ISSN 0103-5150
Fisioter. Mov., Curitiba, v. 27, n. 2, p. 251-259, abr./jun. 2014

DOI: http://dx.doi.org.10.1590/0103-5150.027.002.AO10

Elaboration and assessment of clinical protocols to support the evaluation of stand-to-sit activity

Elaboração e Avaliação dos Protocolos para auxílio na avaliação da atividade de sentar

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Abstract

Introduction: Evaluation of sit-to-stand and stand-to-sit activities is used by physical therapists in patients with neurological and musculoskeletal disorders. Sit-to-stand activity presents different descriptions of phases and movements; however the phases of stand-to-sit activity have not been established yet. **Objectives**: To describe the movements during stand-to-sit activity and create an evaluation protocol. **Materials and methods**: Stand-to-sit activity was described on anterior and lateral views based on the observation of 27 healthy subjects. The body segments chosen to analyze were feet, ankles, knees, hips, pelvis, trunk, spine, upper limbs, head and cervical spine. The movements of body segments were described as adduction and abduction, eversion and inversion, valgus and varus, neutral position and asymmetry. The protocol was assessed with questionnaires answered by 12 physiotherapists experts in the area. **Results**: Stand-to-sit activity was divided in 4 phases: 1- "Neutral position", 2- "Pre-squat", 3- "Squat" and 4- "Stabilization". Two models of protocols were developed considering 5 body segments to the anterior view and 7 segments for the lateral view. **Conclusion**: Stand-to-sit activity was described in 4 phases with sequential movements

of each body segment. These protocols allow physiotherapists to identify unusual movements of body segments during the stand-to-sit activity.

Keywords: Physiotherapy. Biomechanics. Musculoskeletal abnormalities. Activities of daily living. Disability evaluation.

Resumo

Introdução*: Levantar e sentar são movimentos comuns da vida diária, e sua avaliação é utilizada frequentemente por fisioterapeutas em pacientes com disfunções neurológicas e musculoesqueléticas. A atividade de levantar apresenta diferentes descrições quanto às fases e movimentos, enquanto a atividade de sentar ainda não apresenta suas fases estabelecidas.* ***Objetivos****: Descrever os movimentos durante a atividade de sentar e elaborar protocolos de auxílio à avaliação.* ***Materiais e métodos****: Esta atividade foi descrita nas vistas anterior e lateral com base nos achados de um levantamento bibliográfico e na observação das filmagens de 27 indivíduos funcionalmente independentes. Os segmentos corporais analisados foram pés, tornozelos, joelhos, quadris, pelve, tronco, coluna lombar, membros superiores, coluna cervical e cabeça. Seus movimentos e condições foram descritos: adução e abdução, eversão e inversão, valgismo e varismo, posição neutra e assimetria. Os protocolos foram avaliados por meio de questionários de avaliação, respondidos por 12 fisioterapeutas especialistas na área.* ***Resultados****: A atividade de sentar foi descrita de acordo com o estabelecimento de 4 fases. 1- "Posição inicial", 2- "Pré-agachamento", 3- "Agachamento" e 4- "Estabilização". Foram elaborados 2 modelos de protocolos, sendo considerados 5 segmentos corporais para a vista anterior e 7 segmentos para a vista lateral.* ***Conclusão****: A atividade de sentar foi descrita em 4 fases, e em cada uma ocorrem movimentos sequenciais de cada segmento corporal. Estes protocolos permitem identificar as alterações de segmentos corporais durante a atividade de sentar por meio da comparação dos movimentos descritos. A classificação do grau de inadequação corresponde ao número de segmentos corporais com movimentos alterados.*

Palavras-chave*: Fisioterapia. Biomecânica. Anormalidades musculoesqueléticas. Atividades cotidianas. Avaliação da deficiência.*

Introduction

Sit-to-stand and stand-to-sit are activities required for functional independence (1, 2, 3). Physiotherapists usually perform the evaluation of these movements in patients with neurological and musculoskeletal disorders (4). Movements of daily activities are difficult to describe because of different possibilities that each individual performs the same movement (5). Activities such as gait have full description of movements, and despite the conceptual differences described in the literature, the evaluation and phases of gait are already established (5). Sit-to-stand activity shows different descriptions of phases and movements and is considered to be a preceding phase of gait (6, 7).

