

**Title: POSTURAL DYSFUNCTIONS: Recommendations for prevention, diagnosis and therapy - Consensus**

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**Abstract:**

**Conflict of interest:** All the members of the working-group have stated the absence of conflict of interest concerning the purpose of this document.

Dr. Roberta Merlotti<sup>3</sup> fulfills the role of secretary for this working-group.

**Key Words:**

**Introduction**

The implementation of appropriate responses and adjustments carried out both before and during every movement helps guaranteeing a correct postural balance.

Anticipatory or compensatory adjustments are appropriate responses to sensory stimuli mainly collected by cutaneous and photo-receptors, and by vestibular and musculo-articular proprioceptors as well.

Hence posture can be conceived as a “multiple-entries” structured system. Somatosensory and vestibular data are transmitted to the cerebellum and to the cerebral cortex by the proprioceptors. In detail, muscular and articular proprioceptors carry information concerning muscle tensions and the biomechanical condition of the body, which are very important for the choice of temporal and vectorial properties of mechanical postural responses.

The vestibular system contains the proprioceptors of the saccule and utricle, which supply data concerning gravity, while the receptors of the Cristae within Ampullae – in the semicircular ducts – show the speed of head rotation. This information is important in order to maintain balance on unstable surfaces and during head movements. The foot sole mechanoreceptors are ones of the most important cutaneous receptors. The 104 different foot sole mechanoreceptors are activated following a vibrating or stretching pressure on the foot sole.

The data which contribute in maintaining balance in upright position – both in static and dynamic state – are spread from the foot sole mechanoreceptors to the central nervous system. The stimulation of the main areas supporting the foot activates adaptive postural adjustments. The resulting responses consist in body incline in the opposite direction of the stimulated area, which “fakes” a disequilibrium condition.

The information conveyed by foot sole mechanoreceptors contribute to the awareness of body posture due to the illusory perception of declivity induced by tactile pulse trains on the foot sole of a blindfolded person. This hypothesis is strengthened by the decrease of the afferent data as consequence of the heat reduction of the foot sole – due to anesthesia or weariness of the foot sole muscles – which is associated with increasing postural oscillations.

The photoreceptors are involved in the stabilization of posture, as proved by the increasing postural instability resulting from the reduction of visual activity. Visual stimuli give information about proximity and distance. The sight reduces postural oscillations when the subject is in upright position, and this grows in clinical relevance both in elderlies and in pathological conditions determining a decrease in visual activity.

Two are the main matters often discussed among the studies on postural control related to visual problems: the role of the central and peripheral visual fields and the role of the optical flow, that is the apparent movement of the elements in a visual area.

The central visual field is correlated to the focal view, while the peripheral visual field is related to the “overall” view. The first one is important for the outline of physical properties while the second one processes the spatial elements of the surrounding area. Postural responses are different depending on the selective provision of visual stimuli in the central or peripheral visual field.

Vectorial responses depend on the orientation of the head or of the look in relation to visual stimuli when stimuli are created in the peripheral visual field. These responses are essential for keeping postural stability, while if the stimuli are directed to the middle of the visual field – suggesting the importance of the peripheral visual field in the visual control of posture – it is possible to notice more important postural oscillations. The visual flow determines postural oscillations and, consequently, stabilizing adjustments. According to recent studies, the visual flow improves postural responses if the central stimulation and the stimulation of the peripheral visual field are both present at the same time.

In conclusion, we can assert that visual data provide in advance cognitive dynamic models concerning potentially destabilizing situations and contribute to the orientation of the subject in the surrounding area. The central nervous system, through cortical, brain stem and spinal circuits, controls posture and its adjustments.

For what concerns cortical circuits, both in primates and in human beings, at the level of cerebral cortex and especially of the temporoparietal junction, an area of fundamental importance for the control of posture has been detected. This area holds multisensory integration processes (somatosensory, vestibular, visual, occlusal and temporomandibular) from which result internal models of position of the various parts of the body and of the vertical axis in relation to which the body is oriented.

These models are fundamental for the organization of the anticipatory responses of the supplementary and pre-supplementary motor areas, which are conveyed to the spinal cord through the direct pyramidal tract. Contextually, the direct and crossed pyramidal tracts convey movements.

Brain stem circuits integrate sensory data deriving from peripheral areas with movements and cerebellar modulation, originating compensatory responses used for maintaining the right posture. These compensatory responses are conveyed to the spinal cord through the extrapyramidal tracts and, in detail, by the reticulospinal, vestibulospinal and tectospinal tracts.

It is important taking into consideration that the control of posture is a complex mechanism which is activated during most of the activities carried out by a human being during his whole life and that that system has a great adaptability.

This adjustment can occur both in a short-term period, that is a period of continuous changings of the conditions of the environment surrounding us, and in a long-term period, that is the morphological variation of the body caused by growth and aging.

These adjustment phenomena seem to be exclusively somatic; however, according to recent studies, important connections between the cerebellum and the limbic system prove that the nature of this phenomena is visceral emotional as well.

Hence, we can assert that posture represents, in the soma, the manifestation of the sensorimotor and the visceral motility of the central nervous system in relation to the phylogenetic and ontogenetic aspect.

