

Considerations on Ergonomic Issues in Physiotherapy Activity

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Abstract. Nowadays, the ergonomic issues become more and more important in all economic activity domains. Work-related Musculoskeletal Disorders (MSDs) represent the main problem generated by the poor ergonomic design of the workplaces. The healthcare domain involves high level ergonomic risks related to physical and mental load of the work which could lead to MSDs. The paper presents an analysis of these ergonomic risks for physiotherapy activity and identifies potential measures to improve the health and safety in this domain. The physical load of the physiotherapist's work is generated by the risk factors such as awkward postures, repetitive movement or working with patients with motor disabilities. The mental load of the physiotherapist's work depends on risk factors such as working with patients with cognitive impairment and daily or weekly patient flows. The proposed preventive measures are organisational and technical. The organisational measures are based on the requirements of the occupational health and safety (OHS) legislation and on the good practice examples. The technical measures are based on the analysing the documentation of physiotherapy modern equipment. The results of the study can be used to improve the ergonomics and the health and safety of any workplace in physiotherapy activity.

1 Introduction

The International Ergonomics Association defines Ergonomics as “*the scientific discipline concerned with the understanding of interactions among humans and other elements of a system*” [1]. The term Ergonomics originally comes from the ancient Greek words *ergon* (work) and *nomos* (a law governing human behaviour) and was introduced in 1857 by the Polish biologist Wojciech Jastrzębowski in his study “*Ergonomics in a sketch, or theory of work based on laws derived from Nature*” [1-3]. The introduction of this term was determined by the emphasis of mechanising and of the human-machine interaction in the context of industrial revolution phenomenon, started in England, at the end of the 18th century [4].

Nowadays, the Ergonomics study domain covers more than the concept of *work* as an activity performed with the scope of earning money and includes all activities whereby a

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rational human operator systematically pursues an objective [5]. Thus, sports, leisure activities, domestic work, social services or controlling a vehicle are included [5].

As the human capacity to adapt at work conditions are not unlimited, one of the objectives of Ergonomics is to define the ranges of adaptability and to analyse the adverse effects which could appear when they are exceeded. This affirmation results from the ILO Encyclopaedia of Occupational Health and Safety which mentions that *“the human being is highly adaptable but not infinitely, so there are ranges of optimum conditions for any activity”*. Also, it mentions that *“one of the tasks of ergonomics is to define what these ranges are and to explore the undesirable effects which occur if the limits are transgressed—for example if a person is expected to work in conditions of excessive heat, noise or vibration, or if the physical or mental workload is too high or too low”* [5].

Ergonomics is a discipline that can be applied to OHS to help ensure that workplace risks are prevented at the design stage, eliminated at a later stage, or controlled and reduced if they cannot be eliminated [3].

Work ergonomics, as a particular domain of Ergonomics, deals with work system composed by operator (human) – work task – means of production (tools, machinery, raw materials, facilities) – work environment, from the perspective of interaction between human and other elements of the system and the adaptation of these elements to physical and psychic characteristics of the operator [4]. In the frame of ergonomics approach, work accidents and occupational diseases are work system dysfunctions, deviations from its normal state of function [4]. The causes of these deviations are represented by the workplace risks and should be searched at the level of each work system element, respectively, worker (human), work tasks, means of production (tools, machinery, raw materials, facilities) and work environment [4, 6]. Also, the identification of hazards associated to workplace risks and the assessment of these risks must be performed for each of the above mentioned work system element, according to the Methodological Norms for Applying the Provisions of OHS Law no.319/2006 [7].

Applied to OHS in Physiotherapy, Ergonomics aim to protect the health of operator (physiotherapist) in the context of interaction with the work system elements including patients, technical equipment used for therapy and the environment in which the activity is performed.

2 Law provisions on Work Ergonomics for Physiotherapy activity

The Work ergonomics objectives are subscribed to the general OHS objectives, respectively ensuring the safety and protect the health of workers during working process. Thus, in the absence of a specific legislation, the Work ergonomics aspects are provided by the general OHS legislation.

The core elements of this legislation are provided by the Constitution of Romania. Thus, in Chapter II – *“Fundamental Rights and Freedoms”*, art.22 (1) provides that *“the right to life as well as the right to physical and psychic integrity of the person are guaranteed”* and art.41 (2) provides that *“employees have the right to measures of work social protection”* regarding their health and safety inclusively [8].