Previous studies have been focus on analyzing the factors that influence the performance of stand-to-sit movement (8, 9, 10), such as height and type of chair, the presence of back, feet position, positioning of upper limbs (5, 6) and balance condition (5). The different purposes and methodologies of the studies make them difficult to become useful for clinical practice (kinematic analysis, electromyography to analyze the muscular activation pattern (11, 12); movement analysis through observation of videos (13); force platform for measuring the center of mass during the phases of activities) (14).

Stand-to-sit activity is considered to be a complex activity (5) and its isolated observation is difficult due the mode of execution on transfer from upright posture to sitting position (11). Kralj et al. (15) reported that stand-to-sit activity is divided in 4 phases: initial phase (anterior tilt of trunk), descending (vertical displacement), seat loading (weight transfer to the seat) and stabilization (trunk and balance adjustment). Perracini et al. (16) consider this activity to be performed in a sequential order of anterior tilt of the pelvis (phase I),

vertical displacement of the body (phase II), angular displacement of knee (phase III) and stabilization of posture (phase IV). The analyze of functional activities requires knowledge of patterns of movement to identify kinesiological problems (1, 6).

The lack of a gold standard method to identify the positions of body segments during the execution of stand-to-sit activity (1) makes it difficult to evaluate them in clinical practice. The appropriate description of this activity allows physiotherapists to identify different movements of body segments according to each phase of stand-to-sit activity. However there is no consensus among the authors about the phases of stand-to-sit activities, and this highlights the importance of describing the stand-to-sit activity (17).

Based on this context, the objective of this study was to describe the movements of stand-to-sit activity and to create observational protocols.

Materials and methods

The study included 27 subjects (age = 31.37 ± 12.52 years), 17 women (age 29.64 ± 10.61 years, height of 1.62 ± 0.08 cm, weight of 64.59 ± 12.88 kg, and body mass index (BMI) of 24.55 ± 4.82 kg/m^2) and 10 men (age 34.3 ± 15.41 years, height of 1.70 ± 0.08 cm, weight of 70.2 ± 11.56 kg and BMI of 24.22 ± 2.77 kg/m^2). These participants attended the Physiotherapy Service of Central Institute of HC-FMUSP, and they were teachers, physiotherapists, graduate students, employees or participants in the quality of life group in the elderly.

Participants were included if they had proper height to maintain the hips and knees at 90° and 80° of flexion, respectively, while sitting on a bank of 48 cm of height (18). The exclusion criteria were: presence of musculoskeletal pathologies; current pain; functional dependence to execute sit-to-stand and stand-to-sit activities; dizziness or vertigo in the last 6 months. All participants signed a consent form to participate in the study. The study was approved by the Ethics Committee for Analysis of Research Projects of the Institution (0610/11).

Procedures

We conducted a literature review of stand-to-sit activity through databases Scopus and Science Citation Index Expanded of the Institute for Scientific Information - Isi Web of Knowledge. The keywords used were "Daily Living Activities"; "Functional assessment"; "Abnormal Movements"; "Biomechanics"; "Analysis"; "Joints" in the period between 1986 and 2011. Participants were recruited in attendance of Unit of Physical Therapy, Speech Therapy and Occupational Therapy - High Complexity in Central Institute of HC-FMUSP with prior appointment by telephone or personally.

Participants stood barefoot and wore gym clothes during the acquisition of the videos. An acrylic goniometer (Carci®, São Paulo) was used to proper position the hips and knees. Subjects were asked to perform the stand-to-sit activity from the upright posture. The initial position was upright with feet parallel and spaced at 10 cm apart, and the final posture was sitting. A backless carbon chair (ISP Electromedical, 00045A31, Sao Paulo) with no support for the upper limbs and with a height of 48 centimeters was positioned behind the participant.

The upper limbs position was due the study which was identified 13% reduction of the load on the vertebrae when there is support from upper limbs on thighs compared to the positioning of the upper limb parallel along the body (8).