## **PURPOSE OF THE DOCUMENT**

This document aims at providing recommendations on the basis of scientific evidence, clinical practice and consensus between experts concerning prevention, diagnosis and treatment of postural dysfunctions in the different ages of life – developmental age, adult age and old age > 65 – and follows the “*National Guidelines on Classification and Measuring of Posture and its Dysfunctions*” provided by the Ministry of Health in December 2017. ([http://www.salute.gov.it/portale/documentazione/p6\\_2\\_2\\_1.jsp?lingua=italiano&id=2717](http://www.salute.gov.it/portale/documentazione/p6_2_2_1.jsp?lingua=italiano&id=2717)).

### **Subjects**

Addressees of this document are, in particular, pediatricians, general practitioners, geriatricians, orthopaedists, physiatrists, sports doctors, rheumatologists, ophthalmologists, otolaryngologists, audiologists, phoniatriests, coroners, occupational doctors, healthcare professionals and, among the professionals not dealing with healthcare: PhDs in sport sciences; parents and educators, in particular for what concerns the

recommendations about the developmental age (youth and adolescence); caregivers, for every age of life.

## Materials and Methods

Ministerial Decree (MD) of February 7th, 2018

### Bibliographic Research

It was considered appropriate to pose clinical questions requiring answers based on evidences pertaining to the most recent literature in order to write up this document. Some key words match with these questions according to MeSH (Medical Subject Headings) criteria.

<p>Which measures can be adopted in order to prevent postural dysfunctions?</p>	<p>amblyopia refractive status orthoptics defects strabismus convergence insufficiency ocular motility low vision erected posture scoliosis postural stability low back pain physiotherapeutic strategies flatfoot plantar foot pain vascular disease vascular remodeling preventive and adapted motor activity obesity and quality of life <b>musculoskeletal asymmetry</b></p>
<p>What can we do in order to make a correct diagnosis of postural dysfunction?</p>	<p>malocclusions postural assessment postural balance (PB) postural clinical evaluation vestibulo-ocular reflexes visual field defect retina diseases optical coherence tomography ophthalmic evaluation cycloplegia <b>orthoptics evaluation</b> foot evaluation</p>
<p>Which are the correct treatment programs for postural dysfunctions?</p>	<p>rehabilitation postural re-education visual rehabilitation correction of strabismus refractive errors surgery refractory errors correction asymmetry orthopaedic treatment scoliosis Global Postural Reeducation (GPR)</p>

It was taken into consideration scientific works published between January 1st 2008 and December 31st 2017, on the basis of the following research limitations: age from 0 to 65 years old; species: human; article typology: *clinical trial, clinical trial form I to IV, controlled clinical trials, randomized controlled trials*; language: English.

The electronic databases which have been used are:

MEDLINE [<http://www.ncbi.nlm.nih.gov/pubmed/>];

EMBASE [<http://www.embase.com/>],

SCOPUS [<http://www.scopus.com/>],

GOOGLE-SCHOLAR [<http://www.scholar.google.it/>]

LILACS [<http://lilacs.bvsalud.org/en/>]

SciELO [<http://www.scielo.org/php/index.php>]

The 7 group coordinators autonomously selected every title/abstract and searched for the “full text”. Every working group has been assigned with pertinent publications which have later been recorded using a specific form. At least two members autonomously evaluated each work.

Table 1 (levels of evidence, Sommerfield et al. 2000) and Table 2 (Strength of recommendations, METHODOLOGICAL MANUAL, “How to produce, divulgate and update recommendations for clinical practice”, May 2002, National Institute of Health (NIH)) helped evaluating scientific validity.

**Table 1. LEVELS OF EVIDENCE**

I	Evidences obtained by the meta-analysis of multiple studies, well-outlined and controlled; randomized trials with few false positive and false negative errors (high power).
II	Evidences obtained by at least one well-outlined experimental study; randomized trials with many false positive and false negative errors (low power).
III	Evidences obtained by well-outlined semi-experimental studies, and non-randomized studies, controlled by a single group, before/after comparison, cohort studies or case-control sequence.
IV	Evidences obtained by well-outlined studies, non-experimental, as comparative and descriptive studies on correlation, and case-studies.
V	Evidences obtained by case report, clinical examples and experts' point of view.

**Table 2. STRENGTH OF RECOMMENDATIONS (DEGREE)**

A	The implementation of a particular process or diagnostic test is highly recommended. It suggests a particular recommendation supported by scientific evidences of good quality, even if not necessarily of type I or II.
B	Show doubts about that peculiar process and about its recommendation, but its implementation shall be carefully taken into consideration.
C	There is a significant uncertainty in favour or against the recommendation about following that process or not.
D	The implementation of the procedure is not recommended.
E	The implementation of the procedure is highly advised against.

In case of lack of evidence, the above-mentioned indications are reported as if based on the consensus of the experts.

