MAPO Method to Assess the Risk of Patient Manual Handling in Hospital Wards: A Validation Study

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Objective: To validate the effectiveness of MAPO method (Movement and Assistance of Hospital Patient) after the introduction of some changes to improve assessment objectivity.

Background: The number of operators exposed to patient manual handling is increasing considerably. MAPO, proposed in 1999 as a useful tool to estimate the risk of patient manual handling, is a method characterized by analytical quickness. It has recently been improved to better match the 2012 ISO (International Organization for Standardization) technical report.

Methods: A multicenter study was conducted between 2014 and 2016 involving 26 Italian hospitals in the Apulia Region. MAPO method was used to assess the risk of patient manual handling in 116 wards. A total of 1,998 exposed subjects were evaluated for the presence or absence of acute low back pain in the previous 12 months.

Results: Only 12% of the investigated wards fell in the green exposure level (MAPO index = 0.1–1.5), 37% resulted in the average exposure level (MAPO index = 1.51–5) and the remaining 51% in the higher exposure level (MAPO index >5). The results confirmed a positive association between increasing levels of MAPO index and the number of episodes of acute low back pain (adjusted *p* trend = .001).

Conclusion: The improvements made over the past years led to a more objective assessment procedure. Despite the changes, the study confirmed the effectiveness of MAPO method to predict low back pain.

Application: MAPO method is an accurate risk assessment tool that identifies and evaluates workplace risks. The proper application of the method significantly improves working conditions.

Keywords: patient manual handling, low back pain, risk assessment, caregivers

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INTRODUCTION

Patient manual handling is one of the most significant work-related risk factors among health care professionals (Caruso & Waters, 2008; Davis & Kotowski, 2015; Marcum & Adams, 2017; Marras, 2008; Oranye, 2018; Waters, Nelson, & Proctor, 2007; Yassi & Lockhart, 2013). The number of operators exposed to this specific risk has risen considerably due to global population aging and to the increasing prevalence of overweight and obese patients (Choi & Brings, 2016; Daraiseh et al., 2003). In terms of musculoskeletal disorders, manual handling of disabled patients is one of the major causes of back pain and upper limb disorders (Davis & Kotowski, 2015; Koppelaar, Knibbe, Miedema, & Burdorf, 2013; Occhionero, Korpinen, & Gobba, 2014; Skela-Savič, Pesjak, & Hvalič-Touzery, 2017).

In health care settings, overexertion injuries are the costliest workers' compensation claims. In addition to the direct costs of injuries, indirect or hidden costs (which can be anywhere from 1.1 to 4.5 times actual direct costs) may include overtime and productivity loss due to the replacement of injured employees. Added costs may include training and absenteeism, which affects retention and turnover (Olinski & Norton, 2017).

In Italy, more than six million workers are exposed to the risk associated with manual handling operations (Eurofound, 2015). In 2016, a report by the National Institute for Insurance against Accidents at Work (INAIL) revealed that musculoskeletal disorders account for 64% of the total work-related diseases (INAIL, 2017). In this scenario, risk assessment is essential to identify and evaluate workplace risks and improve working conditions. Several methods

to assess and evaluate patient manual handling have been validated to date (Johnsson, Kjellberg, Kjellberg, & Lagerström, 2004; Karhula, Rönnholm, & Sjögren, 2009); MAPO being one of them. MAPO method, proposed in 1999 (Menoni, Ricci, Panciera, & Occhipinti, 1999), is widely applied in Italy, Spain, France, and South America. Its effectiveness has already been validated by three multicenter cross-sectional studies in several Italian hospitals (Battevi et al., 1999; Battevi & Menoni, 2012; Battevi, Menoni, Ricci, & Cairoli, 2006); the results have shown a positive association between increasing levels of MAPO index and the number of episodes of acute low back pain (LBP). MAPO method focuses on the following factors: work organization, average frequency of handlings, type of patients, equipment, environmental conditions, and training of the operators. It is also characterized by analytical quickness, thanks to the Data Collection Sheet (Menoni, Battevi, & Cairoli, 2015) which shortens significantly the time to assess risks in hospital wards. This document allows interviewers to also focus on the organizational and timing aspects of handling operations performed on non-self-sufficient patients. The final part includes a Note section to be filled in with a list of infrequent handling operations.