There were two videos taken simultaneously: on the anterior view and on the left lateral view. The left side view was chosen to standardize the acquisition of videos during the evaluation. The videos were registered through two digital cameras (Sony® DSC-W350, 14.1 mega pixel) arranged on two tripods (Weifeng®, Wt3750). Each camera was positioned at the same distance (395 cm for the anterior tripod and 197.5 for the lateral tripod) and height (82 cm for the anterior tripod and 76 cm lateral) for all subjects. The video recorded for 5 seconds with the participants on the standing position, and they were instructed to perform the activity after a sound signal. The recording was completed after 5 seconds of the end of the activity. The videos were analyzed by physiotherapists of this study. The body segments chosen to analyze were feet, ankles, knees, hips, pelvis, trunk, lumbar spine, upper limbs, cervical spine and head.

Two protocols of stand-to-sit activity (anterior view and lateral view) were developed based on information obtained from activity in the anterior and lateral views.

The protocols are based on the sequence body segments movements in each phase. To calculate the

individual condition it was elaborated a classification of inadequacy about movements. The professional may give 1 point for each movement out of what is expected. In the end of its evaluation it has to sum what was punctuated on each body segment. The sum of situations are made based on the inadequacy level of the movement for each phase, whereas the result is higher when the movement is more out of what is expected. After this stage, we were able to identify the condition of each segment according to the legend of the points. The degree of inadequacy is the number of phases in which the segment showed a different position from what is described in the protocol based on literature.

Assessment of protocols

The assessment of the protocols was performed through questionnaire answered by 12 physiotherapists. The questionnaire was compound by items that includes characteristics of movements of the joints. The questionnaire consisted of 7 items for each protocol such as "clear instructions to use the protocol", "questions formulation," "order of body segments evaluation," "number of body segments used for each evaluation"; "definition and sequence of phases"; "interpretation of the segmental evaluation"; "general conclusion of the results". These responses were presented according to the following classification: "Very good," "Good," "Regular", "Bad."

Data analysis

The stand-to-sit activity was described from the observation of the videos and they were matched to the literature review. The answers about the assessment of the protocols were calculated through simple equations in Microsoft Office Excel 2007 program.

Results

Two protocols were developed to evaluate the movement of stand-to-sit activity. The description of the body segments were made according to 4 phases: "Initial Position", "Pre-squat", "Squat" and "Stabilization". One protocol was developed in the anterior view (AV) and the other in the lateral view (LV). The body segments chosen to analyze in the AV were "feet", "ankles", "knees", "uppe limbs" and "trunk" (Table 1); and the LV were "ankle", "knee", "hip", "trunk", "upper limb", "cervical spine" and "head" (Table 2). Each protocol was based on the adequacy of movements of each phase of stand-to-sit activity according to the information obtained in the videos and in the literature review. The classification of conditions for each body segment with their respective values is disposed in Table 3.

Assessment of protocols

The number of each answers made by the physiotherapists was represented in graph form for both protocols. The number of answers regarding the items about the system for the evaluation of stand-to-sit activity on the AV is presented in Figure 1.

The answers of evaluators for the system to evaluate the stand-to-sit activity in LV are represented in Figure 2.

In protocol on LV, the results for “clarity of instructions” were 67% “Good” and 33% “Very good”. For the “number of body segments considered” the majority of evaluators (58%) considered “Good” 34% “Very good” and 8% considered “Regular”. The “definition and sequence of phases” was considered “Good” for 50% of the evaluators “Very good” for 33% and “Regular” for 17% of them. On the “interpretation of the segmental evaluation”, 75% answered “Regular” for 92% of the evaluators, and 8% considered it “Good”. The “general conclusion of the results” was an item considered “Regular” by the majority (67%) of physiotherapists, 17% of them responded “Bad” and 16% considered “Good”.

In the evaluation of protocol on AV, to the “clarity of instructions”, 58% of the evaluators answered “Good” and 52% answered “Very good”. On the “number of body segments considered”, 67% of the evaluators answered “Good”, 25% answered “Very good” and 8% answered “Regular”. For the “definition and sequence of phases”, the evaluators answered predominantly “Good” (58%), followed by “Very good” (25%) and 17% considered “Regular”. For the “interpretation of the segmental evaluation”, the majority of evaluators answered “Regular” (83%) and 17% considered “Good”. For the “general conclusion of the results”, 58% of evaluators considered “Regular”, 25% considered “Good” and 17% answered “Bad”.

