procedures for the analysis of multiple repetitive tasks.
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Keywords: *OCRA method ,repetitive movements , multiple tasks, job rotation*

INTRODUCTION

Work-related musculoskeletal disorders of upper limbs (UL-WMSDs) and spine have enormously spread out, achieving nearly epidemical level in all industrialized countries (Hagberg et al.,1995).

As to the origin of such alterations, it is to be underlined that all together organizational and biomechanical factors (frequency of technical actions, stereotypy of movements, use of force, postures and awkward movements, lack of recovery times, actual duration of exposure to repetitive tasks, additional factors such as vibrations, cold, hits, etc) are to be considered as a major determinant of risk presence.

The European data concerning UL-WMSDs (Eurostat 2004) evidence that productive sectors more affected by such diseases (after manufacturing) are construction, fishing and agriculture.

These preliminary epidemiological data concerning these particular sectors (characterized by exposure to several different cycle distribution tasks, be it weekly, monthly or yearly), confirm the need to tackle more systematic studies on biomechanical load risk and their specific correlated damages.

AIMS

The traditional risk analysis methods on subjects exposed to several repetitive tasks are generally focused on typically "daily" exposure studies: recently, when using the OCRA index (or OCRA checklist) considering the presence of more than one repetitive task, to a "traditional" procedure that has been previously proposed, an alternative approach, based on a concept that the most stressful task is the minimum starting point was proposed (Occhipinti et al., 2008; Colombini et al., 2008)

In many working sectors however (i.e. in agriculture) exposure may vary in duration and type over a longer period (one week; one month; one year).

This study is aimed at:

- defining a specific procedure tackling the preliminary organization and inherent risk analysis of all tasks (characterized by biomechanical overload) typical of a particular processing lasting and concluding over a wide time range (be it a week, a month, a year).
- setting, on the basis of available models for the analysis of daily exposure, some exposure risk analysis multitask models taking into account the turnover along such longer exposure periods.

To validate such models, the specific final result (overall exposure risk index) should be compared with resulting prevalence of workers affected by UL-WMSD. Those data are achievable through active health surveillance programmes; this predictive characteristic is already present in OCRA method exposure to one or more repetitive tasks with daily turnover (Occhipinti et al., 2007).

The final aim of this research project by EPM-Milano Research Unit (for the time being fully on voluntary basis and made possible thanks to the operating support by several public services (ASL Ancona and ASL Asti, Siena University, Barcelona Polytechnic) and private firms (Studio Fanti) is creating a simple and practical tool (through a software) allowing to automatically estimate the exposure risk of turnover multitasks over long periods by simply outlining exposure durations of each task in the identified period.

This good practice tool will be useful for professionals (prevention technicians and occupational physicians, insurance companies, etc.) interested in risk prevention and management of biomechanical overload as well as recognition of work-related diseases. The final procedure and tool will be proposed for a new ISO TR "Application document for ISO 11228- part 1,2 and 3 and for ISO 11226"

METHODS: ORGANIZATIONAL DATA

General aspects for assessment of exposure levels to works characterized by multi-task turnover

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

- facing a preliminary organizational study to establish the kind of turnover: the periodicity of the different tasks (implemented by the worker or by the homogeneous group of workers employed in the same tasks in the considered period) repeated in time, daily or weekly or monthly or yearly.
- defining the risk level inherent in each task, using the OCRA checklist. Intrinsic level means ascribing to the task a net duration of 440 minutes/shift with 2 breaks, 8-10 minutes each, and a lunch break of at least 30 minutes.
- applying specific mathematical models assessing exposure to "multitasks".

As to calculation procedures, the 3 stages will be tackled: first the daily, secondly yearly cycle multitasks and later the weekly cycles.

Cyclical turnover and organizational studies on exposure to daily rotating multiple tasks.

This kind of turn-over is typical in the industry and easy to identify: every day is similar to other.

When the repetitive task turn-over is daily, 2 events may occur:

- *rotation occurs at least every hour:*
- *rotation occurs less than once per hour.*

It is not so difficult to obtain accurate exposure data about the net duration (in minutes) of each repetitive task in a shift.

With these data the proportional distribution among tasks over the shift can be obtained being derived for each task as a % on the total of hours worked in the shift.