The 2012 ISO (International Organization for Standardization) technical report provided recommendations on how to assess and manage risks associated with patient manual handling. This report mentioned MAPO methodology as a useful tool to plan tailored preventive actions and choose suitable equipment for different types of patients (ISO TR 12296, 2012). MAPO scores can be classified into three different exposure levels: negligible (green), medium (yellow), and high (red).

Risk assessment and the relative methods should be constantly updated to cater to the needs of the ever-changing health care facilities. For this reason, a new multicenter study was conducted between 2014 and 2016 involving 26 Italian hospitals in the Apulia region; the project was supervised by the Department of Services and Preventive Medicine in Milan. This paper provides a further validation of MAPO method after some improvements made to better match the 2012 ISO technical report.

MATERIALS AND METHODS

In 2014, the Department of Services and Preventive Medicine in Milan started a 3-year project in collaboration with the Apulia region. All participants (health and safety professionals) were provided with a 3-day training course focused on work-related musculoskeletal disorders and the use of MAPO method to assess the risk of patient manual handling. Our staff provided ad hoc IT support throughout the phase of data collection and a course on health care equipment addressed to occupational physicians and hospital referrals. Safety professionals assessed the risk of patient manual handling, whereas occupational physicians evaluated clinical conditions during health surveillance. During several meetings, the Department of Services and Preventive Medicine checked and discussed all the risk assessments. Monthly reports were aimed at checking whether occupational physicians adhered to the protocol.

Variables of exposure and damage were collected from the end of 2014 to June 2016.

Participation in the project was on a voluntary basis; the only requirement was full agreement to the proposed methodological protocol.

At the end of the study, a total of 308 wards in 29 hospitals were selected, although only 217 wards in 26 hospitals were thoroughly evaluated (70% of the total). Exposed subjects working 36 hr per week and rotating on different shifts were included in the study, whereas caregivers working for less than 36 hr per week were excluded. To eliminate a selection bias, 101 wards were excluded because the number of examined subjects was not equal to or greater than 70% of the subjects exposed to patient manual handling. After direct consultation with occupational physicians, the following subjects were excluded from the study: those with less than 1 year of service, workers with job limitations due to back diseases and assigned to wards with a low MAPO index, and those who suffered from more than five episodes of acute LBP in the previous 12 months. The final number of exposed caregivers was 1,998.

Risk Assessment

The description of MAPO method is widely documented in previous publications (Battevi et al., 2006; Menoni et al., 2015). However, significant changes in the procedure to calculate the different determinants of MAPO index have been made between 2006 and 2015. Such adjustments could affect the relationship between MAPO index and lumbar damage.

The value of each determinant, however, has not changed since 1999 (Menoni et al., 1999).

In this study, MAPO index has always been calculated with the following formula:

$$(\mathrm{NC/OP} \times \mathrm{LF}) + (\mathrm{PC/OP} \times \mathrm{AF}) \times \mathrm{WF} \times \mathrm{EF} \times \mathrm{TF}$$

where NC and PC are, respectively, the noncooperative and partially cooperative patients (ISO TR 12296); OP is the number of operators working in the wards over a 24-hr period; LF is the lifting factor; AF is the minor aids factor; WF is the wheelchair factor; EF is the environment factor; and TF is the training factor.

The most important changes introduced in 2015 (Menoni et al., 2015) to calculate the different determinants of the MAPO index have been the following:

- The criterion of numerical sufficiency for the lifting factor (LF) and the minor aids factor (AF) is fulfilled when all the beds in the ward are four-segment adjustable electric beds.
- LF and AF are considered adequate when at least 90% of total patient lifting operations are performed using lifting aids.
- To be considered adequate, TF requires a documentation attesting the effectiveness of the training course. As suggested by ISO TR 12296, a proper examination was introduced after a training course, if the previous one was held more than 2 years before the risk assessment.

