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Articoli/*Articles*

# BERNARDINO RAMAZZINI AND THE NEW EPIDEMICS OF WORK-RELATED DISORDERS

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*SUMMARY*

*RAMAZZINI AND THE NEW EPIDEMICS*

*Work-related diseases (such as musculoskeletal disorders, neoplasms cardio-circulatory and psycho-social problems disorders) represent an increasing problem that countries are becoming aware of. In particular, musculoskeletal disorders, affecting workers in a variety of occupations, are a major cause of lost time from work and workers' disability. The paper reviews Ramazzini's observations of musculoskeletal disorders of subjects working in the second half of the seventeenth century. He observed that several clinical pictures were linked to a variety of factors (prolonged stationary postures, unnatural postures, repetition of movements, heavy muscular performance) and stressed the need to provide workforce with hygienic measures and information about hazards and preventive measures. It is worthy to stress that Ramazzini's observations, based on original intuitions and critical reasoning, anticipate the modern approach based on epidemiological principles.*

*Questo contributo è dedicato a Pericle Di Pietro († 2 gennaio 2010)*

## *Introduction*

Work-related diseases represent an increasing problem that countries are becoming aware of. In fact, recent studies show that the

*Key words:* Occupational medicine - Occupational health - Public health - Epidemiology - Musculoskeletal disorders

number of work-related diseases, such as musculoskeletal disorders (MSD), neoplasms and cardio-circulatory and psycho-social problems disorders seems to be underestimated. It has been shown that new working conditions (including demographics patterns, new technologies and new models of organization, a diffuse social, economic and cultural development) entail the exposure of 41% of the working population (more than 81 million workers) in the 27 EU member states to factors adversely affecting physical health. The most frequently involved factor is exposure to specific work postures, work movements or heavy loads handling, whereas the most frequent disorders are back, neck, shoulder, arm or hand problems accounting for 62% of workers with a sick leave and 27% with a sick leave higher than one month[1]. Not specific to any type of job, MSD affect workers in a wide variety of occupations, usually take years to develop and are a major cause of lost time from work, workers' disability, compensation claims and health care costs[2]. MSD include back pain and cumulative trauma disorder (a variety of soft-tissue injuries and disorders affecting tendons, tendon sheaths, muscles, or nerves). It was not until the 1970s that working conditions were investigated with the aim to measure the prevalence of workers affected by MSD, to establish a causal link between work and the syndromes and to suggest appropriate preventive measures[3]. Since then scholars and researchers actively studied the association workplace -MSD in an effort to diagnose, treat and prevent the occurrence of MSD in workers[4].

Following the observation of the dramatic increase of MDS (the ''occupational epidemic of the 1990s'')[5] among workers employed in apparently safe tasks, this contribute aims at reviewing and discussing the observations made by Bernardino Ramazzini (Carpi 1933 – Padova 1714) on the disorders of musculoskeletal apparatus of workers of the second half of the seventeenth century.

## *The treatise* De Morbis Artificum Diatriba

Although the first observations about health disorders in workers can be traced back to prehistory, some evidence was provided by the Egyptians[6], the Hellenics and, in the sixteenth century, by Philipp von Hohenheim (Paracelsus) e Georg Bauer (Agricola)[7,8]. Incomplete or limited to particular working environments, these observations are of limited scientific value but testify awareness that working activities could be related to health problems[9]. At the end of the seventeenth century this field received a great contribution with the work of a doctor at the University of Modena in Italy. In fact, Bernardino Ramazzini went beyond the usual doctor's practice of his time and investigated the role of work in determining the diseases. He systematised the then existing knowledge and described specific health alterations caused by several jobs[10]. It is especially because of his personal contribution collected in the treatise *De Morbis Artificum Diatriba* (Diseases of workers) (Fig. 1)[11] that Bernardino Ramazzini is the world-recognised father of the discipline "occupational medicine"[12]. The work had a great impact in the development of medical sciences[13] and according to a classic of history, Ramazzini's *Diatriba* is to the development of occupational medicine what Vesalius' work is to anatomy and Morgagni's to pathology[14]. Presently, he is a widely known