The obtained percentages outline the intrinsic time distribution present among developed tasks. The methods reported in previous papers (Occhipinti et al., 2008; Colombini et al., 2008), and summarized (for the OCRA checklist) later, could be applied.

Cyclical turnover and organizational studies on exposure to yearly rotating multiple tasks.

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

WORKING TASKS	QUALITATIVE DESCRIPTION OF WORKED MONTHS / YEAR												
	JAN	FEB	MAR	APR	MAY	JUNE	LJULY	AUGU	SEPT	OCT	NOV	DEC	ACTUALLY WORKED DAYS / YEAR
DAYS WORKED /MONTH	20	20	20	20	25	20	23	0	25	13	25	0	210,00
A		1	1							1			
B				1	1	1							
C									1				
D											1		
E	1	1											
F						1	1						
G							1						

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

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.

TASKS	**QUALITATIVE DESCRIPTION OF WORKED MONTH / YEAR:** percentage results weighted on 20 day/ month constant													
	JAN	FEB	MAR	APR	MAY	JUNE	LJULY	AUGU	SEPT	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%		
A		**0,5**	**1,0**							**0,6**			**2,1**	**19,3%**
B				**1,0**	**1,3**	**0,5**							**2,8**	**25,0%**
C									**1,3**				**1,3**	**11,4%**
D											**1,3**		**1,3**	**11,4%**
E	**1,0**	**0,5**											**1,5**	**13,6%**
F						**0,5**	**0,6**						**1,1**	**9,7%**
G						**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	LJULY	AUGU	SEPT	OCT	NOV	DEC	TOTAL HOURS
A		**80**	**160**							**100**			340.00
B				**160**	**200**	**80**							440.00
C									**200**				200.00
D											**200**		200.00
E	**160**	**80**											240.00
F						**80**	**80**						160.00
G							**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
A		**50%**	**100%**							**100%**			20,2%
B				**100%**	**100%**	**50%**							26,2%
C									**100%**				11,9%
D											**100%**		11,9%
E	**100%**	**50%**											14,3%
F						**50%**	**44%**						9,5%
G							**56%**						6,0%
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**0%**	**100%**	**100%**	**100%**	**0%**	**100% (on 1680 hours)**

Table 4 - Example of different 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 year: worked out from Table 3).

In addition, to describe 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 reference working duration constants expressed in hours/month (160), days/month (20), days/year (220), months work/year (11), worked hours/year (1760)

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.

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

The example reported in Table 6 sows this passage: the total original (from table 4) worked hours/year is 1680: considering that the constant used is equal to 1760 hours (table 5), there is a 0.5% reduction of working activity. The result is that the percentages reported in the column of "weighted proportional distribution" (respect to the constant) 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.

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%
A		**50%**	**100%**							**100%**			340	20,2%	19,3%
B				**100%**	**100%**	**50%**							440	26,2%	25,0%
C									**100%**				200	11,9%	11,4%
D											**100%**		200	11,9%	11,4%
E	**100%**	**50%**											240	14,3%	13,6%
F						**50%**	**44%**						160	9,5%	9,1%
G							**56%**	**100%**					100	6,0%	5,7%

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

THE OCRA METHOD FOR DAILY ROTATING TASKS

OCRA checklist for assessment of "intrinsic level" of exposure

The OCRA method (Occhipinti, 1998 ; Colombini et al. 2002), now adopted by ISO (ISO 12228-3) and CEN (EN1005-5) standards 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, additional risk factors, net duration of the repetitive task(s).

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

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

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 stereotypy) and additional factors (vibrations, extreme cold temperatures, countershocks, 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 additional factors.

The sum of the obtained partial values produces a numerical figure (score) 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.

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

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 was the only task developed along the whole shift (approx 440 net minutes of repetitive task duration 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 tasks 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.

TYPE OF WORKING TASKS	recovery	frequence.	force	side	shoulder	wrist	elbow	hand	stereotypy	Tot . posture	additional	INTRINSIC checklist value (duraion 8 hours incl. canteen and two breaks 10 minutes each)
A	4	7	2	RG	10	2	3	2	1.5	11.5		**24.5**
B	4	7	2	RG	8	2	3	2	1.5	9.5		**22.5**
C	4	7	1	RG	2	2	2	2	1.5	3.5		**15.5**
D	4	9	0	RG	8	2	2	8	1.5	9.5		**22.5**
E	4	8	3	RG	8	2	3	2	1.5	9.5		**24.5**
F	4	5	0	RG	1	2	2	8	1.5	9.5		**18.5**
G	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.