OHS Law no.319/2006 provides in art.6 (1) that *“the employer has a duty to ensure the safety and health of workers in every aspect related to the work”* [9]. For fulfilling this duty, the employer shall observe a series of preventive general principles, including *“adapting the work to the individual, especially as regards the design of work places, the choice of work equipment and of working and production methods, with a view to alleviating monotonous work and work at a predetermined work-rate and to reducing their effect on health”* – art.7 (3). This principle refers the Work ergonomics aspects from the point of view of the physical effort provided by the worker, as well as of its psychic effort.

As regards the physiotherapy activity, the Work ergonomics aspects to be considered in order to alleviate the physical effort are the followings:

- Providing the necessary equipment and furniture so that during the therapy exercises with the patients, the physiotherapist is not forced to sit in strained or vicious positions (for example, leaning forward or sideways, with the weight of the body unevenly distributed on both legs, etc.);
- Providing the necessary equipment for avoid the long term physical effort of the physiotherapist (for example, sustaining a patient with motor disabilities while performing the therapy exercises.

The mitigation of psychic effort should be achieved by:

- Scheduling the therapy activities so as to alternate the difficulty degrees of the manoeuvres and the physical and mental loads of the therapist. The goal is to avoid monotonous movements (the same movement performed several times) or repetitive (several movements performed repeatedly) that can have negative effects on the worker both mentally and physically, by overloading certain groups of muscles;
- Organising the therapy activity so as to ensure the recovery of the therapist's capacity for mental and physical effort.

OHS Law no.319/2006 also requires the employer to identify the hazards and to assess the risks and to elaborate a preventive and protective plan, consisting of technical, sanitary, organisational and other types of measures. Based on these measures, the employer has the duty to elaborate organization's own OHS requirements, considering the particularities of the activities and workplaces under his responsibility.

The identified risks of occupational injury and illness will also include the risks related to work ergonomics, such as: physical and psychic overloading, strained or vicious positions and monotonous or repetitive movements. For preventing these ergonomics risks, preventive measures shall be established and a proper training based on these measures shall be provided to workers.

Government Decision (GD) no.1091/2006 concerning the minimum safety and health requirements for the workplace provides Work ergonomics requirements regarding: temperature in work and rest rooms, natural and artificial lighting, rooms dimensions and air volume [10]. Also, specific ergonomics principles are provided regarding: workplace dimensions, avoiding strained and unnatural positions, workplaces where worked are performed in sitting/orthostatic position, equipment and furniture, setting the height of the work plan, avoiding twisting and bending movements of the body, as well as very wide movements of the arms by properly setting up of the technological flow.

3 Ergonomics risks specific for physiotherapy activity

Any professional activity involves the existence of risks which could generate work accidents or occupational diseases. These risks should be identified and assessed using a risk assessment method in order to establish and implement the required preventive and protective measures.

A risk assessment were performed by the authors for a physiotherapy workplace using the MEVA method developed by National Research and Development Institute of Occupational Safety (INCDPM) Bucharest. The method facilitates the sorting of the identified risks by the four elements of work system, respectively, worker, work tasks, means of production and work environment, using a workplace assessment card and a predefined "*Risk factors identification list*" [6].

For the purpose of the paper, from the identified risks only those related to ergonomics were retained. These risks are grouped on two categories: physical underload/overload and psychic underload/overload. The work ergonomics risks identified for the physiotherapy

activity, as a result of the above described assessment, are shown in the Table 1. Taking into account the similarity of the workplaces, these risks could be considered relevant for all the workplaces with physiotherapy activity. However, the parameters of the risks (severity and probability) could significantly differ from case to case. Also, particular work conditions should be considered for a certain workplace assessed. These risks could determine the occurrence of MSDs, together with extraprofessional factors such as age or life style.

Table 1. Work ergonomics risks in the physiotherapy activity.

1. Physical underload/overload	
a. Static physical effort	
i. Forced or vicious work positions (twisted body, curved column, weight unevenly distributed on the lower limbs etc.)	
ii. Orthostatic or sitting work position for long periods of time	
b. Dynamic physical effort	
i. Stress of certain groups of muscles and joints by monotonous or repetitive movements	
ii. Intense dynamic physical effort for long periods of time	
iii. Manual handling of heavy loads for short periods of time (i.e. sustaining patients with motor disabilities, handling of heavy equipment)	
2. Psychic underload/overload	
a. Related of the interaction with patients	
i. Monotonous or repetitive movements in the case of successive treatment of patients with similar conditions	
ii. Difficult communication with patients with intellectual disabilities	
b. Related of work organising	
i. Uneven distribution of patients during working day or week	
ii. Periods of day or week with a higher concentration of cases with high difficulty of treatment	

3.1 Forced or vicious work positions

These are awkward working positions that cause excessive static stress on some groups of muscles or joints. They differ from neutral (natural) positions by the following characteristics [11]:

- The maximum force produced is less than the maximum force produced in the neutral positions;
- Fatigue occurs faster than in neutral positions;
- Causes more stress in muscles and joints than neutral positions.