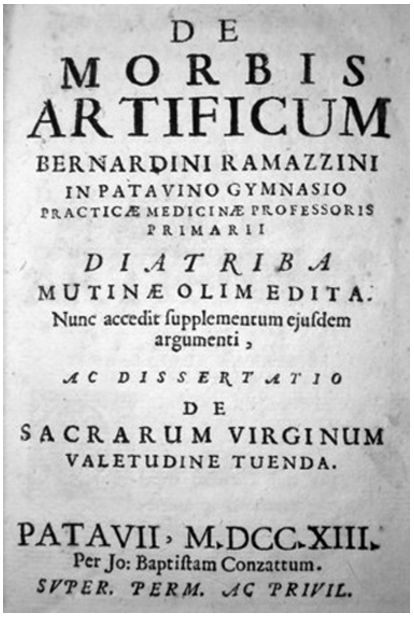
DE
MORBIS
ARTIFICUM
BERNARDINI RAMAZZINI
IN PATAVINO GYMNASIO
PRACTICÆ MEDICINÆ PROFESSORIS
PRIMARII
DIATRIBA
MUTINÆ OLIM EDITA.
Nunc accedit ſupplementum ejuſdem
argumenti,
AC DISSERTATIO
DE
SACRARUM VIRGINUM
VALETUDINE TUENDA.
PATAVII, M.DCC.XIII.
Per Jo: Baptiſtam Conzattum.
SUPER. PERM. AC PRIVIL.

Fig. 1 - Frontpage of the *editio princeps* (Padova, 1713) of the Diatriba

author, appreciated by the scientific and academic community[15] and a reference for doctors and scholars of different medical disciplines[16]. He showed that the "walk-through", presently a well-established practice[17], allowed the proper identification of hazards responsible for health disorders. But this view was not suggestible in the seventeenth century[18]. However, Ramazzini stressed that he did not consider degrading, either for himself or for the other doctors, to systematically visit the working sites in order to investigate whether the activities carried out could be responsible for the observed workers' diseases:

> *Ego quidem pro viribus effeci quod potui, neque indecorum credidi in viliores Officinas pedem quandoque immitere, &...Artium Mechanicarum secreta contemplari*[19].

As pointed out by Carnevale[20], the observation of the association between hazard and disease is based on intuitions and logical deductions, and anticipates the scientific approach based on epidemiological principles[21]. This approach, based on the observation of pathological pictures in groups of workers and not in individuals, shows the originality of Ramazzini's thought[22] because he usually dealt with individual patients. His attitude reveals a population-based approach instead of clinical or individual observation, allowing to recognize the awareness Ramazzini had about the importance of community health problems[23].

### *The observations of the relationship between working conditions and the musculoskeletal disorders*

Ramazzini knew that dangerous materials (such as mineral dusts, vegetal particles and vapours) could be inhaled or absorbed through the lungs or, like the mercury ointment, could penetrate the skin. Furthermore, he identified physical agents (including noise, heat, cold, and humidity) as potentially responsible for illnesses. However, he realised that it was not possible to ascribe the whole spectrum of

workers' diseases to the characteristics of the working environment and he observed that a variety of MSD could originate from prolonged, violent and irregular motions and prolonged unnatural postures of the worker's body in several occupations (Table 1):

> *...modo ad alios Artifices, quibus aliis ex causis, veluti situ quondam membrorum, ac motionibus corporis incongruis, morbosi affectus succrescunt, dum operantur... (Caput XXX - De morbis, quibus tentari solent Statarii Artifices)*[24].