**RECOMMENDATIONS: “Which procedures can be implemented in order to prevent postural dysfunctions?”**

The prevention of postural dysfunctions shall be carried out all life long, promoting:

- The adoption of a varied and balanced diet (B);
- The maintenance of an optimal body weight to evaluate in relation to the body mass index (BMI) and considering the waist circumference (B);
- A healthy diet and way of life, and a regular sport activity calibrated on individual characteristics (A);
- A good posture, both in static and dynamic, during everyday life (B);
- The scrupulous monitoring aimed at preventively identifying potential postural dysfunctions and/or diseases that may cause them. This monitoring shall first be carried out by the General Practitioner (GP) and the pediatrician, as well as the specialist (orthopedy and traumatology, physical medicine and rehabilitation, sports medicine, rheumatology, ophthalmology, otorhinolaryngology, audiology, phoniatics, geriatrics, forensic medicine, occupational medicine).

**A greater circulation of postural evaluation could let specialists achieve purposes of prevention, particularly during the developmental age (A).**

The examination for the postural assessment can help identifying a postural dysfunction at its first step and implementing – if necessary – an appropriate treatment along with the most recommended rehabilitation process.

The postural assessment requires a multidisciplinary approach that shall provide for the involvement – depending on age and type of case – of the General Practitioner, the pediatrician and the expert (physiatrist, orthopedist, otorhinolaryngologist, audiologist, ophthalmologist) and the odontologist (Consensus of the Experts).

Screening exams aiming at the preventive identification of postural dysfunctions are highly recommended. There are also some evidences in favour of the efficacy of treatments, especially the conservative ones. The adolescent idiopathic scoliosis is a suitable example: its preventive identification allows to implement an adequate conservative therapy; to stop the evolution of the pathology; to avoid wrong postures (B).

Postural assessment shall be carried out together with a scrupulous global clinical exam in order to exclude some complications of other nature; it permits to verify if the position of the body is in line (in axes) with the ideal position.

Taking into consideration the indications reported in the “*National Guidelines on Classification and Measuring of Posture and its Dysfunctions*”([http://www.salute.gov.it/portale/documentazione/p6\\_2\\_2\\_1.jsp?lingua=italiano&id=2717](http://www.salute.gov.it/portale/documentazione/p6_2_2_1.jsp?lingua=italiano&id=2717)), the global postural assessment shall be carried out through (B):

- A scrupulous collection of anamnestic data;
- The examination of postural attitude, both static and dynamic;
- The way in which the foot-sole lies on the surface, both in static and dynamic;
- The analysis of potential anomalies localizable in one or more body regions, including vascular alterations;
- The analysis of the oculomotor and visual systems;
- The analysis of the functioning of the spine, cingulum (pelvis and shoulders) and main fulcrum of upper and lower limbs (joint mobility, strength tests, global and segmental muscle length).

In addition to cervical lordosis, also dorsal kyphosis, lumbar lordosis, the position of the head, the horizontality of the line of sight, the position of pelvis (anterior or posterior pelvis tilt) and the position of knees shall be examined on a sagittal plane.

On a coronal plane, it is important to examine: the lines of symmetry in relation to ocular alignment and, so, the rotation and/or the inclination of the head in relation to the reference plane; the symmetry of clavicles; the symmetry of waist “triangles”; the alignment of the anterior superior iliac spine (ASIS); the alignment of the lower limbs and potential lower and upper limbs’ heterometry. In case of heterometry, it

mush be distinguished from a functional heterometry by specific clinical and instrumental investigations.

On a rear view of the coronal plane it is important to evaluate the lines of symmetry of the auricles, of the head, of the shoulders, of the shoulder blades and of the axillary creases; the alignment of the posterior superior iliac spine, of the gluteal creases, of the lower limbs and, in particular, of the popliteal fossas and of the malleolus.

For a good completion of a correct and accurate postural evaluation, it could be important and useful to do some tests as ( C): maneuvers for the convergence of feet; ocular vestibular evoked myogenic potentials (o-VEMPs) and cervical vestibular evoked myogenic potential (c-VEMPs); march in place test; Fukuda stepping test; thumb test; Finkelstein test (thumb test); Nahmani test; Romberg's test; head rotation test; Video-Head Impulse test; Functional-Head Impulse test.

It is recommended to verify – potentially using specific tools such as inclinometers or spirit level analyzers – the gap between the coronal plane of the bi-pupillary plane, the coronal plane of the biacromial breadth and the one of the iliac crests ( C).

Concerning the sagittal plane, it is recommended to take as a reference the Frankfurt Plane and the Barrè Vertical Axis – according to the criteria of Stagnara – which allows analyzing the following parameters: distance occiput plumb line; *flèche cervicale*; dorsal plane; *flèche lombaire*; gluteal plane (B).

When necessary, it is recommended to integrate the evaluation of posture with optoelectronic photogrammetric systems in order to quantize, analyze and ease the interpretation of the anthropometric resultants in the three planes of space – both in static and dynamics.

## **DEVELOPMENTAL AGE**

**In the Developmental Age, it is proper to preventively individuate any postural dysfunction because it could determine a set of problems for the psychosomatic development (B).**

The Developmental Age is an existential period which is fundamental for postural adjustments, because an optimal physical development, together with correct postures – both in static and dynamic – are essential conditions for a healthy and efficient body, starting from the musculoskeletal system [3, 10].