In both protocols, the "order of evaluation of body segments", 50% considered "Very good", 42% "Good" and 8% "Regular".

Regarding to "formulation of the questions", 58% answered "Good", 34% answered "Very good" and 8% answered "Regular" for both protocols.

Table 1 - Description of stand-to-sit activity on anterior view

Body segment	Phase 1 – Initial position	Phase 2 – Pre-squat	Phase 3 – Squat	Phase 4 - Stabilization
Right foot	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position *Adduction* Abduction
Left foot	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction
Right ankle	Neutral position Eversion Inversion	Neutral position Eversion Inversion	Neutral position Eversion Inversion	Neutral position Eversion Inversion
Left ankle	Neutral position Eversion Inversion	Neutral position Eversion Inversion	Neutral position Eversion Inversion	Neutral position Eversion Inversion
Right knee	Neutral position Valgus Varus	Neutral position Valgus Varus	Neutral position Valgus Varus	Neutral position Valgus Varus
Left knee	Neutral position Valgus Varus	Neutral position Valgus Varus	Neutral position Valgus Varus	Neutral position Valgus Varus
Right upper limb	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction
Left upper limb	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction	Neutral position Adduction Abduction
Trunk	Symmetry Asymmetry	Symmetry Asymmetry	Symmetry Asymmetry	Symmetry Asymmetry

Source: Research data.

Table 2 - Description of stand-to-sit activity on lateral view

Body segment	Phase 1 – Initial position	Phase 2 – Pre-squat	Phase 3 – Squat	Phase 4 - Stabilization
Ankle	Neutral position	Dorsiflexion	Maximum dorsiflexion of the activity	Dorsiflexion
Knee	Maximum extension	Flexion 20° (19)	Flexion 75° (20)	Flexion 85° (20)
Hips	Neutral position	Flexion 10° (20)	Flexion 70° (20)	Flexion 90° (2)
Trunk	Neutral position	Flexion 45° (19)	Extension	Neutral position
Upper limbs	Neutral position	Neutral position	Anteriorization	Neutral position
Cervical spine	Neutral position	Extension	Flexion	Neutral position
Head	Neutral position	Posteriorization	Neutral Position	Neutral position

Source: Research data.

Table 3 - Conclusion of the results about the segments during the activity

General Conclusion of Body Segments in the Activity
Adequate Condition (0 points):
Inadequate Condition Level I (1 point):
Inadequate Condition Level II (2 points):
Inadequate Condition Level III (3 points):
Inadequate Condition Level IV (4 points):

Source: Research data.