Forced or vicious positions determine either contraction or elongation of muscles and tendons. Also, they concern the main anatomical elements, as shown in Table 2 [11, 12].

3.2 Orthostatic or sitting work position for long periods of time

When the worker remains in a static position (standing or sitting) for long periods of time, the prolonged load applied to the muscles leads to fatigue. Prolonged lack of muscle movement also impedes the blood circulation required for the supply of oxygen and nutrients to the muscles and the removal of metabolic waste [11].

Table 2. Forced or vicious positions of main anatomical elements

Main anatomical elements	Forced or vicious positions
Wrist joint	Radial deviation Ulnar deviation Wrist flexion Wrist extension
Elbow joint	Elbow flexion Elbow extension
Shoulder joint	Shoulder flexion Shoulder extension Shoulder abduction Shoulder abduction & extension
Cervical spine	Head bowed over 15° from vertical axis
Thoracic spine	Chest bowed over 20° from vertical axis
Lumbar spine	Back flexion Back extension Twisting about waist Lateral bending
Lower limbs	Kneeling on one or both knees Seated in a squat position Standing with the weight of the body unevenly distributed, without the possibility of alternation Seated on a chair without the possibility of supporting the soles on the floor or on a special support

3.3 Stress of certain groups of muscles and joints by monotonous or repetitive movements

Monotonous movements are simple movements, but which the worker is obliged to perform repeatedly, with a high frequency, without the possibility of alternating with other movements.

Repetitive movements are short series of simple movements, which the worker is forced to perform repeatedly, with a high frequency, without the possibility of alternating with other movements.

Execution by the worker of monotonous or repetitive movements over long periods of time can lead to overload of certain groups of muscles and joints and to the appearance of MSDs, such as: carpal tunnel syndrome, disc herniation, tendonitis or bursitis.

3.4 Intense dynamic physical effort for long periods of time

Therapeutic procedures that require the physiotherapist to exert intense physical effort for long periods of time, without ensuring the rest time necessary to restore the body, can lead to physical fatigue and the appearance of MSDs.

3.5 Manual handling of heavy loads for short periods of time

This risk factor is manifested when it is necessary to support the movement of patients with neuromotor disabilities or to handle heavy work equipment. Also, the manifestation of this risk factor is dependent on individual characteristics (age, gender, physical condition, health).

3.6 Monotonous or repetitive movements in the case of successive treatment of patients with similar conditions

In addition to musculoskeletal disorders, monotonous or repetitive movements can also produce neuro-psychic stress. This is difficult to quantify and depends on extra-professional and individual factors.

3.7 Difficult communication with patients with intellectual disabilities

The difficulty of communicating with patients with intellectual disabilities is determined by the way they respond to the physiotherapist's instructions during treatment. An important role is played by individual factors, including the physiotherapist's ability to establish an effective communication with patients in this category.

3.8 Uneven distribution of patients during working day or week

Generally, this risk is dependent on external factors and it is not under the totally control of employer or physiotherapist.

3.9 Periods of day or week with a higher concentration of cases with high difficulty of treatment

This risk cannot be totally controlled by employer or physiotherapist. However, an important role in mitigation of this risk is played by the professional experience of the physiotherapist.

4 Measures to prevent ergonomic risks specific to physiotherapy activity

In accordance with the OHS Law no. 319/2006, the employer must carry out, with the help of specialized personnel, the assessment of the risks of accidents and occupational diseases in the enterprise/unit. At least one preventive measure must be established for each of the identified risks. These measures are included in the prevention and protection plan which is composed of technical, sanitary, organizational or other measures. Also, the established preventive measures will be the basis for the development of organization's own OHS instructions. These instructions are intended to supplement or detail the provisions of the legislation in force and will be presented to the worker during training in the field of OHS.

For the ergonomic risks specific to the physiotherapy activity identified in the previous chapter, the preventive measures may be of a technical or organizational nature. These measures will be further analysed.