The pediatrician is a fundamental reference for the evaluation of posture.

The other above-mentioned medical experts can be a reference as well and shall work together with the pediatrician in order to implement a right and complete diagnostic-therapeutic pathway.

In order to avoid permanent postural dysfunctions, it is proper for every subject to be monitored from his birth until the end of the skeletal growth and of the development process, at least once a year – with particular attention around the age of 6.

In case of one or more dysfunctions (a specific disease – somatic, vestibular, visual), the pediatrician shall suggest the patient the best expert and verify the outcomes of the specific interventions once or twice a year (every 6 or 12 months) [24,28,36]. (Experts Consensus) (Tables 3 and 4).

**Table 3: Conditions to identify and evaluate in the Developmental Age**

Birth - 1 year old	<ul style="list-style-type: none"> <li>- plagiocephaly;</li> <li>- craniosynostosis and asymmetries;</li> <li>- characteristics of ocular motility and anatomical integrity of eyes;</li> <li>- characteristics of the auditory system;</li> <li>- congenital muscular torticollis (twisted neck);</li> <li>- axial asymmetries;</li> <li>- muscle hypotonia of the frontal and posterior planes;</li> <li>- persistence of primitive reflexes;</li> <li>- late manifestation (appearance) of parachute reflexes;</li> <li>- hip dysplasia;</li> <li>- curved knee;</li> <li>- clubfoot, talipes valgus deformity, metatarsus adductus;</li> <li>- characteristics and properties of the acquisition of motor skills.</li> </ul>
1-3 years old	<ul style="list-style-type: none"> <li>- characteristics and properties of motor skills;</li> <li>- characteristics and properties of ambulation (on tiptoes, axis deviation of the lower limbs, potential asymmetries in static and dynamics);</li> <li>- analysis of the anatomical integrity of the eyes, of potential refractive errors, of ocular motility, of convergence, strabismus and nystagmus;</li> <li>- evaluation of mouth breathing and bad habits;</li> <li>- evaluation of the auditory function;</li> <li>- craniofacial vascular malformations.</li> </ul>

3-8 years old	<ul style="list-style-type: none"> <li>- mild spinal asymmetries;</li> <li>- characteristics and properties of ambulation (on tiptoes, axis deviation of the lower limbs, potential asymmetries in static and dynamics);</li> <li>- analysis of the anatomical integrity of the eyes (potential refractive errors, amblyopia, low vision, congenital disorders, retinal diseases and disorders of the optic nerve, functional alterations of extraocular muscles);</li> <li>- convergence insufficiency, strabismus and nystagmus;</li> <li>- speech production;</li> <li>- auditory and vestibular function;</li> <li>- vascular malformations.</li> </ul>
8-14 years old	<ul style="list-style-type: none"> <li>- analysis of the anatomical integrity of the eyes (potential refractive errors, amblyopia, low vision, congenital disorders, retinal diseases and disorders of the optic nerve, functional alterations of extraocular muscles, convergence insufficiency, strabismus and nystagmus);</li> <li>- auditory and vestibular function;</li> <li>- mild spinal asymmetries;</li> <li>- functional and structural disorders of the lower limbs;</li> <li>- limb vascular malformations;</li> <li>- scarring;</li> <li>- potential lymphoedema;</li> <li>- characteristics and properties of ambulation (on tiptoes, axis deviation of the lower limbs, potential asymmetries in static and dynamics);</li> <li>- evaluation of full body muscle rigidity.</li> </ul>

In order to prevent or limit positional plagiocephaly, it is necessary to provide precise indications aimed at limiting potential problems resulting from pre- and perinatal plagiocephaly, particularly babies from 0 to 4 months.

It is important to prevent babies from keeping their head on only one side while they are sleeping, and not to limit the movement of the muscles of the neck while they are awake. Anyway, it is necessary to prefer and guarantee a supine position when the baby is sleeping.

**Table 4: Main preventions to promote in order to avoid postural dysfunctions in Developmental Age**

<p><b>Early diagnosis</b> and treatment of:</p> <ul style="list-style-type: none"><li>- musculoskeletal disorders;</li><li>- disorders of the visual system;</li><li>- alteration of vestibular and/or auditory area.</li></ul>
<p><b>Promotion of:</b></p> <ul style="list-style-type: none"><li>- an appropriate and supervised physical activity;</li><li>- an adequate sport activity;</li><li>- a varied and balanced diet;</li><li>- balanced head movements in order to avoid deformations and/or rigid positions of the head;</li><li>- the physiological development of the psychomotor learning in the developmental age (crawling, prone rolling, straightening). For safety reasons, carriage devices shall be used for a limited lapse of time.</li></ul> <p><b>Avoiding</b> enlarging the hole of the teat and <b>reduce</b> the use of the baby bottle from the 2<sup>nd</sup> year of the baby.</p>
<p><b>Reduction/limiting</b> of asymmetrical loads on the spine (i.e. reducing the weight of the backpack and wearing it in a correct and symmetric way).</p>
<p><b>Promotion</b> of exercises for the normalization of muscle and myofascial tone in case of hypotonia and/or myofascial muscle rigidity.</p>
<p><b>Correction</b> of dysmorphia and/or foot dysfunctions and/or suprasegmental disorders using adequate foot proprioceptive orthoses and implementing rehabilitation processes and pathways according to the prescription of the specialist.</p>

It is fundamental to pay attention to the substitution of the maternal breast, especially from the 2nd year of the baby: the prolonged and inappropriate use of the dummy shall be disincentivized, while an “anatomic” and not “dropped” pacifier shall be preferred in order to obtain a proper tongue placement. In fact, it is necessary to place the tip against the hard palate (behind the upper front teeth): in this way, phonation and speech, deglutition, breathing and head movements are made easier.