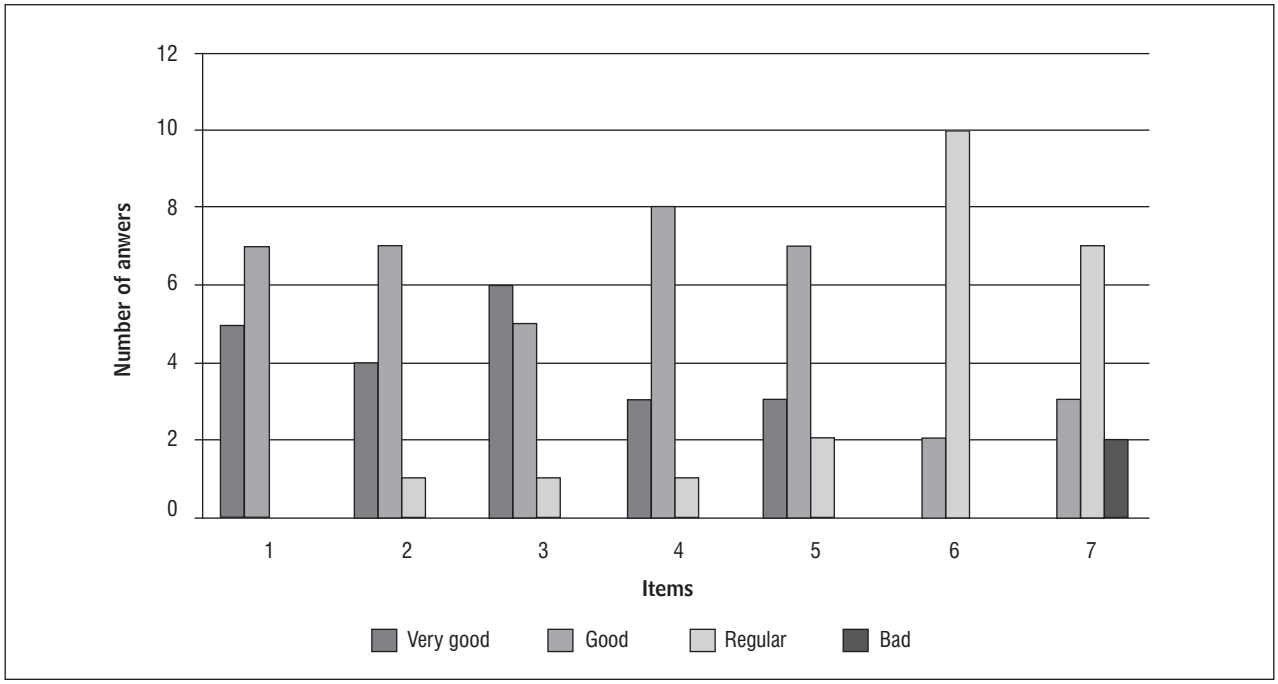

Figure 1 - Number of answers about the items in evaluation questionnaire for the assessment of protocol to support the evaluation of stand-to-sit activity in AV

Note: 1) clear instructions to use the protocol; 2) questions formulation; 3) order of body segments evaluation; 4) number of body segments used for each evaluation; 5) definition and sequence of phases; 6) interpretation of the segmental evaluation; 7) general conclusion of the results.

Source: Research data.

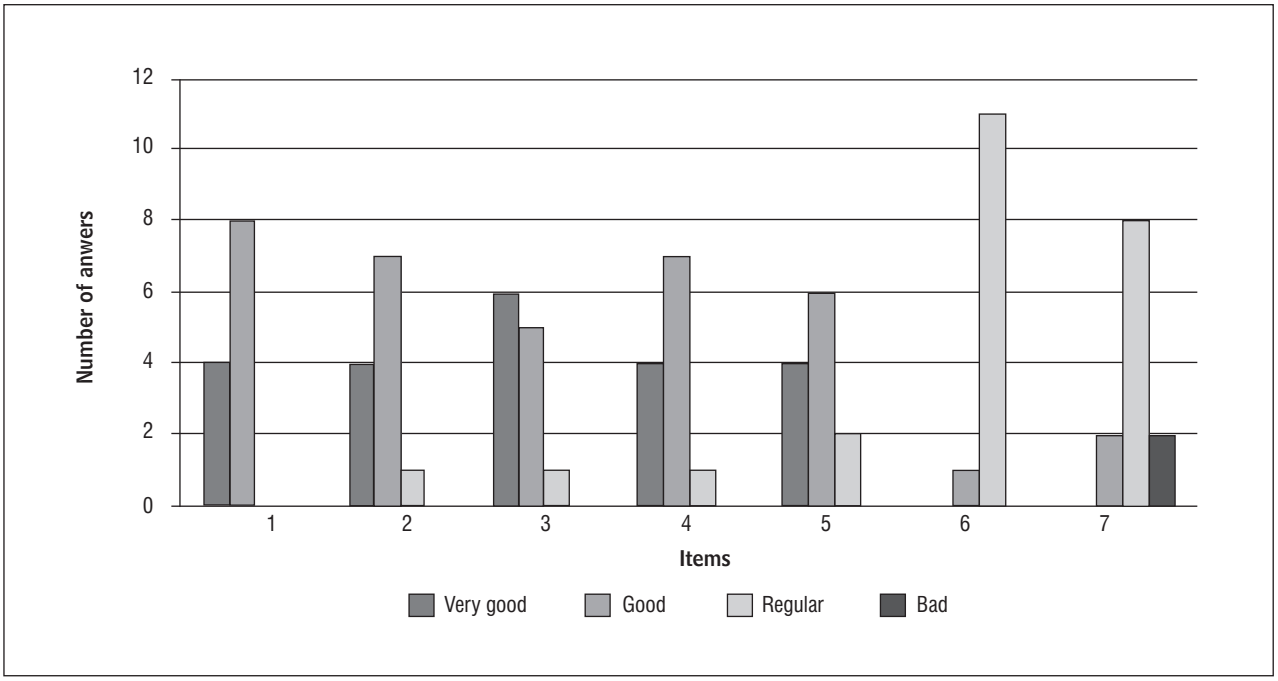

Figure 2 - Number of answers about the items on the questionnaire for the assessment of protocol to support the observation of stand-to-sit activity in LV

