Edmonton Obesity Staging System (EOSS) and Work Ability in the Evaluation of Workers Affected by Obesity

A Preliminary Report

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Objective: Obesity and work-ability may be influenced by reduced performance, associated diseases, and obesogenic environment. **Methods:** Two hundred seventy-six male (46.7 ± 10.6 years; BMI $33.3 \pm 4.4\,kg/m^2$) and 658 female (48.4 ± 9.7 years; BMI $33.6 \pm 5.4\,kg/m^2$) were enrolled. They were classified by Edmonton Obesity Staging System (EOSS) and interviewed for ''perceived'' work-ability. **Results:** Total work ability score was 1.3 ± 2.1 in EOSS 0, 1.2 ± 1.5 in EOSS 1, 1.8 ± 2 in EOSS 2, 2.0 ± 2.2 in EOSS 3. Work-ability, in relation to EOSS adjusted for sex, age, work categories referred to EOSS 0, was highest in EOSS stage 3 ($P < 0.001$ for trend) and with reference to Administration; Industries showed the worst score ($P < 0.001$) followed by Health ($P = 0.001$) and Service ($P = 0.01$). **Conclusion:** The relation between EOSS and work-ability empowers clinical decision-making and helps to assess the impact of overweight on health and fitness for work.

Keywords: EOSS, obesity, occupational medicine, work ability

In Italy, 42.5% of working male subjects is overweight and 10.5% is affected by obesity, whereas only 26.6% of women is overweight and 9.1% is affected by obesity. These data also refer to European population.[1,2] Obesity increases the risks of several diseases and is associated with a higher prevalence of poor work ability and ensuing disability pensions, especially due to mental disorders, musculoskeletal and cardiovascular diseases.[3,4] Associations between obesity and work ability may be complex and influenced by work-related factors. Body weight and obesity degree, measured by body mass index (BMI), is not the only factor that predicts an increased risk of poor work ability; other factors, such as associated diseases (eg, diabetes, metabolic syndrome), unhealthy behaviors (eg, lack of physical activity), and lack of social support, might be relevant factors. Thus, it is important to identify workers at risk, employed in physically strenuous work, in order to develop occupational health services promoting effective strategies.[5]

The current classification of obesity based on BMI, waist circumference, and other anthropometric factors might have some limitations when applied to clinical practice, albeit useful in studies on population. Hence, these systems do not collect data on comorbidity rate, functional limitations, or mortality.

In 2010, Sharma[6] suggested health professionals a wide range of medical and psychosocial problems related to individuals affected by obesity; they provide important indications for treatment but, in some cases, also pose significant barriers to treatment. His Edmonton Obesity Staging System (EOSS) is a risk-stratification system that classifies obese individuals into five graded categories, based on their morbidity and health-risk profile.[7] For each category, clinical management is suggested considering not only body weight, from lifestyle modification to weight loss program, but also the appropriate treatment setting for extant clinical comorbidities. The clinical relevance of EOSS is the demonstration that its stage might be helpful to identify patients with high mortality risk and plan adequate intervention strategy.[8]

In study population, the reduction in work ability was generally evaluated with a Work Ability Index (WAI). It is a questionnaire measuring seven items to address work ability, possible involved diseases, symptoms, and sickness absence. Different studies analyzed the predictive validity of the questionnaire both in its full-length version and in its single items.[9] Considering obesity-related disability, some items appear more significant.

Item I asks about current work ability compared with lifetime best, which was previously well related to predicting sickness absence.

Item II reports the ability in relation to physical job demand, which in obesity might be influenced by reduced physical performance.

Item IV is the perceived ability due to the disease, with its global impact on job demand and high predictive value.[10]

Item V reports the number of days on sickness absence during the last 12 months as a direct measure of work disability.[11]

The administration of a single specific item, instead of its full version, appears reasonably reliable for its compliance and lower cost.[11]

The present study aims at evaluating the distribution of EOSS classification in a group of workers affected by overweight-obesity and whether the reduction in work ability, due to severe obesity and its comorbidities, is related to the progression of EOSS class. The possibility to use EOSS class in the prediction of work-eligibility might help to develop specific protocols in public health policies to reduce sickness absenteeism and early retirement of patients with obesity.