It is good practice not to enlarge the hole of the teat with the purpose of feeding the baby quicker. Furthermore, the administration of solid foods shall be incentivized – at the right time – because it favors the proper development of maxillary teeth.

In case of persistent tongue dysfunctions after a period of absence of use of dummy and baby bottle, the expert shall make an evaluation. It is good practice to precociously bring to orthostatism and ambulation because that negatively affects myofascial and musculoskeletal systems (not completely formed yet) and the building of the baby’s “step diagram”.

A prolonged use of playpens and the use of walkers and other aids is advised against because these aids tend to impede the important phase of crawling and induce the baby to non-correct habits such as staying on tiptoes or developing an asymmetric motricity while learning how to stay upright.

It is fundamental not to excessively help the baby learning how to stay upright, favoring the crawling phase. A barefoot ambulation, preferably on non-smooth surfaces, stimulates proprioceptive results and postural balance, promoting a correct “motor and sensory diagram”.

It is important to pay particular attention to potential alterations of the vestibular system because they could provoke important asymmetries in muscle tension between the two sides of the body [21].

Localized deficits modify the natural order of muscle tone between gravity- and anti-gravity muscles as well. A direct consequence is the wrong assessment of the position of the body.

The vestibular system positively affects the skeletal muscles of the body and permits to keep your balance (reducing the loss of balance and the risk of falling) and to control movements: especially during the motor learning, it permits to orient oneself thanks to

its contribution in the inner reconstruction of references of the vertical axis and of the barycentre.

Furthermore, it is necessary to consider the indirect effects of vestibular deficits on cognitive processes in relation to the near peripersonal space. The lack of vestibular data requires the substitution – often hard – with visual proprioceptive or other types of signals in order to keep balance, posture and sight. This decreases attention, limits concentration and can negatively affect mental processes, compromising other activities such as multi-tasking, the elaboration of sequences and the transfer of attention.

In these situations, children may find difficulties in organizing more than one data or information and, in particular, in integrating new information keeping in memory the other and previous elements.

A vestibular dysfunction may cause low scholastic results because it provokes an oculomotor dysfunction followed by an unavoidable repercussion on reading skills and a growing cognitive effort for keeping balance, which causes an emotional disorder.

Vestibular and visual disorders play an important role in determining postural dysfunctions of the head which cause an alteration of the perception of the subjective visual vertical. At the same time, disfunctions of the posture of head may determine a craniocaudal deficit.

An eye-muscle imbalance generally leads to an altered perception of what's surrounding the subject. The postural control system can compensate for this anomaly through rotations and slope of shoulders and pelvis: at a postural level, a visual adjustment affects the underlying structures and the muscle chains, vice versa.

Therefore, in case of an individual with an abnormal position of the head or with other types of posture alteration, it is suggested an eye examination, an orthoptic exam and a vestibular evaluation within the third year of age and not later than the fifth, in order to exclude the presence of visual and vestibular systems' diseases.

An adjustment of the visual system through the alteration of the position of the optical axis may determine a loss of parallelism of the eyes which leads to heterophoria and/or heterotropia.

A cone beam low dose – only if necessary and diriment – can be implemented for a tridimensional diagnosis of facial bones and cervical segment by the 9<sup>th</sup> year of age (Experts Consensus) [6].

An informed parental consent is essential for every X-ray exam. Cone Beam CT units, used on patients in developmental age, shall provide for exposure parameters which shall be reduced in relation to the ones for adult patients ( C).

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## **ADULT AGE**

**During the adult age, it is important to make a postural evaluation in order to identify potential – also asymptomatic – dysfunctions, because preventive interceptions and treatments can prevent from pathological conditions.**

**It is important to disincentivize a sedentary lifestyle, while a moderate and constant physical activity – appropriate for every individual characteristic – shall be promoted also in order to maintain a balanced body weight (B) (See Table 5).**

**Table 5: Main actions of prevention to promote in order to avoid postural dysfunctions in adult age (B)**

**Preventive interception and treatment** for diseases of:

- musculoskeletal system;
- visual system;
- auditory and/or vestibular system.

**Promotion of:**

- appropriate and supervised physical activity;
- sport activities;
- a varied and balanced diet;
- global postural reeducation (GPR) methods.

**Correction of** foot and/or suprasegmental disorders and/or dysmorphia through adequate proprioceptive foot orthoses and rehabilitation pathways prescribed by an expert.