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:

Checklist OCRA Multitask Simple = [(pA x % tA) + (pB x % tB) +….+(i..pN x % tN)] x Md (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)

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

Table 9 – Calculation of the OCRA checklist final score concerning the workplace investigated with relation to repetitive work net duration.

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:

Checklist OCRA Multitask Complex = $score_{1(Dum1)}$ + ($\Delta score_1$ x K) (2)

Where:
1,2,3,…,N = repetitive tasks ordered by exposure level (1= the highest) using for calculating risk index the Duration multiplier (Dum_i) related to their actual duration in the shift.
Dum_i = Duration multiplier considering the actual task duration in the shift
Dum_{tot} = Duration multiplier considering the total duration of all repetitive tasks in the shift
Δ **$score_1$** = difference between: score of task $_1$ considering Dum_{tot} and Score of task$_1$ considering Dum_1
K = $\frac{(score_{1\,max} * FT_1) + (score_{2\,max} * FT_2) + \ldots + (score_{N} * FT_N)}{(score_{1\,max})}$
$Score_{i\,max}$ = Score task$_i$ considering Dum_{tot}
FT_i = task time fraction(value 0 to 1) in relation to the total duration of ripetitive works.

THE OCRA METHOD FOR LONG PERIODS ROTATING TASKS

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 (index and checklist) based on equation (2).

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 (equation (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 multiplier that is 0.95)
- the OCRA checklist intrinsic values of each task re-evaluated considering the actual, above reported, organizational factors present in a typical shift.

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

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)

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.

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).

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 (equation (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:

%Task duration (weighted on time constant) x total net duration of repetitive task during a shift (3)

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/TSHIFT
RG	**LF**		**RG**	**LF**	**tasks**	**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

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

- considering the total exposure time (shift) to all 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, according to equation (3), it will be possible to proceed to calculate final exposure values for the Multitask Complex OCRA (Table 13).

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).

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, shows the highest values (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.

	a) WEIGHTED AVERAGE INDEX FOR EXPOSURE TIME	b) WEIGHTED AVERAGE INDEX FOR EXPOSITION CONSTANTS	c) MULTITASK COMPLEX MODEL
RG	**20.8**	**19,8**	**21.6**

LF	**12,9**	**12,3**	**12,7**

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

Cyclical turnover, organizational studies on exposure to weekly periodicity multitasks and mathematical models for the final risk evaluation

Some working situations clearly show a weekly rotation pattern of repetitive tasks: let us mention the tasks carried out in the kitchens (specially for food preparation in business or school canteens), for some organizational models of cleaning, supermarkets, etc.

In some cases not only tasks vary day by day but also shift duration itself changes over the week.

Just to allow assessment of exposure level, an analytical model was set up essentially recalling the previous one but allowing a more accurate daily diversification.

Description of task periodicity and duration along the different weekdays

Also in this case as well, the first step is to identify the workers' homogeneous group carrying out the same tasks over the week: which and how many workers are involved and which tasks are they going to carry out.

The input model for information collection on duration of different tasks in the work-shift is only ANALYTICAL. It is not difficult to obtain more accurate exposure data (over the day) such as detail of minutes worked for each task developed during a work-shift. If there are organizational discrepancies in the different weekdays, they are to be accurately described (Table 15).

This table clearly shows that organizational information needed are aimed at obtaining the REPETITIVE WORK NET TIME as a whole and for each developed repetitive task. This will allow to obtain both their intrinsic % distribution and distribution weighted over the above mentioned times constants (see Table 5).

OCRA checklist for assessment of risk intrinsic level.

Intrinsic risk index is assessed for identified tasks using OCRA checklist as already described for yearly cycle tasks.

Exposure will be calculated for each working day in the week.

When all week days were similar, one day assessment would be sufficient to represent weekly exposure; but when daily variation are present in tasks distribution and shift duration, for each working day we will have to focus on:

-shift duration

-total net duration of repetitive works

- duration of each repetitive work

-duration and distribution of breaks.