The procedure to calculate all the other factors has remained the same.

Classification of MAPO index results. The wards included in the study were classified according to the three levels of MAPO index (Menoni et al., 2015). Different exposure levels entail different preventive actions:

- 0.1 to 1.5 = negligible exposure level (green), except for hyper-susceptible workers.
- 1.51 to 5 = medium exposure level (yellow), requiring a medium and long-term intervention plan.
- >5 = high exposure level (red), requiring an immediate intervention plan.

Damage Assessment

The presence or absence of damage (at least one episode of acute LBP in the previous 12 months) was investigated for each subject participating in the study. This variable is defined as "the presence of progressively severe LBP with or without lower limb irradiation, forcing patients in bed for two days or one day in case they are taking anti-inflammatory noncorticosteroid and/or relaxant drugs." These kinds of episodes should require a sick leave to help differentiate chronic lumbar pain from acute LBP.

This choice was due to the well-known association between lumbar biomechanical overload and stimulation of LBP (Marras, 2008; Radwin, Marras, & Lavender, 2001; Yassi et al., 1995).

After a period of training by supervisors from the Department of Services and Preventive Medicine in Milan, occupational physicians were entrusted with data collection of the exposed sample and they were periodically checked. As in the previous studies by Battevi et al., the damage assessment protocol involved a first phase aimed at clearly identifying the subjects, their affiliation ward, their ward and job seniority, and any transfer from another ward due to lumbar spine problems. This section was designed to avoid overestimating the number of acute LBP episodes in some wards. The acute LBP observation protocol was administered to at least 70% of the caregivers in each evaluated ward.

Statistical Analysis

The odds ratio (OR) was calculated for two increasing exposure levels (MAPO index = 1.51–5 and >5) by comparing them with MAPO index 0.1 to 1.5 (absent or irrelevant risk of exposure to

patient manual handling). Crude and multivariate analyses were performed; in particular, multivariate random-intercept logistic regression model (considering hospitals as the random effect) was applied and corrected for gender, age, and body mass index (BMI) as potential confounding factors (Basagaña et al., 2018). Stata 15 (StataCorp, 2017) was used for data analysis.

RESULTS

Exposure Levels of Investigated Wards

The investigated sample included 15 different types of wards. MAPO exposure level for patient manual handling has been calculated for each ward as shown in Table 1. Only 12% of the investigated wards fell in the green exposure level (MAPO index = 0.1–1.5), 37% resulted in the average exposure level (MAPO index = 1.51–5), and the remaining 51% in the higher exposure level (MAPO index >5).

Table 2 shows the analysis of single risk determinants. The elaboration of a risk reduction plan requires the analysis of each determinant included in the formula to calculate MAPO index, as well as the identification of intervention priorities and focused actions aimed at reducing the exposure level. The results showed that 64% of the investigated wards presented an absent or inadequate and insufficient lifting device factor (LF); additionally, almost every ward presented an absent or inadequate and insufficient minor aids factor (AF) and training factor (TF): 97% and 94%, respectively.

Characteristics of the Exposed Sample

Upon the adoption of the selection criteria, the total number of exposed subjects was 1,998, whose characteristics are listed in Tables 3 and 4. The sample included a large majority of females (male-female ratio = 1:2.5, with a mean average age of 49 years for males and 47 years for females) and a ward seniority of 22 and 20 years for males and females, respectively. Table 3 shows that nearly half of the subjects fell within the 45 to 54 year range (40.1%), 29.7% within the 35 to 44 year range, and 23.2% within the >55 year range; subjects <35 years were scarcely represented. Table 4 shows that 35% of the sample fell within the 10 to 19 year range of job seniority and 32% within the 20 to 29 year range. Out of 116 wards, the most frequent types were medicine, surgery, cardiology, gynecology, and intensive care unit (ICU). Nursing staff was 86.5% (74% females), hospital support staff was 13.2% (55.3% females), and technical staff was 0.3% (86% females). Out of 1,998 exposed subjects employed full-time, 80.5% followed a rotating shift schedule, working three shifts (day, swing, and night shift); 9.7% followed a rotating shift schedule, working two shifts (day and swing shift); and the remaining 9.8% followed a fixed shift schedule.