Note: 1) clear instructions to use the protocol; 2) questions formulation; 3) order of body segments evaluation; 4) number of body segments used for each evaluation; 5) definition and sequence of phases; 6) interpretation of the segmental evaluation; 7) general conclusion of the results.

Source: Research data.

Discussion

The purpose of this study was to elaborate a protocol and provide proper evaluation of stand-to-sit activity. It is necessary to establish the movement that is considered "normal" to identify possible abnormalities in clinical applications (21). The protocols in this study were developed in order to allow the physiotherapists to have a standard reference of evaluation.

Two protocols were elaborated in this study. On AV a neutral position was identified in each body segment, which represents the adequate position during the execution of the activity. On LV different descriptions were used to represent the correct position and the differences were considered inadequate.

The stand-to-sit activity was divided into 4 phases: "Initial Position", "Pre-squat", "Squat" and "Stabilization". This segmental visualization of activity facilitates the identification of inadequacy and show in which exactly phase the inadequacy occurs. On the first phase it´s expected an anterior tilt of trunk; then occurs a vertical displacement of body which represents the second phase; on the third phase the weight is transferred to the chair and on fourth phase the trunk balance is adjusted and the body is stabilized.

Rising from a chair is an important prerequisite to the physiological and functional activity gait, being an important indicator of functional independence. The stand-to-sit activity is also performed several times per day and the movement perform of weight transference from stand to sit might display musculoskeletal abnormalities.

Ashford and De Souza (18) conducted a study to compare the pattern of muscle activation between stand-to-sit and sit-to-stand activities through electromyography activity. Muscles of lower limbs (gluteus maximus, hamstrings, gastrocnemius and anterior tibialis anterior) and inferior trunk (rectus abdominals and lumbar erector spinae), showed similar patterns in time of activation in both activities. However, the harmstrings muscles showed concentric contraction in sit-to-stand activity and excentric contraction during stand-to-sit activity. It must be investigated the influence of this similar pattern of muscle activation on movement pattern during this activity. It could explain the differences of complexity between the activities.

There are different factors that influence the execution of stand-to-sit activity due its complexity related to the demands of adapting the motor system in the transfer of postures (6). Aging must implies on the activity performance, which seems to be directly related to physiological changes in the central nervous system (10, 20). Dubost et al. (20) compared the movements of the body segments of stand-to-sit activity between young adults (mean age = 26.8 years) and elderly (mean age = 75.9). The study showed that elderly people display lower center of mass displacement (~10°). The authors suggest that elderly people have different strategy of decreasing anterior displacement of mass, and this strategy might be an early indicator of loss of proper postural control caused by age advance.

Reisman et al. (10) compared stand-to-sit and sit-to-stand activities, and found that stand-to-sit activity showed displacement of the center of mass further away from the base of support at the beginning and end of activity to provide greater body stability.

In addition, specific features of movements during the stand-to-sit activity may vary in different populations. Obese individuals have this activity compromised by overweight, which makes their performance worse (22). Individuals with low back pain present compensatory movements through the activation of other muscles, resulting in altered distribution of load and inadequate movements during stand-to-sit activity (23). In contrast, the sit-to-stand activity is enough described in the literature and is considered an indicator for the risk of falls in the elderly.

The protocols developed in this study can be used for the population to identify possible patterns of inadequate movements of certain body segments in different groups with specific characteristics.

Conclusion

The stand-to-sit activity was defined through the establishment of 4 phases with specific movements of body segments ("feet", "ankles", "knees", "hips", "upper limbs", "trunk", "cervical spine" and "head") in a sequentially order. The use of this protocol allows and aids the physiotherapist to identify the body segments which have problems during a certain phase of stand-to-sit activity.

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Received: 08/01/2013
Recebido: 01/08/2013

Approved: 03/17/2014
Aprovado: 17/03/2014