These data will allow to recalculate for each task the OCRA checklist, this time amended for the actual net duration of shift repetitive works and the actual distribution of recovery times day by day.

NON REPETITIVE WORKING TASKS	DISTRIBUTION OF SHIFTS OVER THE WEEK BY HOMOGENEOUS GROUP										
	MON	TUE	WED	THUR	FRI	SAT	SUN				
Shift duration (in minutes)	**200**	**300**	**350**	**400**	**400**	**480**					
x	5,0	5,0	5,0	5,0	5,0	5,0					
y						5,0					
z		10,0		10,0	10,0						
Total duration of breaks by shift (min.)	**0,0**	**10,0**	**15,0**	**20,0**	**25,0**	**30,0**					
Net duration of repetitive tasks	**195**	**275**	**330**	**365**	**360**	**440**	**0**	**1965**	**4,1**	**100,0%**	**89,3%**
REPETITIVE WORKING TASKS	MON	TUE	WED	THUR	FRI	SAT	SUN	TOTAL OF WORKED MINUTES	TOTAL DAYS	% ON TOTAL OF HOURS WORKED A WEEK	% EXTIMATED ON TIME CONSTANT
H	195	100	100		100	440		935	1,9	47,6%	43%
I		100			90			190	0,4	9,7%	9%
L		75	130		100			305	0,6	15,5%	14%
M			100	365	70			535	1,1	27,2%	24%

Table 15 – Description of breaks and repetitive and non-repetitive tasks carried out in the different weekdays to obtain the REPETITIVE WORK NET TIME per each worked day.

Calculation models for weekly exposure assessment

In view of achieving the final weekly exposure values, stage calculation is proposed: assessment of daily exposure and subsequent collection of results for assessing weekly exposure.

a) Assessment of daily exposure

Like for daily turnover in repetitive tasks, 2 events may occur: rotation takes place at least every hour; rotation takes place less than once per hour.

- When rotation among repetitive tasks occurs at least every hour, to calculate the exposure value, the time-weighted average of final intrinsic risk indices is calculated using equation (1):

-When rotation occurs less than once per hour, the weighted average the mathematical model using the "worst working situation" is to be used: Checklist OCRA Multitask Complex equation (2) should be used.

These two representative exposure evaluation model will allow to calculate the risk level for each day of the week: the first representing exposure to tasks with at least an hourly rotation and the second represents a condition with rotation exceeding one hour (Table 17).

Once the values per working day have been obtained, two assessment paths have to be followed to evaluate the final week exposure risk index :

- rotation among tasks is any day of the week at least hourly. The derived data, representative of each working day, are those traditionally obtained with the classical weighted average model (equation 1) (see Table 18:part A).
- condition with rotation exceeding one hour: it suggested to use the formula of the Checklist OCRA Multitask Complex (equation 2). (see Table 18:part B)

MONDAY						
1.AVERAGE WEIGHTED ON DURATION IN SHIFT (FOR ROTATION AMONG TASKS LESS THAN ONE HOUR)			**2. MULTITASK COMPLEX OCRA MODEL FOR ROTATIONS EXCEEDING ONE HOUR**			
% intrinsec	Weighted OCRA checklist INDEX RG limb	Weighted OCRA checklist INDEX LF limb	OCRA checklist INDEX MAX RG (total time)	OCRA checklist INDEX PARTIAL RG (partial time)	OCRA checklist INDEX MAX LF (total time)	OCRA checklist INDEX PARTIAL LF (partial time)
100%	12	9,8	12,0	12,0	9,8	9,8
	12,0	**9,8**	**12,0**		**9,8**	
WEDNESDAY						
1.AVERAGE WEIGHTED ON DURATION IN SHIFT (FOR ROTATION AMONG TASKS LESS THAN ONE HOUR)			**2. MULTITASK COMPLEX OCRA MODEL FOR ROTATIONS EXCEDING ONE HOUR**			
% intrinsec	Weighted OCRA checklist INDEX– RG limb	Weighted OCRA checklist INDEX LF limb	OCRA checklist INDEX MAX RG (total time)	OCRA checklist INDEX PARTIAL RG (partial time)	OCRA checklist INDEX MAX LF (total time)	OCRA checklist INDEX PARTIAL LF (partial time)
30,3%	4,8	3,9	21,7	11,8	13	7
39,4%	8,6	2,9	15,7	11,1	7,4	5,2
30,3%	2,2	1,4	7,4	4	4,6	2,5
100%	**15,6**	**8,2**	**18,9**		**10,9**	