Ramazzini observed that the causes of these abnormalities were linked to the maintenance either of prolonged stationary postures or of unnatural postures and to the requiring heavy muscular performance. Although a detailed tool for assessing factors associated with work related musculokeletal disorders was not developed, Ramazzini understood the relationship between posture, repetition of movements, weight lifting, muscular load and certain disorders (sciatica, gibbus, valgoid condition, hernia, pain in different parts of the body, fatigue, arthritis, paralysis, lameness, shoulder dislocation and muscular tension), allowing him not only to describe the anatomical localization of the disorder, but also to identify intensity and duration of the risk factor[25].

Table 1 - Occupations at risk of musculoskeletal disorders according to the Bernardino Ramazzini's *De Morbis Artificum Diatriba*.

| | |
|---|---|
| Athletes | Bakers and Millers |
| Blacksmiths | Brick-makers |
| Carpenters | Coppersmiths |
| Farmers | Fishermen |
| Horsemen | Hunters |
| Miners | Porters |
| Potters | Printers |
| Razor and Lancet Grinders | Runners |
| Sailors and Rowers | Sedentary workers |
| Soap-makers | The Learned |
| Voice-trainers and Singers | Weavers |
| Well-diggers | Workers on minutes objects |
| Workers who stand | Writers and Notaries |

*Biomechanical load from awkward and standing posture*

The responsibility of biomechanical overload and awkward postures is identified and recognised to cause diseases affecting miners**:**

> *...altera ad motus quosdam violentos, incompositos, & incongruas corporis configurationes refertur, propter quas Vitalis Machinae naturalis structura vitiatur...*[26].

In particular, Ramazzini described that a prolonged stationary posture in printers who "have to stand incessantly at work…is very fatiguing, for almost the whole body must be exerted in such a task; hence these workmen inevitably suffer from lassitude and intense fatigue"[27]. Ramazzini pointed out that standing is responsible for disorders in workers "even for a short time, proves so exhausting compared with walking and running, though it be for a long time" and proposed a pathophysiological mechanism to explain the observation: "It is generally supposed that this is because of the tonic movement of all the antagonist muscles, both extensors and flexors, which have to be continually in action to enable a man to keep standing erect"[28].

Clinical pictures are reported in different occupations as a consequence of unnatural postures: "Tailors are often subject to numbness of the legs, lameness, and sciatica, because while they are sewing garments they are almost of necessity obliged to keep one of the legs back against the thigh"[29]. On the other side, Ramazzini identifies the health problems resulting from a sedentary behaviour in "Those who sit at their work and are therefore called chair-workers" observing that "who sit while they work at their job, become bent, hump-backed, and hold their heads down like people looking for something on the ground…"[30]. Sedentary attitudes leading to lumbago ("All sedentary workers suffer from lumbago")[31] are reported both in the learned men, who "…physically inactive in proportion to the activity of their minds and brains, suffer the drawbacks of a

sedentary life"[32] and in goldsmith "who hammer gold into the finest possible leaf " and in coppermisths who "…become humpbacked besides, from that continual stooping over the work"[33].

*Fatigue from heavy and prolonged muscular performance*

Musculoskeletal overload is reported as a major cause of disease among potters "who sit at the wheel and turn it to shape the vessels...from excessive fatigue of the feet they are often subject to sciatica"[34]. Porters are considered workers at risk for this reason ("one sees a vast number of porters whose work is indispensable for loading and unloading merchandise …" and "From carrying huge weights on their shoulders they too often suffer from various and even very serious diseases…the dorsal vertebral are constantly bent forward and become set in that position"[35]. Fatigue as a consequence of heavy and prolonged muscular performance is recognised in several occupations: in carpenters ("carpentering is a toilsome business and greatly fatigues the workers…This kind of work is very tiring…"[36], in farmers ("…they have to wrestle with unending toil and the direst poverty on another man's estate")[37], in soap-makers ("Any harm that comes to these workmen from their work is caused solely by excessive toil day and night…")[38], in weavers ("This kind of work is certainly very fatiguing, for the whole body is tasked, both hands, arms, feet, and back, so that every part of the body at once shares in the work")[39]. The last job is recognised as particularly dangerous for females ("Now an occupation so fatiguing...especially for women, for if pregnant they easily miscarry and expel the foetus prematurely…")[40].