**Correction of body dysmorphic and paramorphic disorders using specific rehabilitation techniques.**

During the everyday activities, and in the workplace as well (use of *personal computer*, weight lifting, ecc.) it is important to maintain the ergonomics and to modify the posture induced from the type of activity in order not to have an excessively fixed posture for a prolonged lapse of time.

Myofascial and muscle stretching exercises are useful in case of full body rigidity. In case of an excessively prolonged orthostasis, it is recommended to wear an adequate footwear [1,2,3,11,12].

Shoes shall be provided with comfortable heels, cushioned footbeds, stable heel seat linings and an anatomical insole.

In critical phases such as pregnancy and menopause, women shall pay more attention to the monitoring of posture in order to avoid an imbalance of the sagittal plane with an increasing lumbar lordosis during pregnancy and an increasing dorsal kyphosis during menopause.

In the adult age, potential vestibular disorders can be accompanied by often extreme vertigo symptoms.

The expert usually focuses on easily controllable symptoms (thanks to the instinctive recovery lead by the central system) while pays less attention to permanent damages of the vestibular system which lead to pathology and shall be carefully evaluated and classified.

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## AGE > OVER 65 YEARS OLD

It is useful to make a postural evaluation in people over 65 years old as well – both healthy and with specific symptomatology not matching with pathologies outlined by specific diagnostic exams – in order to individuate potential dysfunctions ( C ) (See Table 6).

### **Table 6: Main actions of prevention to promote in order to avoid postural dysfunctions > 65 years old (C)**

#### **Preventive interception and treatment for:**

- diseases of the musculoskeletal system;
- diseases of the visual system;
- alterations of the auditory and/or vestibular system;
- alterations of cognitive and psycho-limbic system.

**Promotion of:**

- appropriate and supervised physical activity;
- a varied and balanced diet;
- global postural reeducation (GPR) methods and proprioceptive exercises aimed at improving balance and reducing falls.

**Reduction and limitation** of asymmetrical loads on the spine.

**Correction of** postural dysmorphia and paramorphia using specific rehabilitation techniques, also using – if necessary – specific orthoses prescribed by an expert.

**Correction of** foot and/or suprasegmental disorders and/or dysmorphia through adequate proprioceptive foot orthoses rehabilitation pathways prescribed by an expert.

In this age range, during everyday life, it is necessary to maintain the ergonomics and a good tone of myofascial system and muscle chains [1].

The prevention from falling – supported by a reevaluation and a possible readjustment to the everyday life framework – is particularly important in case of manifestation of signals of an altered posture [9].

This phenomenon is correlated to a fragile balance, very common among individuals of 65 years old and more, which is intensified by a lack in the vestibular functioning [3,5].

In particular, the vestibulo-ocular reflex – which is deficient for physiological reasons – negatively affects visual activity when moving and this causes a bigger cognitive effort which is not used for other tasks such as memory and paying attention.

This condition gets worse if there is a permanent vestibular disorder, favoring falls and direct consequences (traumatisms, fractures, disabilities, loss of safety, anxiety of falling again, reduction of motor activity, depression, social isolation).

The reduction of visual activity and perception of moving in the environment, especially in this age, is strictly correlated to the reduced ability to control balance [4].

Hence, it is important to use an adequate footwear and, potentially, personalized foot orthoses according to the anatomical morphology of feet, to deformities (physiological and typical of this age) and to the dynamics of the step.

Furthermore, postural rehabilitation pathways (with stretching and muscle-strengthening exercises [6] in aquatic and/or terrestrial micro-gravity-based environments [2,7]) and cognitive training exercises are really useful, because they seem to be more effective in postural imbalance prevention. Each activity shall be practiced in “safety conditions”.

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*Which pathways to undertake for a correct diagnosis of postural dysfunction?*

**Postural evaluation (measurement of postural *flèches* and symmetry, evaluation of balancing) represents the reference diagnostic procedure for a diagnosis of postural dysfunction.**

**If necessary, the expert could take advantage of more exams carried out with specific tools ([http://www.salute.gov.it/imgs/C\\_17\\_pubblicazioni\\_2717\\_allegato.pdf](http://www.salute.gov.it/imgs/C_17_pubblicazioni_2717_allegato.pdf)) (A).**

During daily clinical routine, it is good practice not to use complex and expensive investigations, except under opinion or prescription of the expert.

If necessary, it is possible to conduct a radiological investigation in orthostasis (on graph paper in two projections) of the rachis – and this choice shall be adequately justified.

In the developmental age, the patient shall not undergo standard radiograph more than once a year and, in case of need of regular checks, it is necessary to use a non-invasive optoelectronic instrumentation [7,8,13,14,15,16].

Keeping in mind the correlation between posture and vestibular, visual, somatosensory systems – already described – in case of a suspected dysfunction is good practice to suggest the patient to hear the opinion of an expert for potential clinical and instrumental in-depth analysis (B) ([http://www.salute.gov.it/imgs/C\\_17\\_pubblicazioni\\_2717\\_allegato.pdf](http://www.salute.gov.it/imgs/C_17_pubblicazioni_2717_allegato.pdf))

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### ***Which are the clinical pathways to undertake for postural dysfunctions?***

Motor disorders, in children and adolescents, manifest through postural dysfunctions – in most of cases. Hence, experts recommend a global postural reeducation (GPR) aimed at recreating the right synergy between sensory input and somatic output, with a readjustment of posture and an optimized motor coordination [10,13,14,18,22]. (A).