4.1 Forced or vicious work positions

4.1.1 Technical measures

• Equipping the workplace with furniture and appliances with ergonomic design

In addition to fulfilling the ergonomic requirements for use by the patient, the devices in the physiotherapy office must be able to be adjusted, where appropriate, according to the anthropometric characteristics of the therapist and the particularities of the treatment performed, so that the therapist works continuously in the ergonomically correct position.

Thus, in the case of physiotherapy tables and massage tables it is important to be able to adjust the height of the table to avoid incorrect working positions of the therapist, especially the incorrect position of the spine (Fig.1).



Fig. 1. Three section physiotherapy table, adjustable on height with an electrically operated system (source: <https://www.quirumed.com/>)

4.1.2 Organizational measures

• Ergonomic arrangement of the physiotherapy office

The arrangement of furniture and therapy devices in the office must be done in such a way as to ensure the necessary space for:

- Handling of therapy devices, taking into account the range of motion of their various components;
- Positioning of auxiliary equipment (material carts, cabinets) so that it is easily accessible during treatment and does not impede the movement or performing of other treatment activities in the room;
- The movements performed by the therapist during the treatment;
- Circulation in the room and carrying out other treatment activities.

When placing the auxiliary devices and equipment, the working areas will be taken into account, differentiated by the frequency of access during work (Fig.2):

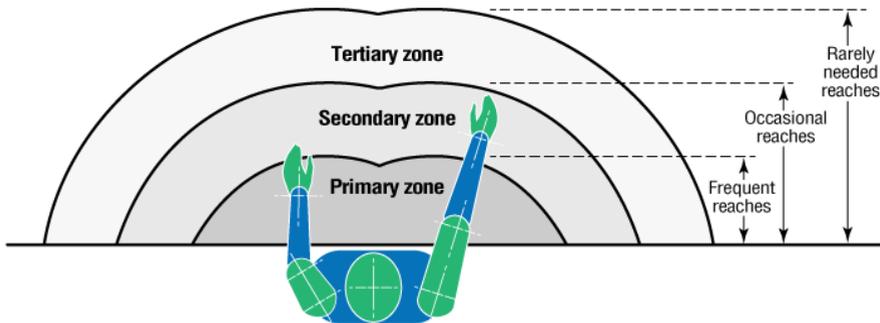


Fig. 2. Ergonomic work zones – horizontal section (source: https://www.ccohs.ca/oshanswers/ergonomics/sitting/sitting_basic.html)

- Primary area, with frequent access;
- Secondary area, with occasional access;
- Tertiary area, with rare access.

The dimensions of these areas depend on the anthropometric characteristics of the worker.

• **Appropriate training of workers**

In this context, appropriate training of workers must include:

- Ergonomically correct working positions;
- Correct adjustment of the equipment so as to ensure a correct working position of the physiotherapist during work;
- Correct positioning of mobile auxiliary equipment (trolleys) in ergonomic work areas, depending on the frequency of access during work.

4.2 Orthostatic or sitting work position for long periods of time

4.2.1 Technical measures

• **Transformation of workplaces with exclusively orthostatic or exclusively seated work position into workplaces with the possibility for the worker to choose between the orthostatic and the seated position**

Where possible, depending on the particularities of the work carried out, the worker should be able to adjust the appliances and the chair so that he can choose between working in a sitting and orthostatic position and can alternate these two positions periodically (Fig.3). It is recommended to alternate sitting and orthostatic positions every 20-30 minutes.

• **Equip the workplace with ergonomic chairs adapted to the activity carried out**

For office work, ergonomic chairs are indicated that allow the support of the spine up to the level of the thoracic spine.

For physiotherapy activities in which the seated position of the therapist is possible, the chairs that support the spine up to the level of the lumbar spine or the “saddle” type chairs are indicated, which allow adequate mobility of the worker and better access to the work area with patient (Fig.4).



Fig. 4. Periodic alternation of work positions (source: <https://medium.com/@centuryoffice/why-invest-in-a-sit-stand-desk-25cbbfd8bc2>)



Fig. 3. Ergonomic chairs that can be used for physiotherapy (sources: <https://www.kavo.com/dental-practice-equipment/physio-evo-evo-f-operator-stools>; <https://www.seersmedical.com/en-us/product/deluxe-ergonomic-saddle-stool>; <https://www.mastermassage.com/products/copy-of-master-massage-ergonomic-swivel-saddle-stool-posture-chair-with-a-durable-pneumatic-hydraulic-lift-sleek-black-color-1>)

4.2.2 Organizational measures

- **Appropriate training of workers**

In this context, appropriate training of workers must include instructions on how to properly adjust and use the devices and chairs to ensure the correct ergonomic position of the physiotherapist while working.