Ramazzini reported fatigue in writers and notaries ("the maladies that afflict the clerks aforesaid arise from constant sitting…the incessant movement of the hand and always in the same direction")[41] and observed that it was caused by the muscular overload of the arm and leading to the progressive impairment of the function are observed in clerks and secretaries. In these workers also the obser-

vation that "the strain on the mind from the effort not to disfigure the books by errors or cause loss to their employers when they add, subtract, or do other sums in arithmetic"[42] is worthy to be considered because it anticipates the occurrence of modern psychological stress. A WHO scientific group[43] exploring the burden of musculoskeletal conditions of the new millennium confirmed most observations made by Ramazzini. As shown in table 2, the group analysed the factors responsible for MSD, by considering both individual intrinsic aspects (such as obesity and genetic predisposition) and extrinsic factors (mostly but not exclusively related to the work) and concluded that (i) there is a "moderate to strong association" between spine disorders and heavy physical loading[44] (ii) the most common risk factors for neck and arm or arms are exposure to repetitive movement and a static posture[45] , (iii) similar occupational factors are recognised in the genesis of cumulative trauma disorders (repetitive motion, forceful exertions, mechanical insult, awkward postures)[46], (iv) in addition to several non-occupational factors (such as pregnancy, chronic disease and recreational factors) a variety of job-related factors are associated with MSD, including work-load, time and work pressure, work variability, poor and monotonous work[47].

Table 2 - Risk factors for non-specific musculoskeletal disorders according to the WHO report (* identifies the factors identified and described by Ramazzini).

| Extrinsic Factors | Intrinsic Factors |
|---|---|
| Heavy physical labour* | Anthropometrics (obesity, increased height) |
| Frequent bending and twisting* | Spinal abnormalities |
| Lifting and forceful movements* | Genetic predisposition |
| Repetitive movements* | Pregnancy |
| Vibration | Psychosocial factors (psychosocial stress, health beliefs, family stress)* |
| Smoking* | |
| Improper body mechanics* | |
| Insufficient exercise* | |
| Prolonged sitting or driving* | Ageing |

*Advice, recommendation and suggestions of preventive measures*

The need to establish a correct approach in adapting work to man became a major concern in the last years. According to the principles of ergonomics[48], preventive interventions are presently based on engineering controls, availability of an appropriate equipment and administrative measures. Ramazzini anticipated the modern strategies for preventing MSD by (i) pointing out stakeholders' responsibilities[49] in the protection of workers' health, (ii) stressing workers' responsibilities in their own health protection, (iii) intervening on factors within the work organization and (iv) providing workers with appropriate recommendations. Although Ramazzini did not develop a complete approach for preventing MSD in workforce, he not only understood the relationship between postural attitudes, repetition of movements, weight lifting and certain disorders but perceived the need to identify them in order to prevent their occurrence[50].

In addition to the need for appropriate tools ("workers are warned to use shorter stirrup")[51], Ramazzini recommended the periodic interruption of the working activity and the reduction of its duration for a number of hard jobs requiring a standing position[52] or a severe muscular effort[53]. Throughout the text, several points show that Ramazzini felt the need to provide advises and recommendations. This attitude reveals a sense of paternalism typical of the clinician who has oriented his activity as a duty towards patients. His terminology, mostly aimed at advising workers about appropriate attitudes, is that of the clinician asking the patient to limit himself, to be moderate and to avoid risks ("Therefore in work so taxing moderation would be the best safeguard against these maladies, for men and women alike; for the common maxim "Nothing to excess" is one that I excessively approve…")[54], to limit the working activity ("…we must advise men employed in the standing trades to interrupt when they can that too prolonged posture by sitting or walking about or exercising the body

in some way")[55]. Furthermore, Ramazzini suggests moderation to the workers involved above all in hard jobs such as standing workers, weavers, and woodworkers ("I have no precautions to suggest except this: They should be moderate and not overwork…")[56] and suggests physical exercise to sedentary workers ("They should be advised to take physical exercise, at any rate on holidays. Let them make the best use they can of some one day, and so to some extent counteract the harm done by many days of sedentary life")[57].