Table 17 – Exposure indices (only Monday and Wednesday are presented here) of exposure risk assessment to several tasks per week workday. Two final values are reported: the first representing exposure to at least hourly rotation tasks, the second represents a condition with rotation exceeding one hour.

OCRA checklist: risk indices per day			**PART A: WEIGHTED AVERAGE MODEL (days and whole week)**		
	RG	**LF**	% intrinsec	Parzial score. RG	Parzial score. LF
MON	**12,0**	**9,8**	9,9%	1,2	1,0
TUE	**14,9**	**10,4**	14,0%	2,1	1,4
WED	**15,6**	**8,2**	16,8%	2,6	1,4
THUR	**7,6**	**4,8**	18,6%	1,4	0,9
FRI	**15,0**	**9,7**	18,3%	2,7	1,8
SAT	**17,0**	**14,0**	22,4%	3,8	3,1
SUN					
				DX	SX
			100%	**13,8**	**9,6**

OCRA CHECKLIST: risk indices per day			**PART B: WEIGHTED AVERAGE MODEL (on week basis)**			**PART B: COMPLEX MODEL (week basis)**			
	RG	**LF**	% intrinsec	Parzial score. RG	Parzial score. LF	OCRA checklist INDEX MAX RG (total time)	OCRA checklist INDEX PARTIAL RG (partial time)	OCRA checklist INDEX MAX LF (total time)	OCRA checklist INDEX PARTIAL LF (partial time)
MON	**12,0**	**9,8**	9,9%	1,2	1,0	**18,9**	**9,5**	**17,9**	**9,0**
TUE	**18,9**	**7,6**	14,0%	2,5	1,6	**18,9**	**9,5**	**17,0**	**8,5**
WED	**18,9**	**10,9**	16,8%	3,2	1,8	**18,9**	**9,5**	**10,9**	**5,5**
THUR	**12,0**	**17,9**	18,6%	1,4	0,9	**18,6**	**9,3**	**9,8**	**4,9**
FRI	**18,9**	**7,6**	18,3%	3,4	2,1	**12,0**	**6,0**	**7,6**	**3,8**

SAT	**18,6**	**17,0**	22,4%	3,8	3,1	**12,0**	**6,0**	**7,6**	**3,8**
SUN									
			100%	**15,5**	**10,5**	**17,9**		**15,1**	

Table 18 –Exposure indices for the whole working week. Two sets of final values are reported: the first including exposure to at least one hourly rotation task (part A) and the second represents a condition with rotation exceeding one hour (part B).

CONCLUSIONS

In some productive areas (agriculture, construction, cleaning, food, etc.) the need is emerging to face upper limb biomechanical overload. Exposure assessment is much more complex being characterised by the presence of several working tasks over periods longer than the current working day (weekly, monthly, yearly turnover).The present work reports organizational study procedures as well as exposure models (starting from OCRA checklist intrinsic values per each identified task) to get to assess the final exposure value via 3 calculation model assumptions..

The future work allowing selection of the most reliable model (because more predictive), will necessarily go through the collection of epidemiological data. Now collection points of this information are active in Italy (Siena University), in Spain and Chile (UPC Barcelona). The first national data on vineyard pruning and olive harvest in the Siena area (approx 90 workers) and other fruit harvesting in the Romagna area (approx 50 workers) seem to confirm once again better prevision for OCRA Multitask Complex model.

Unfortunately clinical data collection in agriculture as in superstores or the cleaning sector is extremely complex and hence collection of sufficient epidemiological data might ask for rather long times.

In the meanwhile, to help colleagues in collecting organizational and exposure data, easily usable software are available and able to provide, once final organizational data have been input as well as different task intrinsic indices, the automatic computing of exposure levels to these extremely complex work organizational models under the different assumptions of definite mathematical models.

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