METHODS

Participants

We recruited a cohort of workers from different companies in Northern Italy, all of them referring to the Occupational Medicine Unit of ''Clinica del Lavoro Luigi Devoto,'' University of Milan, for their annual routine health surveillance of work. In the period from March 1, 2010, to June 30, 2011, workers who showed a condition of overweight obesity - defined as a BMI higher than 25 or $30\,kg/m^2$

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according to WHO[12] - at a physical examination, were referred to the Internal ''Obesity and Work'' Service by the occupational physician. Then, they were asked to voluntarily participate in the present study by signing an informed consent. The study cohort consisted of workers from several occupational areas according to official European ATECO classification and Regulation (EC) No. 1893/2006 of the European Parliament and of the European Council of December 20, 2006.[13]

Our database consisted of 934 workers (response rate of 85%) affected by obesity. Because of the importance of reducing bias associated with obesity, we used people-first language according to the standard recommendation of The Obesity Society and Canadian Obesity Network.[14] The study was approved by the Ethics Committee of our Institute (Study registration number: 1370).

Clinical Data

The anthropometric factors measured on these workers were weight (kg), height (cm), BMI (kg/m^2), and systolic and diastolic blood pressure (mmHg). Fasting blood tests were taken to assess blood glucose, total cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, serum uric acid, insulin, glycated hemoglobin (Modular, Roche, Basel, Switzerland). A medical evaluation was performed to recall medical history and clinical comorbidities, pharmacological treatment, and social condition (type of education).

EOSS

The EOSS system consists of the following five stages:

(1) Stage 0: no obesity-related risk factors (physical, psychopathological, functional);
(2) Stage 1: mild physical, psychopathological and metabolic symptoms;
(3) Stage 2: metabolic symptoms needing medical treatment, and/or moderate psychological symptoms and/or moderate functional limitations;
(4) Stage 3: functional symptoms and organ damage affecting the living standard;
(5) Stage 4: severe disabilities from obesity, severe disabling psychopathology, severe functional limitations.[7]

The several complications and/or alterations related to obesity are allocated into four categories, according with the following Mental/Mechanical/Metabolic and Monetary (MMM&M) criteria[6]:

''Metabolic'' [anxiety-depression syndrome, panic attack, emotional eating, binge eating disorder (ED), psychosis, work-related stress];

''Mechanical'' (osteoarthritis, esophageal reflux, obstructive sleep apnea, urinary incontinence, lower limbs thrombosis);

''Metabolic'' (type 2 diabetes, increased glycemia, hyperinsulinism, insulin resistance, hypertension, dyslipidemia, steatohepatosis, gout, and metabolic syndrome defined in presence of at least three of these measures[15]: waist circumference >102 cm in men, ≥ 88 cm in women; triglycerides ≥ 150 mg/dL or 1.7 mmol/L or in treatment; HDL-cholesterol ≤ 40 mg/dl or 1.3 mmol/L in men, ≤ 50 mg/dL or 1.3 mmol/L in women or in treatment; blood pressure ≥ 130 mmHg systolic blood pressure or ≥ 85 mmHg diastolic blood pressure or in treatment; fasting glucose ≥ 100 mg/dL or impaired glucose tolerance or type 2 diabetes);

''Monetary'' (education, employment, low income, life/health insurance, disability, bariatric supply, dietary products, surgery).

The EOSS level is categorized reckoning the highest-stage risk factor present in each individual. For example, an individual with normal fasting glucose, normal lipids, no psychopathology, no functional limitations (stage 0), but with diagnosed hypertension (stage 2), is categorized as EOSS stage 2. Similarly, an individual with borderline hypertension, impaired fasting glucose (stage 1), osteoarthritis, and anxiety disorder (stage 2) is also categorized as EOSS stage 2.

Work Ability Measures

Work ability was evaluated using four specific items of WAI:

(1) item1 ''How much change has your current work ability undergone compared with your best lifetime in the last 12 months?'';
(2) item 2 ''How strong is ache or the impairment in the upright position at the end of a work day?'';
(3) item 4''How do you evaluate your work impairment due to obesity?'';
(4) item 5 ''How many days on sickness absence did you make during the last 12 months?''.

The questions were asked by an occupational psychologist during an interview

The maximum value of the score was 10 for each of the four items; we obtained the total perceived work ability from the sum of each item divided by the number items (four). The poor work ability was considered from 5 to 10.

Statistical Analysis

As a number of subjects were assessed more than once, we fitted GEE (generalized estimating equations) regression models to reckon intraindividual correlations.[16] We used linear GEE models when considering work ability score as the outcome, and logistic GEE models when considering poor work ability (yes/no). Models were adjusted for sex, age, and work category. Statistical analyses were performed using Stata 14 (StataCorp. 2015. StataCorp. 2009. Stata: Release 14. Statistical Software; StataCorp LP, College Station, Texas).