Ophthalmologists recommend the best achievable correction of ametropia, convergence insufficiency, strabismus and other pathologies. The ophthalmologist will choose the best treatment in order to reach this goal. Treatments can be both medical and surgical, or a simple prescription for corrective lenses. Certain disorders may require rehabilitation techniques.

In children and adolescents, foot-sole disorders (i.e. flat feet, hollow foot or pes valgus) and ambulation diseases (i.e. on tiptoes or in hyper pronation) can be related to specific postural disorders of the lower limb, of the rachis and of the pelvis. They can also be the cause, a compensation and/or a consequence [23,25,26].

There is not any evidence in favor of the treatment of the asymptomatic foot, for which is suggested a clinical monitoring. For the treatment of the asymptomatic foot, orthopedics and physiatrists recommend rehabilitative therapies and the use of proprioceptive foot orthoses ( C).

Surgery shall be chosen only for specific cases with persistent pain and ambulation diseases – only when suggested by the orthopedist (B). stretching and muscle strengthening exercises and proprioceptive exercises (both barefoot and with shoes and foot orthoses) are recommended for what affects the rehabilitative therapy. There are not specific evidences on the right moment for undergoing a treatment with orthoses (it is possible to start at the age of 3 – if suggested by the expert) nor on the best efficient model of foot orthoses ( C).

Substantial heterometries of lower limbs (more than 5 millimeters) require periodic checks for the evaluation of postural balance (Experts' Consensus). For the compensation of heterometries, experts suggest the use of foot orthoses with an adequate correction for the dysmetria. This correction can be both clinical and optoelectronic in order to evaluate the “step dynamic”. It is recommended an individualized treatment plan aimed at increasing the symmetry of posture both in static and dynamics. ( C).

In case of structural dysfunctions of the body, i.e. of rachis (Cobb angle larger than 25° or smaller – during puberty – with an ascertained development and the presence of hunchback), experts recommend [22,29,30] (A):

- the individual global rehabilitation aimed at rebalancing muscle tone;
- the stretching of myofascial lines (Experts' Consensus);
- exercises aiming at improving static and dynamic proprioceptive function in aquatic or terrestrial micro-gravity-based environments (Experts' Consensus);
- conservative treatments with orthopedic corsets (A) [22,29].

There are no scientific evidences proving the efficacy of a corset rather than another one (Experts' Consensus). It is recommended to use the corset only in a pathway of global rehabilitation, individualized through: specific muscle and myofascial chains stretching exercises; exercises for the rebalance of muscle tone of the trunk; proprioceptive exercises; exercises for a self-correction posture [22,29] (B).

For it is a global developmental disease, treatments shall always be personalized, prescribed and periodically verified (6-8-12 months) by the experts – orthopedist or physiatrist – and, furthermore, aiming at stabilizing a correct posture [22].

Healthcare professionals involved in the project must have a specific competence in the treatment of postural dysfunctions and scoliosis [22].

In case of non-structural dysfunctions, experts recommend: exercises aiming at rebalancing muscle tone; specific muscle and myofascial chains stretching exercises; exercises for the proprioception of rachis in aquatic or terrestrial micro-gravity-based environments; exercises for a self-correction posture during ordinary activities [29,22,7] (C).

For this purpose, experts recommend therapeutic protocols for the optimization of posture, aimed at re-establishing the space alignment of the body using global postural reeducation techniques involving muscle and myofascial chains [22]. In order to achieve a correct alignment of the body, such as to guarantee the best reactivation of the postural tone system – experts indicate individualized rehabilitation pathways with repetitive trainings. These rehabilitation pathways aim at emphasizing the afferent input and at improving the movements as a complex function. For this purpose, motor exercises in terrestrial micro-gravity-based environments with a three-dimensional body alignment and exercises for the functional re-education of the tongue seem to be very useful.

These exercises introduce a mechanical and proprioceptive modification in the body. The exercise in a micro-gravity-based environment determines the maintenance of the induced postural optimization which becomes automatic in relation to the execution of motor exercises (C). Instructions for ergonomics and for a correct postural hygiene are recommended.

Non-performance-based activities and non-competitive sports are highly recommended.

In literature, there is not a univocal data concerning competitive and non-competitive sports with asymmetrical solicitation; motor activities and sports which require a “global effort” and which respect the morpho-functional characteristics of every individual are very useful and recommended (B).

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In adulthood, postural dysfunctions often originate a pain symptomatology carried by spatial and functional subsystems of the body: scapulohumeral waist (acromioclavicular, sternoclavicular and scapulohumeral joints), pelvic girdle and lower limbs (ankle and foot complex).

These functional and spatial unities are connected by the relay system of the spinal column and interact through fascia osteo-muscular and nervous subsystems.