Association Between MAPO Index and Episodes of Acute LBP in the Previous 12 Months

Table 5 shows the positive association between MAPO index and episodes of acute LBP in the previous 12 months. The results of crude analysis were confirmed after the adjustment for potential confounding factors (i.e., hospital, gender, age, BMI).

DISCUSSION AND CONCLUSION

In this study including 1,998 caregivers exposed to patient manual handling among 26 different hospitals in the Apulia region, we documented the association between increasing levels of MAPO index and episodes of acute LBP. In particular, we observed that ORs for the medium and high exposure levels were consistent with previous studies, although slightly lower.

After the updates and following validation studies that have been made since 1999, MAPO method has been adapted to better match new international standards. Changes in the procedure to calculate some determinants of the method have improved the risk assessment, providing more objectivity in revealing criticisms in the different hospital wards.

To maximize MAPO effectiveness, the Data Collection Sheet must be properly filled in. The interviewers should highlight the real number and type of patient manual handling operations to calculate the actual percentage of lifting operations.

TABLE 1: Types of Hospital Wards Investigated and Their Distribution by MAPO Risk Level

	No. of Wards	MAPO Index Level		
		0.1–1.5	1.51–5	>5
Type of Ward		%	%	%
Medicine	22	0	31.8	68.2
Surgery	21	0	19	81
Cardiology	13	7.7	61.5	30.8
Gynecology-obstetrics	10	40	50	10
Orthopedics	10	0	20	80
Cardiac intensive care unit	9	11.1	33	55.6
Nephrology	8	25	50	25
Neurology	6	16.7	16.7	66.7
Urology	6	0	100	0
Otolaryngology	3	66.7	33	0
Ophthalmology	2	50	50	0
Geriatrics	2	0	0	100
Other	2	50	0	50
Infectious diseases	1	0	100	0
Psychiatry	1	100	0	0
Total	116	12.1	37.1	50.9

Note. MAPO = Movement and Assistance of Hospital Patients.

TABLE 2: Analysis of Single Risk Determinants of Patient Manual Handling

	Single Risk Determinants		
	Sufficient and Adequate	Inadequate or Insufficient	Absent or Inadequate + Insufficient
Factors	%	%	%
Lifting factor (LF)	5.2	31.1	63.8
Minor aids factor (AF)	1.7	0.9	97.4
Environmental factor (EF)	30.2	68.9	0.9
Wheelchair factor (WF)	65.5	25.9	8.6
Training factor (TF)	4.3	1.7	94

In fact, despite the introduction of four-segment beds, this study has shown that a high number of patient handling tasks are still performed in bed. This situation may be partly due to urgency and habit. Sometimes, risk assessment may lead to an overestimation of the number of patient manual handling operations, meaning that not all the lifting operations reported are actually performed on most non-self-sufficient patients, as required by MAPO method.

The high number of wards with an absent or inadequate and insufficient lifting factor highlights that major aids are predominantly used to

TABLE 3: Analysis of the Sample by Age and Gender

	Age Class (Years)				
	<35	35–44	45–54	≥55	Total
Gender	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Females	113 (7.9)	446 (31.3)	588 (41.2)	280 (19.6)	1,427 (100)
Males	28 (4.9)	146 (25.6)	213 (37.3)	184 (32.2)	571 (100)
Total	141 (7.1)	593 (29.7)	801 (40.1)	463 (23.2)	1,998 (100)

TABLE 4: Job Seniority Classes by Gender

	Job Seniority (Years)				
	0–9	10–19	20–29	≥30	Total
Sex	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Females	218 (15.3)	520 (36.4)	459 (32.2)	230 (16.1)	1,427 (100)
Males	69 (12.1)	177 (31.0)	183 (32.0)	142 (24.9)	571 (100)
Total	287 (14.4)	697 (34.9)	642 (32.1)	372 (18.6)	1,998 (100)

assist heavy patients. Our database reveals that some wards reported a number of manual handling operations that are incompatible with organizational and timing aspects, leading to an incorrect calculation of the index. This analysis was determined on the basis of the average time recorded during different handling operations, both manual and with aids. Moreover, the Note section of the Data Collection Sheet is rarely filled in, causing the wrong assumption that infrequent patient manual handling activities are actually performed on most non-self-sufficient patients.