RESULTS

We studied 276 male subjects (average age 46.7 years, SD 10.6) with a BMI of 33.3 kg/m^2 (SD 4.4) and 658 female subjects (average age of 48.4 years, SD 9.7) with a BMI of 33.6 kg/m^2 (SD 5.4).

The evaluation of data by BMI classification produced the following results: overweight (BMI 25 to 29.9 kg/m^2) was present in 26.3%; Class I obesity (BMI 30 to 34.9 kg/m^2) was found in 40.6% – this being the most frequent class; Class II obesity (BMI 35 to 39.9 kg/m^2) was present in 21.2%; Class III obesity (BMI >40 kg/m^2) was found in 11.8%.

According to BMI, Class I was found more representative both in women (37,3%) and in men (48.5%); Class II and Class III of obesity showed a progressive reduction in frequency.

By classifying complications according to the ''four M's Method'' (Mental, Mechanical, Metabolic, and Monetary), we found a similar distribution in each EOSS class (Fig. 1) with the following characteristics:

- Mental complications were reported in 72% of workers: a psychological interview showed that 60% suffered from EDs (emotional eating/binge ED), 26% were affected by depression and/or under pharmacological treatment, 15% reported an anxious syndrome, 32% reported work-related stress, and 38% of interviewed workers reported obesity stigma at work and a correlation between their BMI and their professional performance.
- Mechanical complications were reported in 74% of workers: 25% suffered from osteoarthritis, 28% reported esophageal reflux, obstructive sleep apnea and respiratory problems were diagnosed in 32% of workers, 2% reported previous thrombosis and venous insufficiency, 1% reported urinary incontinence.
- Metabolic complications were present in 92% of workers: 79% suffered from hypercholesterolemia or hypertriglyceridemia

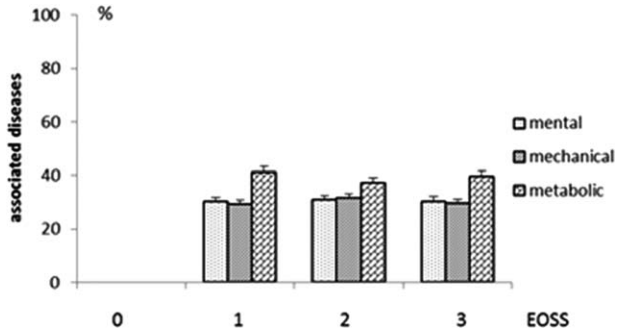

FIGURE 1. Frequency in percentage of complications in each EOSS stage.

with or without fatty liver syndrome, 17% hyperuricaemia, 11% type 2 diabetes, 26% impaired fasting glycemia, and 41% hyperinsulinism and insulin resistance. Furthermore, 42% of the workers were suffering from hypertension and 41% had at least three criteria for metabolic syndrome.

- As for the ''monetary'' criterion, we considered ''Education'' (28% of the workers had received primary education, and 72% higher and graduate education) and work category as reported in Table 1.
- In 7.2% of the workers, we found serious heart (1.8%) or other system diseases (5.4% in peripheral neuropathy, osteomyelitis, deforming arthritis, cancer, lupus erythematosus, chronic renal diseases, injury issues, chronic obstructive pulmonary disease, psychopathology in pharmacological therapy).

The results by EOSS system are reported in Table 1: 2.9% of workers in Stage 0; 37.0% in Stage 1; 55.4% in Stage 2; 4.7% in stage 3. No one in Stage 4.

Considering the perceived work ability and using the administration categories (the most sedentary ones) as reference, the workers in industry presented a greater difficulty in working with a significant relation (Table 2).

The mean perceived work ability was 1.1 ± 1.7 among men and 1.8 ± 1.9 among women. A poor work ability was scored in 1.3% of men and 7.2% of women. The value of total work ability and EOSS classification were significantly correlated in all groups (coefficient = 1.5, $P < 0.0001$). Also, in the adjusted model, the total perceived work ability and poor work ability were significantly, positively associated with EOSS class (Table 3).

DISCUSSION

This study demonstrates that, in the evaluation of work ability in individuals affected by obesity, the application of EOSS classification produces more information not only in terms of the obesity degree, measured by BMI, but also in clinical setting and functional limitations. The results obtained underline the importance of accounting not only for anthropometric parameters but also for organic and functional complications, likely to affect evaluation of work-eligibility for a specific activity.[17–19] Moreover, this evaluation allows physicians to assess workers' state of health more accurately also in view of a health promotion campaign.