*Conclusions*

MSD are an increasing health problem in workplaces[58]. These disorders are a major cause of concern for several reasons: the health disorder on individual workers, the economic impact on businesses, the social costs to countries. These problems include: decreased production, workers' sickness, earlier retirement and disability, insurance costs, losing experienced staff, cost of training new staff, effect of discomfort or ill health on the quality of work. Therefore, health authorities are implementing health policies aiming at improving preventive interventions, including workplace conditions, work practices, information of workers, involvement of workers' representatives and management. The contribution of Bernardino Ramazzini in the field is worthy to be remembered because he went beyond the usual doctor's practice of his time and investigated the role of work in determining MSD. It was rather odd for clinicians of that time to devote themselves to the investigation of the relation between health and work. In fact, the majority of the population faced health problems much more basic (such as typhoid, smallpox and plague) than work-related ones and doctors' attention was attracted mainly by the richest people illnesses[59]. The originality of Bernardino Ramazzini is particularly clear in this context: as a XVII century doctor he anticipated the modern instrument of epidemiology for discovering unsual health changes, investigated the working environment, pro-

vided work environment with hygienic measures and workers with information about hazards.

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3. NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH. *Musculoskeletal disorders and workplace factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. Cincinnati, OH, U.S. Department of Health and Human Services, Public Health Service, 1997.
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6. BRANDT-RAUF P. W., BRANDT-RAUF S. I., *History of occupational medicine: relevance of Imhotep and the Edwin Smith papyrus*. Brit. J. Industr. Med. 1987; 44: 68-69.
7. ROM W. R., *The discipline of environmental and occupational medicine*. In: ROM W. R., *Environmental and occupational medicine*. Boston, Little, Brown and Company, 1983, p. 3.
8. CARNEVALE F., MORIANI G. *Storia della salute dei lavoratori*. Verona, Edizioni Libreria Cortina, 1986, p. 7.
9. *Ibid*., p. 10.
10. Ramazzini's culture is shown by his care in searching for appropriate references and in placing them in the context of the treatise. His work joins literary and philosophical aspects and makes use of many quotations, drawing the attention of the reader towards aspects of human activities and work that might be potential cause of damage. They testify that he was an alert scholar,

fully aware of the need to challenge his observations with the ones of the former scholars (DI PIETRO P., *Le fonti bibliografiche nella De Morbis Artificum Diatriba di Bernardino Ramazzini*. History and philosophy of the life sciences 1981; 3: 95-114).