Given this possible limit of the tool, it is important for the interviewers to know the average time needed to perform each type of handling operation according to the number of operators per shift.

All the exposed caregivers included in this study worked 36 hr per week. Although different types of shift may involve a different number of lifting operations (i.e., compared with morning and afternoon shifts, night shifts involve fewer handling operations), the yearly workload can be considered homogeneous.

Our study presents some limitations. First, information on the amount of overtime hours was not taken into consideration. As reported in the study by Shieh, Sung, Su, Tsai, and Hsieh (2016), every additional daily work hour leads to a 35% increase of the risk of LBP. This data should be considered given that, on average, the caregivers were required to work for more than 9 hr per day. Second, although the literature highlights the importance of psychosocial factors in determining LBP (Hoogendoorn, van Poppel, Bongers, Koes, & Bouter, 2000; Kim, 2018; Marras, 2008; Sterud & Tynes, 2013; Widanarko, Legg, Devereux, & Stevenson, 2015), the present study has not analyzed biomechanical overload and psychosocial factors simultaneously. Most studies that investigated the relationship between these two factors have been criticized for the use of self-reported exposure measurements that may be imprecise and biased, the lack of a multidisciplinary and multilevel approach, and the lack of repeated measurements of musculoskeletal disorders during follow-ups (Karstad et al., 2018).

Our findings proved to be consistent with previous validation studies and confirmed MAPO method effectiveness to predict LBP. However, further research aimed at investigating other variables (such as psychosocial factors and

TABLE 5: Association Between MAPO Index and Occurrence of Acute LBP in the Previous 12 Months

Acute Low Back Pain in the Previous Year						
	Negative	Positive	Crude OR	(95% CI)	Adjusted OR[a]	(95% CI)
MAPO index	No.	No.				
0.1–1.5	243	14	1	—	1	—
1.51–5	681	60	1.53	[0.84, 2.78]	1.33	[0.70, 2.50]
>5	876	124	2.46	[1.39, 4.35]	2.21	[1.20, 4.05]
Gender						
Female	1,289	138	1	—	1	—
Male	511	60	1.1	[0.79, 1.51]	0.97	[0.69, 1.36]
Age (years)						
<35	134	7	1	—	1	—
35–44	538	55	1.96	[0.87, 4.39]	1.82	[0.80, 4.15]
45–54	707	94	2.55	[1.15, 5.61]	2.41	[1.06, 5.43]
>55	421	42	1.91	[0.84, 4.35]	1.66	[0.70, 3.91]
BMI (kg/m^2)						
<20	122	8	1	—	1	—
20–25	748	78	1.59	[0.75, 3.37]	1.57	[0.73, 3.36]
26–30	647	77	1.81	[0.85, 3.85]	1.79	[0.82, 3.87]
30–35	215	27	1.91	[0.84, 4.35]	1.78	[0.77, 4.12]
>35	68	8	1.79	[0.64, 4.99]	1.59	[0.56, 4.49]
p trend			<.001	—	.001	—

Note. MAPO = Movement and Assistance of Hospital Patients; OR = odds ratio; CI = confidence interval; BMI = body mass index.
[a]From a multivariate random-intercept (random effect: hospital) logistic regression model containing all variables shown in the table.

overtime hours) is required to guarantee a more accurate risk assessment of patient manual handling.

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KEY POINTS

- MAPO (Movement and Assistance of Hospital Patient) method was validated after some improvements following the publication of ISO (International Organization for Standardization) technical report in 2012.
- The most important changes concerned the lifting factor (LF), minor aids factor (AF), and training factor (TF).
- The results confirmed the association between increasing levels of MAPO index and episodes of acute low back pain.

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