In our sample, the distribution of clinical complications was extant in all EOSS stages and metabolic diseases were the most frequent. This effect opened different considerations.

TABLE 1. Characteristics of Participants in Relation to EOSS Classification

	EOSS Stage 0	EOSS Stage 1	EOSS Stage 2	EOSS Stage 3
No.	27 (2.9%)	345 (37.0%)	518 (55.4%)	44 (4.7%)
M	4	94	158	20
F	23	251	360	24
Age, years	39.1 ± 9.3	45.0 ± 10.3	50.0 ± 9.2	51.6 ± 9.4
Weight, kg	83.7 ± 13.6	86.1 ± 15.2	92 ± 15.9	92.8 ± 17.1
BMI, kg/m^2	31.6 ± 2.6	32.1 ± 4.6	34.6 ± 5.3	34.4 ± 5.4
Education				
Primary	19 (2.04%)	125 (13.38%)	428 (45.83%)	25 (2.68%)
Higher and graduate	31 (3.32%)	50 (5.35%)	247 (26.44%)	9 (0.96%)
Work categories (no./%):				
Administration	7 (25.9%)	158 (45.8%)	225 (43.4%)	18 (40.9%)
Industries/Commerce	7 (25.9%)	42 (12.2%)	65 (12.5%)	10 (22.7%)
Education	2 (7.4%)	17 (4.9%)	24 (4.6%)	2 (4.5%)
Health	2 (7.4%)	48 (13.9%)	69 (13.3%)	4 (9.1%)
Services	9 (33.3%)	80 (23.2%)	135 (26.1%)	10 (22.7%)
Total work ability score (mean ± s.d.)	1.3 ± 2.1	1.2 ± 1.5	1.8 ± 2.0	2.0 ± 2.2
Poor work ability no./(%)	7 (25.9%)	118 (34.2%)	262 (50.6%)	23 (52.3%)

EOSS, Edmonton Obesity Staging System.

TABLE 2. Association Between Work Categories With Perceived Work Ability

	Industries/ Commerce Coefficient	Education Coefficient	Health Coefficient	Service Coefficient
Total work ability score	2.90 (1.36; 4.45) $P < 0.001$	2.00 (-0.40; 4.42) $P = 0.10$	2.73 (1.13; 4.33) $P = 0.001$	1.47 (0.32; 2.61) $P = 0.01$

TABLE 3. Association Between Perceived Work Ability and EOSS Categories

	EOSS 0 Coefficient (95% CI)	EOSS 1 Coefficient (95% CI)	EOSS 2 Coefficient (95% CI)	EOSS 3 Coefficient (95% CI)	Trend
Total work ability score	Ref	+0.2 (−3.2–+3.5)	+2.2 (−1.2–+5.6)	+3.2 (−1.0–+7.3)	+1.6 (+0.9–+2.4) $P < 0.0001$
Poor work ability (yes/no)	Ref	+2.1 (+0.8–+5.0)	+4.4 (+1.8–+10.8)	+5.3 (+1.8–+16.0)	+1.9 (+1.5–+2.5) $P < 0.0001$

Results from generalized estimating equation (GEE) models adjusted for gender, age, and work category.
EOSS, Edmonton Obesity Staging System; OR, odds ratio.

Mental Complications

In this category, we can consider different conditions that are directly or indirectly related to the work environment in workers with obesity. Previous studies analyzed some possible models of interaction – in the development of adverse outcome – between personal risk factors, such as the presence of EDs or depressive symptom and occupational risk factors, such as sedentary work or job strain .[20] The frequency of ED is high among workers affected by obesity with a range of 3.3% to 5.5%[21] and particularly so among women. Different studies reported that binge eating might increase the risk of developing components to the metabolic syndrome (type 2 diabetes, dyslipidemia, hypertension) over and above the risk attributable to obesity alone.[22] Furthermore, in our sample, work-related stress was reported by 32% of interviewed workers. A significant percentage of workers reported obesity interferences with their working performance. From a social perspective, workers with obesity are likely to be excluded or marginalized already during the recruiting processes or public competitions. During the psychological interview, 38% of workers reported a relation between their BMI and their professional performance and even some stigma. They are believed to be responsible for their own condition, and this does not boost competitiveness.[2] Literature reports that misinformation about obesity may lead to weight bias and stigma. In order to reduce the latter and improve individuals' knowledge about obesity, educational tools and multilevel approaches are needed.[14,23–25]