11. RAMAZZINI B., *De morbis artificum diatriba*. Mutinae, Typis Antonii Capponi, 1700. The second edition was published in Padua one year before the author's death (RAMAZZINI B., *De Morbis Artificum Diatriba*. Patavii, Baptistam Conzattum, 1713. After the classical translation in English by Wilmer Cave Wright (RAMAZZINI B., *De Morbis Artificum Diatriba. Diseases of Workers. The Latin text of 1713 revised with translation and notes by Wilmer Cave Wright*. Chicago, The University of Chicago Press, 1940; New York, The Classics of Medicine Library, Division of Gryphon Editions, Special edition, 1983), a new translation of Ramazzini's work has been edited by Carnevale F., Mendini M., Moriani G. with the scientific editing by Blanc P. And Slack R.S. (RAMAZZINI B., *Works*. Verona, Cierre Edizioni, 2009). A detailed monograph dedicated to Ramazzini has been prepared by Di Pietro for the Collegium Ramazzini (DI PIETRO P., *Bernardino Ramazzini. Biography and bibliography*. Eur. J. Oncol 1999; 4: 185-249). For a short essay on the *Diatriba* see: FRANCO G., *Ramazzini's and workers' health*. Lancet 1999; 354: 858-61 and FRANCO G., FRANCO F., *Bernardino Ramazzini's "De Morbis Artificum Diatriba"*. Am. J. Public Health, 2001; 91: 1380-2.
12. Several treatises of occupational and medicine acknowledge the figure of Ramazzini as the "founder of the discipline" (see note n. 7, p. 3) recognizing him the privilege to be the artificer of the "modern development of occupational medicine" (WALDRON H.A., *Lectures notes on occupational medicine*. Oxford, Blackwell Scientific Publications. 1990, p. 1). Ramazzini's main merit lies in his contribution to the knowledge of the work-related diseases and in the emphasis given to the medical history. It was Ramazzini who suggested that, in addition to the questions recommended by Hippocrates, the physicians should ask the patient one more, namely "What are you doing for a living?" (see FRANCO G., *What do you do for a living?* Spine J 2008; 8: 1047).
13. The impact of this work is testified by his ranking at the 38th place amongst the 100 texts (including Hippocrates' thoughts and the computerized tomography scan description) having the greatest impact on the development of medical science as reported by the *One Hundred Books Famous in Medicine*. New York, The Grolier Club. 1994, quoted by FELTON J. S., *The heritage of Bernardino Ramazzini*. Occup. Med. 1997; 47: 167-175.

14. ROSEN G. *A history of public health*. Baltimore, The Johns Hopkins University Press, 1993, p. 71.
15. Ramazzini's fame spread while he was still alive and is presently still expanding. Apart from streets and hospitals bearing his name, various scientific societies, research centers and one scientific journal have been named after him. See DI PIETRO P., *Bernardino Ramazzini. On the CCCL anniversary of his birth*. Bologna, Grafiche Veronesi, 1983, p. 13. There are several scientific communities entitled to his name: amongst them the "Ramazzini Society" (founded in 1946), a scientific society dealing with the advance in knowledge in industrial medicine, the "Collegium Ramazzini" (founded in 1982) including a limited number of scientists involved in environmental and occupational health research and the "Associazione Universitaria Italiana di Medicina del lavoro *Bernardino Ramazzini*", grouping the academics of the discipline throughout the Italian universities (see FRANCO G., *The present state of occupational and environmental medicine in Italy*. Int. Arch. Occup. Environ. Health 1995; 67: 353-358).
16. Pneumologists recognize his observations of occupational lung disorders to be of importance (BISETTI A., *Bernardino Ramazzini and occupational lung medicine*. Ann. N. Y. Acad. Sci 1988; 534: 1029-1037). Dermatologists consider him the father of occupational dermatology (SCHUBERT H., *Bernardino Ramazzini. On the 275th anniversary of the death of the founder of occupational dermatology*. Dermatol. Monatsschr 1989; 175: 757-760). Neurologists account for his observations about headache as a frequent symptom in several working activities (ZANCHIN G., *Headache as an occupational illness in the treatise "De Morbis artificum diatriba" of Bernardino Ramazzini*. Cephalalgia 1996; 16: 79-86). Others consider him the father of environmental health (HOOK G. E., *Ramazzini: father of environmental health?*, Environ. Health Perspect 1995; 103: 982-983 and one of the founders of sports medicine (BUCHANAN W. W., *Bernardino Ramazzini, physician of tradesmen and possibly one of the "fathers" of sports medicine*. Clin. Rheumatol 1991; 10: 136-137).
17. Factory visitation by physician is highly relevant because on the one hand it allows the physician to be aware of the working conditions and, on the other hand, it makes the employer and the employees aware of the contribution of the health professional to health and safety improvement (WELTER E. S., *The role of the primary care physician in occupational medicine: principles, practical observations, and recommendations*. In: ZENZ C. *Occupational Medicine*. Chicago, Year Book Medical Publisher, 1988, p. 65.