4.3 Stress of certain groups of muscles and joints by monotonous or repetitive movements

4.3.1 Organizational measures

- **Organizing the activity on ergonomic criteria**

When distributing work tasks and scheduling patients, care should be taken to avoid situations in which a worker is forced to perform monotonous or repetitive movements.

- **Appropriate training of workers**

Workers should be trained in musculoskeletal disorders that may be caused by monotonous or repetitive movements and how to avoid them (work breaks, muscle relaxation exercises etc.).

4.4 Intense dynamic physical effort for long periods of time

4.4.1 Organizational measures

- **Organizing the activity on ergonomic criteria**

When distributing work tasks and scheduling patients, the aim should be to alternate therapeutic activities that involve intense physical effort on the part of the therapist with activities that involve low physical stress, as well as ensuring work breaks necessary to restore the body.

- **Appropriate training of workers**

Workers should be trained in musculoskeletal disorders that can be generated by exerting intense physical exertion over long periods of time and ways to avoid them (breaks to restore the body, alternating activities, relaxation exercises etc.).

4.5 Manual handling of heavy loads for short periods of time

4.5.1 Technical measures

- **Providing the necessary technical equipment to avoid manual handling of heavy loads, even for short periods of time**

The need for manual handling of heavy loads arises, for example, in the case of treating patients with neuromotor disabilities (the elderly, victims of accidents etc.) or when handling heavy work equipment in the office.

In order to limit the physical effort of the therapist in the case of working with patients with neuromotor disabilities, auxiliary technical equipment must be provided to support the patient while moving or while performing exercises during treatment.

Depending on the destination, these equipment can be:

- For moving patients (Fig.5);
- For supporting patients during the exercises (Fig.6).

Depending on the power source, these equipment can be:

- Passive (with manual operation);
- Active, mechanic, hydraulic, pneumatic or electric operated or driven by software (with the role of assisting the patient during exercises).

Also, to avoid physical effort, mobile work devices and equipment must be provided with wheels for moving. To avoid accidents, these wheels must have locking systems to prevent moving from the position set for work.



Fig. 5. Devices for moving patients with neuromotor disabilities (sources: <https://www.mantimed.com/services/patient-lifts-ceiling-tracks>; <https://www.rehabmart.com/post/the-5-best-patient-transfer-devices>; <https://healthcarequip.com.au/patient-handling/patient-lifters/evadrive-patient-lifters/>)

4.5.2 Organizational measures

- **Adequate training of workers on the correct use of devices to reduce physical exertion**
This training is necessary to achieve the purpose of use of these devices, but also to prevent accidents of both the therapist and patients caused by improper handling of these devices.
- **Adequate training of workers on the maximum load that can be handled manually by one worker**

In the absence of legislative provisions regarding the maximum limits allowed for the manual handling of the masses, for the elaboration of organization's own instructions for safety and health at work, the values indicated in the specialized literature can be adopted as references.

Thus, the provisions of the General Norms of Labour Protection (edition 2003) can be adopted, which although they have been repealed as a normative act, remain valid from a technical point of view (Table 3).

- **Adequate training of workers on correct manual handling techniques**

For the situation in which the manipulation of the masses cannot be carried out by technical means, the workers must know the correct techniques of manual manipulation, considering

that a wrong manipulation of a mass can lead to MSDs, even if the manipulated mass does not exceed ergonomically permissible maximum limits.
In the case of using incorrect mass handling techniques, the greatest stresses and the most important negative effects are felt in the lumbar spine (Fig.7).