Mechanical Complications

Sedentary jobs might produce painful tensions in shoulders and neck, back problems, and circulatory diseases. Nonsedentary jobs might cause spine and joints overloading. In both jobs, osteoarticular pain, unbalanced postures, breathing impairment could be present. Workers with obesity might have several functional alterations, such as a reduced tolerance to strain and low active range of motion of spine and main joints. Furthermore, they may show diminished muscular strength and tolerance to fixed and prolonged postures impairing their working abilities.[26,27] In our sample, 25% of the workers reported osteoarticular diseases. In mechanical complications, we can also reckon a possible lung volume reduction and hence aggravation of breathing mechanics due to obesity. These symptoms are related to a bad sleep quality or even to an obstructive sleep apnea syndrome (OSAS). In daytime, these conditions may cause drowsiness and bad working performances leading to an increase of work and road accidents.[28] The presence of OSAS was reported by 32% of the interviewed workers. Another mechanical complication related to obesity is gastroesophageal reflux disorders (GERDs) caused by nutritional factors (fat or acid food, chocolate, alcohol, coffee) and by an increase of intra-abdominal pressure.[29] In our sample, 28% of the patients report GERD.

Metabolic Complications

The work environment plays an important role in cardiovascular morbidity and mortality. Several elements are involved: physical, chemical, and psychosocial factors.[30]

Some studies also report negative pathophysiological effect of shift work on BMI and the onset of cardiovascular disease: disruption of circadian rhythms, sleep disturbances, behavior factors (unbalanced diet, which causes an irregular lipid metabolism and an irregular insulin secretion, alcohol abuse and tobacco), and occupational stress.[31,32] Recently, we also found that both sedentary and shift work is associated with low vitamin D levels.[33] In Whitehall II study, work stress was associated with a higher risk of Type 2 diabetes mellitus (T2DM) among women affected by obesity, probably via hormonal processes such as cortisol release in response to stress.[34] Previous reviews reported a suggestive evidence of an association between long work hours and weight gain, especially among men, due to different mechanisms: psychosocial factors increasing the frequency of eating higher caloric value food, decreased physical activity, and reduced sleep.[35] Weight gain, T2DM, cardiovascular disorders, and work-related stress lead to metabolic syndrome.[32] In our sample, the latter was found in 41% of workers and dyslipidemia was found in 71% of workers.

Monetary Complications

Obesity is also associated with increased absenteeism, disability, and a more frequent need of health care support. Consequences may be lower wages and decreased productivity.[18]

The perceived work ability includes different aspects: the capacity of the worker to perform the required work considering the kind of occupation and the worker's health status (mental and physical). Obesity is associated with an increased risk of poor work ability.[36,37] Not only different factors might be involved such as high physical workload, the presence of comorbidities, especially diabetes or osteoarthritis, but also socioeconomic factors such as low level of education and/or occupational class and lack of social support at work. In our sample, we found a significant positive trend between EOSS score and the progressive reduction of perceived work ability, justified by the increased presence of comorbidities and function limitations. For the same reason, the number of workers with poor work ability increased in the high levels of EOSS classification. Furthermore, stage 3 is the less representative group in both sexes and no workers were found in stage 4. It is possible that in these categories, clinical conditions are so bad that work disability reaches high levels or produces loss of work. We need further studies to evaluate, in a larger sample, whether the disability or BMI of stage 3 and 4 are independent factors for work ability.

Physical working conditions partially explained the occupational class differences in physical health functioning and self-perceived health, both of which are associated with lower work ability.[5] Increased physical workload demands, in relation to body

clinical conditions, might justify the differences that we registered in some work categories; poor work ability is especially significant in industry.

The EOSS has some limitations together with advantages in clinic programs, as it is based on definitions prone to change, such as hypertension or dyslipidemia. Furthermore, there might be some reservations about whether a specific condition is caused or just aggravated by obesity (ie, mechanical complication). For the same reason, also the evaluation of work ability is difficult to obtain in workers affected by obesity that are comprehensive of physical and psychological functional limitations. We opted to obtain indirect information by measuring the perceived work inability or frequency of absenteeism.

In conclusion, we believe that the proposed system (EOSS) includes a range of parameters more clinically defined than BMI alone, as it evaluates the same conditions by two different sets of criteria (BMI, comorbidities, and functional limitation).[8,38] Altogether, EOSS is a simple but effective clinical-staging tool that provides information about obesity-related disease, its extent, and severity. The demonstrated relation between work ability and obesity empowers clinical decision-making. It also helps to assess the impact of overweight on health and fitness for work[39] and to plan promotion campaigns for workplace health.

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