18. Ramazzini's attitude towards humile occupations met criticism from local physicians as reported by VOLINI I. F., FLAXMAN N., *Bernardino Ramazzini (1633-1714) the father of industrial medicine*. Medical Life 1938; 45: 5.
19. "I for one have done all that lay in my power, and have not thought it beneath me to step in workshops of the meaner sort now and again and study the obscure operations of the mechanical arts". RAMAZZINI B., *De Morbis Artificum Diatriba*. Translation by Wilmer Cave Wright. Chicago, The University of Chicago Press, 1940; note n. 11, p. 10.
20. CARNEVALE F., MORIANI G., op. cit. note 8, p. 15. See also: CARNEVALE F., *Prefazione*. In: RAMAZZINI B., *Le malattie dei lavoratori*. Roma, Nuova Italia Scientifica, 1982.
21. I took into account Ramazzini's contribution to this topic as far as only his main work is concerned, even though he devoted his attention to this topic in other works dealing with the course of epidemic diseases, their occurrence according to site, humidity, temperature, winds and other elements addressing the interest of readers towards epidemiological aspects of diseases (for a detailed discussion about this point see ZOCCHETTI C., *Bernardino Ramazzini* ante litteram *epidemiologist*. Epidem. Prev, 2000; 24: 276-281). The problem of the relationship between complexity (i. e. the study of complex adaptive system) and epidemiology has been recently debated from an epistemological point of view (PEARCE N.C., MERLETTI F., *Complexity, simplicity, and epidemiology*. Int. J. Epidemiol, 2006; 35: 515–519).
22. See: FRANCO G., *Dall'approccio clinico individuale all'osservazione di ambiente e tecniche di lavoro: il paradigma del pensiero ramazziniano nella* De Morbis Artificum Diatriba. In: TERRIBILE WIEL MARIN T., RIPPA BONATI M., *Simposio su Bernardino Ramazzini e il suo tempo*. Padova, Tipografia La Garangola. 2001, p 17-28 and FRANCO G., *Il pensiero ramazziniano nella* De Morbis Artificum Diatriba. Boll. Soc. Med. Chir. Modena, 2003; 118: 5-12.
23. As reported by FRANCO G., PAITA L., FRANCO F., *Beyond the clinical paradigm: Bernardino Ramazzini's population-based approach for discovering and preventing occupational and environmental diseases*. In: JERDYCHOWSCHY W., VENA J., MAUGERI U., *Challanges to epidemiology in changing Europe*. Proceedings of the Conference, Krakow, July 2-3, 1999, p 185-200, Ramazzini identifies the health changes providing the observed changes with the meaning of what is presently called "sentinel event" and anticipates that kind of observations presently known as "clusters".

24. "I now wish to turn to other workers in whom certain morbid affections gradually arise from other causes, i.e. from some particular posture of the limbs or unnatural movements of the body called for while they work" (Chapter XXX - Diseases of those who work standing). RAMAZZINI B., op. cit. note n. 19, p. 275.
25. FRANCO G., FUSETTI L., *Bernardino Ramazzini's early observations of the link between musculoskeletal disorders and ergonomic factors*. Appl. Ergon, 2004; 34: 67-70.
26. "...the cause I ascribe to certain violent and irregular motions and unnatural posture of the body, by reason of which the natural structure of the vital machine is so impaired that serious diseases gradually develop therefrom" (Chapter I - Diseases to which miners of metal are exposed). RAMAZZINI B., op. cit. note n. 19, p.15.
27. *Ibid*., p. 415.
28. *Ibid*., p. 275.
29. *Ibid*., p. 281.
30. *Ibid*., p. 281.
31. *Ibid*., p. 281.
32. *Ibid*., p. 377.
33. *Ibid*., p. 435.
34. *Ibid*., p. 53.
35. *Ibid*., p. 311.
36. *Ibid*., p. 441.
37. *Ibid*., p. 337.
38. *Ibid*., p. 477.
39. *Ibid*., p. 431.
40. *Ibid*., p. 431.
41. *Ibid*., p. 423.
42. *Ibid*., p. 421.
43. WORLD HEALTH ORGANIZATION. *The burden of musculoskeletal conditions at the start of the new millenium*. Technical Report Series 919. Geneva, WHO, 2003.
44. Other external physical factors involved in spinal disorders include load moment, bending and twisting, heavy physical work and whole-body vibration. See: BOVENZI M., HULSHOF C., *An updated review of epidemiology studies on the relationship between exposure to whole-body vibration and low back pain* (1986–1997). Int. Arch. Occup. Environ. Health 1999; 72: 351–365.