Therefore, it is necessary to identify – through a clinical examination – the system for the compensation of the postural dysfunction; for implementing rehabilitation pathways in order to reinstate postural homeostasis; and, in particular, for the re-establishment of the body alignment in space and of the flexibility of posterior, anterior and crossed muscle chains. For the adults, the diagnosis of postural dysfunction generates a necessity for a re-programming with postural optimization. ( C ) [1,2,3,4,5,7,8,10,11,12,13,14] (Experts' Consensus).

According to scientific evidences, every patient affected by acute, subacute and chronic unilateral or bilateral vestibulopathy should undergo a vestibular rehabilitation. For what concerns vestibular rehabilitation, experts recommend motor exercises aimed at recovering deficit functions on the basis of neurophysiological mechanisms according to the principles of addiction, adjustment, sensory and behavior substitution for a functional recover of vestibular lesions. Exercises for gaze stabilization (stimulate visual information); exercises for a right posture of tongue, soma and body itself (stimulate proprioception); exercises for the balance (stimulate vestibular information) are recommended for the rehabilitation pathway.

Sensory recalibration is an important aspect of vestibular rehabilitation.

Furthermore, repetitive exercises guided through head movements provoking vertigo are useful for the research of the progressive reduction of vertigo symptomatology, basing on the principle of addiction, according to the “vestibular habituation training” [15,16].

The therapeutic approach shall be multidisciplinary and shall include periodic checks of the objectives of the rehabilitation program.

The above-mentioned information is recommended for disorders of the visual system as well.

The exercises aim at re-creating the correct synergy between sensory input and somatic output, with a readjustment of posture and an optimization of motor coordination in order to better manage the asymmetric adjustments of the ambulation.

Exercises of static and dynamic proprioception increase are recommended.

Experts recommend viscoelastic foot orthoses with the aim at supporting and/or viscoelastic proprioceptive foot orthoses, which can be adaptive or compensative. According to literature, lumbar supports shall only be used in case of acute pain and for short periods [6] ( C).

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In elderlies, a postural disease is often associated with specific pathologies of the neuromusculoskeletal system. Hence, it is highly recommended to monitor and treat the postural disease even when it is an adaptive and non-symptomatic compensation, in line with the concepts of prevention of disability and falls. ( C).

Furthermore, in case of an elderly patient, the evaluation and the counseling in relation to the adoption of some simple precautions in order to ease postural stability and reduce the risk of falling (i.e. wearing a closed footwear instead of an open one) are recommended – also through the adaptation of the domestic environment (i.e.: shower support bars and removal of carpets) ( C).

Exercise programs are efficient in the elderlies only if personalized and specific for problems which shall be evaluated and monitored in time, such as hypostenia, balance

and agility disorders, visual deficits, internal pathologies and pathologies related to pharmacological therapies.

In case of painful dysfunction of a subsystem, it is suggested to control it and to normalize the homeostasis of the patient [1,2,3,4,5]. The multidisciplinary postural equipe can guarantee both the specific approach for the system and its correlative for the various subsystems. The priority for a specialistic direction and for the treatment show up in this mechanism (Experts' Consensus).

It is suggested to implement safe and low-impact aerobic rehabilitation programs of easy execution, with exercises aiming at: strengthening the extensor muscles of the rachis (in order to prevent and correct dorsal hyper-kyphosis) and of the lower limbs; controlling balance both in static and dynamics; increasing the elasticity of muscle kinetic chains and of myofascial system. For this purpose, motor exercises with three-dimensional alignment of the body – to do in a terrestrial micro-gravity-based environment – result to be very useful (Experts' Consensus).

Once the rehabilitation program has finished, individuals with stable clinical conditions can benefit from adapted physical activities (APA), preferably supervised by a graduated in Motor Sciences with an important experience and competences in the field of Posturology.

The APA does not belong to health services and aims at regenerating after rehabilitation, contrasting hypomobility and promoting more correct lifestyles (Consensus of the Experts).

Viscoelastic foot orthoses with adaptive or compensative proprioceptive and/or supporting purposes are highly recommended in elderlies as well ( C ) [4].

Lombostat corsets – anti-gravitary or for lumbar support – can be used in case of pain with obvious postural hastenia ( C ) [1]. What previously expressed concerning the diseases of the visual system is valid for elderlies as well.

Anyway, it is important to take into consideration the limited efficacy of some therapeutic options, given the scarce recovery capacity due to the minor “plasticity” and to the potential presence of comorbidity in the visual system (Consensus of the Experts).

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## ***Which professional competences and experiences are useful for preventing, diagnosing and treating postural dysfunctions?***

The diagnosis of postural dysfunction is a medical act (B).

The prevention of postural dysfunctions includes the experts of the various age ranges who implement an interdisciplinary approach (Experts' Consensus).

When the postural dysfunction needs the intervention of a specialist, the implementation of a treatment project according to the functional prognosis with short-, medium- and long.-term objectives, and with programs for specific competences may be necessary (Experts' Consensus). The specialist in physical medicine and rehabilitation (PM&R) can arrange an "ad personam" therapeutic and rehabilitative program for postural dysfunctions.

The team is made up of health-professionals who will act according to current regulations for their professional profile (B)[1,2,3].

Among the non-healthcare professions, the graduated in Motor Sciences can contribute through the adapted physical activity (APA) (Consensus of the Experts).

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