Fig. 6. Devices for supporting or assisting patients (sources: <https://guangzhou-medical.en.made-in-china.com/product/IjaEiGDdgvhx/China-Gait-Training-System-with-Deweight-System-Physiotherapy-Equipment.html>; <https://btetech.com/thumb-primus-the-most-versatile-functional-physiotherapy-equipment/>; <https://www.alterg.com.au/m320>)

Table 3. Maximum permissible limits for manual handling of masses (in kg); source: General Norms of Labour Protection – edition 2003 (repealed)

Handling type	Frequency	Men (age in years)			Women (age in years)		
		16-19	19-45	>45	16-19	19-45	>45
Lift	Rare	35	55	50	13	15	13
	Frequent	25	30	25	9	10	9
	Very frequent	20	25	20	8	9	8
Carry	Rare	30	50	40	13	15	13
	Frequent	20	30	25	9	10	9
	Very frequent	15	20	15	8	10	8
Pull	Rare	15			10		
	Frequent	10			7		
Push	Rare	16			11		
	Frequent	11			7,5		

Note:

- Rare: up to 5% of the duration of the shift;
- Frequent: 6-10% of the duration of the shift;
- Very frequent: over 10% of the duration of the shift

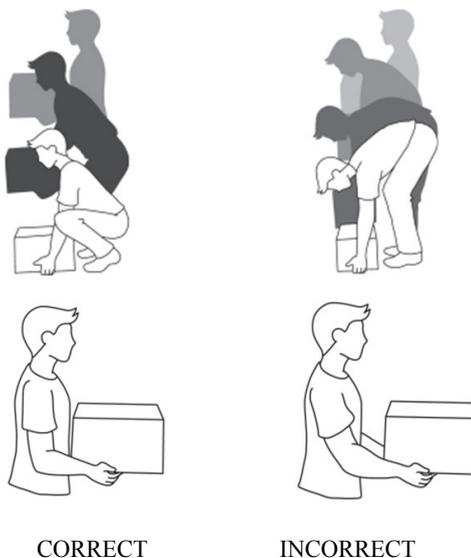


Fig. 7. Lifting technique (source: <https://ptandme.com/safe-lifting-practices-back-injury-prevention/>)

4.6 Monotonous or repetitive movements in the case of successive treatment of patients with similar conditions

4.6.1 Organizational measures

- **Organizing the activity on ergonomic criteria**

When allocating work tasks and scheduling patients, care should be taken to avoid monotonous or repetitive movements and to ensure work breaks to restore the body.

4.7 Difficult communication with patients with intellectual disabilities

4.7.1 Organizational measures

- **Organizing the activity on ergonomic criteria**

When allocating work tasks and scheduling patients, consideration will be given to avoiding neuropsychic overload of workers and ensuring work breaks to restore the body.

- **Adequate training of workers**

Therapists working with patients with intellectual disabilities should receive special training for example, psychology courses on working and communicating with this category of patients.

4.8 Uneven distribution of patients during working day or week

4.8.1 Organizational measures

- **Organizing the activity on ergonomic criteria**

When allocating work tasks and scheduling patients, consideration will be given to avoiding neuropsychic overload of workers and ensuring work breaks to restore the body. It should also be considered to avoid long periods of inactivity of the worker.

4.9 Periods of day or week with a higher concentration of cases with high difficulty of treatment

4.9.1 Organizational measures

- **Organizing the activity on ergonomic criteria**

When allocating work tasks and scheduling patients, consideration will be given to avoiding neuropsychic overload of workers and ensuring work breaks to restore the body. Also, proper arrangements to avoid long periods of inactivity of the worker should be considered.

5 Conclusion

- Ergonomics concerns all professional activities, but also extra-professional activities, such as domestic, sports, recreational etc.
- Work ergonomics is a particular field of ergonomics, which analyses the work system (consisting of the followings elements: executant, work task, means of production and work environment) from the perspective of interaction of human with the other elements of the system and the adaptation of these elements to the physical and mental characteristics of the worker.

- In the physiotherapy activity, the work ergonomics aims to protect the health of the worker (physiotherapist) in the context of interaction with the patient, with the technical equipment used in the applied procedures and with the environment in which the activity takes place.
- Aspects of work ergonomics are regulated in the general framework of OHS legislation.
- The risks of occupational diseases related to the ergonomics of work in the physiotherapy activity are of a physical and neuropsychic nature. These risks are related to the characteristics of the activity (movements and positions adopted during work), the interaction with patients and the organization of work.
- The identification and analysis of these risks is necessary to establish the optimal measures for the prevention of MSDs of physiotherapy workers.
- The measures to prevent the risks related to work ergonomics for the physiotherapy activity identified in this paper are of a technical and organizational nature. These two categories of measures are complementary, they must be applied together to be effective. The technical measures are related to the modernization of the physiotherapy offices and keeping up with the evolution of technology in the field. The difficulty of applying technical measures lies in the relatively high costs of modern equipment. Organizational measures generally concern the arrangement of the workplace and the training of workers. This category of measures is easier to implement and requires lower costs.

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