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47. HALES T.R., BERNARD B.P., *Epidemiology of work-related musculoskeletal disorders*. Orthop. Clin. North Am. 1996; 17: 679–709.
48. Adapting work to man and each subject to his/her job is the main principle of "occupational health", defined in 1950 by the first session of Joint ILO/WHO Committee on Occupational Health. The starting point of this approach is laid down in the basic principle of ergonomics, which considers workers as individuals subject to two different influences: the "external physical working environment" and the "internal biomechanical environment". See: MOORE S. J., *Ergonomics*. In: McCUNNEY R., *A practical approach to occupational and environmental medicine*. Boston, Little, Brown and Company, 1994, p. 396. Ergonomics as a discipline aims to help the individual member of the workforce to produce at levels economically acceptable to the employer while, at the same time, enjoying a high standard of physiological and emotional well-being (TICHAUER E. R., *Ergonomics*. In: CLAYTON G. D., FLORENCE E. CLAYTON F. E. *Patty's Industrial hygiene and toxicology*. New York, John Wiley and Sons, Volume I, part B, 1991, p. 746).
49. In the dedication of his treatise, Ramazzini addresses the "Illustrious, Excellent and Learned Moderators" suggesting them to be far-sighted in the introduction of measures pro work and remarked the responsibility of nobles in assuring healthy working conditions (RAMAZZINI B., op. cit. note n. 19, p. 3).
50. This represents an important anticipation of knowledge and skills that even nowadays have not been completely acquired. Unfortunately many physicians do not fully understand such disorders since they defy the traditional paradigm of disease, that is, they do not occur at one particular time, they develop gradually, and they may not respond to traditional treatment (HOFFMAN H., GRAY D. C., *The establishment of an occupational health program*" In: McCUNNEY R., op. cit. note n. 50, p. 53).
51. RAMAZZINI B., op. cit. note n. 19, p. 308.
52. *Ibid*., p. 274.
53. *Ibid*., p. 414.
54. *Ibid*., p. 433.
55. *Ibid*., p. 279.
56. *Ibid*., p. 443.

57. *Ibid*., p. 283.
58. According to the International Labour Organization, each year there are 337 million occupational accidents, 160 million occupational diseases and 2.3 million workers die as a consequence of occupational injuries and diseases. In terms of compensation, lost of productivity, insurance and medical expenses, these fatalities imply annual losses of 4 per cent of the total gross product of all the countries. A number of ergonomic problems within the workplace contribute to the increasing occurrence of MSD (NIU S., *Ergonomics and occupational safety and health: An ILO perspective*. Appl. Ergonomics. 2010. doi:10.1016/j.apergo.2010.03.004). It is worthy to add that occupational health and safety laws cover less the 10 percent of the population in developing countries, omitting many major hazardous industries and occupations (LADOU J., *International occupational health*. Int. J. Hyg. Environ. Health., 2003; 206: 303-313). For recent data in EU countries see: European Commission on Employment, Social Affairs and Equal opportunities, *First-phase consultation of the social partners on musculoskeletal disorders at work*, 2004. Available at: http://ec .europa .eu/employment social/news/2004/nov/musculoskeletaldisorders_en .html.
59. FRANCO G., *Ramazzini's "De Morbis Artificum Diatriba" and society, culture, and the human condition in the seventeenth century*. Intern. J. Occup. Environ. Health, 2000; 6: 80-85.

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