Age Differences in Movement Patterns Used to Rise from a Bed in Subjects in the Third Through Fifth Decades of Age
Cheryl D Ford-Smith and Ann F VanSant
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Age Differences in Movement Patterns Used to Rise from a Bed in Subjects in the Third Through Fifth Decades of Age

Background and Purpose. The purposes of this study were to describe the movement patterns of middle-aged adults when rising from a bed and to determine whether there are age-related differences in movement patterns across the third through fifth decades of age. Subjects. Ninety-three adults (30 men, 63 women), ranging in age from 30 to 59 years, participated in the study. 

Methods. The subjects were videotaped during 10 trials of rising from a bed. Subjects comprised three age groups, as defined by the decades of the thirties, forties, and fifties. Movement patterns for four body regions were used to classify the videotaped performances. The incidence of each movement pattern was determined for each decade and graphed. Results. Subjects in their thirties differed from older subjects in movement patterns used to rise from a bed. Movement pattern incidence varied across age groups for each body region. The movement patterns of one body region predominated in reverse order of a previously proposed developmental sequence. Conclusion and Discussion. Results indicate physical therapists should consider the patient’s age when selecting movement patterns to teach. [Ford-Smith CD, VanSant AF. Age differences in movement patterns used to rise from a bed in subjects in the third through fifth decades of age. Phys Ther. 1993;73:300-309.]

Key Words: Aging, Functional training and activities, Middle age, Movement.
The purposes of this cross-sectional descriptive study were (1) to use Sarnacki's categories\(^5\) to describe the movement patterns of middle-aged adults when rising from a bed and (2) to determine whether there were age differences in these movement patterns across three decades of adulthood.

### Method

#### Subjects

Ninety-three individuals (30 men, 63 women), ranging in age from 30 to 59 years, participated in this study. The sample was one of convenience. A minimum of 30 subjects were recruited for each of three age groups defined by the decades of the thirties, forties, and fifties. Table 1 presents the subject characteristics for each age group.

<table>
<thead>
<tr>
<th>Age Group (y)</th>
<th>Age (y)</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>30–39</td>
<td>34.4</td>
<td>3.0</td>
</tr>
<tr>
<td>40–49</td>
<td>44.5</td>
<td>3.0</td>
</tr>
<tr>
<td>50–59</td>
<td>54.4</td>
<td>3.1</td>
</tr>
</tbody>
</table>

In older adults, movement patterns have been said to resemble movement patterns seen in early childhood.\(^6,7\) This change in adult movement patterns with increasing age is sometimes referred to as *developmental regression*.\(^6\)

A recent cross-sectional study by VanSant et al.\(^8\) of the movement patterns used by three age groups of adults to come to a standing position from a supine position on the floor has provided some support for the theory of developmental regression during the adult years. The investigators reported a trend for movement patterns to predominate, with respect to age, in reverse order from that described by VanSant\(^9\) across early childhood. VanSant and colleagues\(^8\) hypothesized that individuals in middle adulthood could be regressing to use movement patterns that were common in childhood.

The purposes of this cross-sectional descriptive study were (1) to use Sarnacki's categories\(^5\) to describe the movement patterns of middle-aged adults when rising from a bed and (2) to determine whether there were age differences in these movement patterns across three decades of adulthood.

### Equipment and Layout of the Videotaping Field

Two video cameras\(^*\) and videocassette player/recorders\(^*\) were used to tape each subject while he or she rose to a standing position from a standard twin-size bed. The bed was approximately 1.85 m long, 0.97 m wide, and 0.51 m high.

One camera faced the side of the bed, and the other camera faced the foot of the bed. The side-view camera was positioned perpendicular to the long axis of the bed, approximately 5.83 m from the midpoint of the bed. The center of the camera lens was approximately 0.89 m above the floor. Videotaping from this position provided a view of a subject's right side when lying supine in bed. The other camera was positioned perpendicular to the short axis of the bed, approximately 5.94 m from the midpoint of the bed. The center of this camera lens was approximately 1.03 m above the floor. Videotaping from this position provided a foot view of a subject while lying supine.

During data reduction, the videotapes were viewed using a videocassette player/recorder (model PV1560)* with stop-action and slow-motion capabilities and a television monitor.

### Data Collection

Subjects removed their shoes and socks and lay supine on the bed with their arms beside their body and their head on a pillow. Each subject was videotaped while performing 10 consecutive trials of rising from the right side of the bed. On the cue "Ready," taping began. When the cue "Go" was given, the subject rose from the bed as quickly as possible. This procedure was identical to the data-collection procedure used by Sarnacki.\(^5\) Rest periods between trials were determined by the subjects, but generally lasted less than 1 minute.

### Data Reduction

The videotapes were reviewed, and the movement patterns observed for a body region were classified using Sarnacki's descriptions\(^5\) (Appendix 1). The videotaped data were reduced separately for each body region. The first trial was viewed and the movement classified for all subjects, then the second trial was viewed and classified for all subjects, then the third trial, and so forth until all 10 trials had been classified. This procedure was repeated for each body region. The side-view videotape was used to reduce the data of the RUL and the H-T. The foot-view videotape was used to reduce the data of the LUL and the LLs.

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*Panasonic Co, Div of Matsushita Electronic Corp of America, 1 Panasonic Way, Secaucus, NJ 07904.
### Data Analysis

**Reliability of the classification process.** A randomly selected set of 50 trials were classified independently by each author. We agreed that if 85% or greater of exact agreement was not attained for each body region, the categorical descriptions would be reviewed and decision rules would be generated to improve interrater agreement. Another randomly selected set of 50 trials would then be independently classified by each rater. Interrater agreement was above 85% for each body region. Once the predetermined percentage of interrater agreement was attained, a Kappa statistic was calculated as a measure of reliability.\(^\text{10}\)

### Results

**Reliability of Categorical Descriptions**

We attained at least 86% of exact agreement when we independently categorized the movement patterns of each body region. The percentages of exact agreement and the Kappa statistics are reported in Table 2.

**Movement Patterns Used to Rise from Bed by Individuals in Middle Adulthood**

The categories of movement patterns developed by Sarnacki\(^\text{8}\) were used without modification to characterize the performance of all subjects on all trials. We identified no new patterns in this study.

The incidence of patterns within each body region is reported by age group in Table 3. Across all age groups, the LUL double-push pattern predominated, although the LUL push pattern was also seen in approximately 30% to 40% of the trials of each age group. The frequency with which each LUL movement pattern appeared across trials for each age group is illustrated in Figure 1.

In the RUL, the grasp-and-push pattern predominated in the 30- to 39-year-old and 50- to 59-year-old sub-

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**Table 2.** Percentages of Exact Agreement and Kappa Statistics (N=50 trials)

<table>
<thead>
<tr>
<th>Movement Pattern</th>
<th>Left Upper Limb (%)</th>
<th>Right Upper Limb (%)</th>
<th>Head-Trunk (%)</th>
<th>Lower Limbs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interrater agreement</td>
<td>100</td>
<td>92</td>
<td>88</td>
<td>86</td>
</tr>
<tr>
<td>Intronater agreement</td>
<td>96</td>
<td>96</td>
<td>92</td>
<td>90</td>
</tr>
<tr>
<td>Kappa</td>
<td>1.00</td>
<td>.85</td>
<td>.71</td>
<td>.80</td>
</tr>
</tbody>
</table>

*Repeat classifications by the first and second authors.
*Repeat classifications by the first author.

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**Table 3.** Incidence of Movement Patterns in Each Age Group Expressed as a Percentage of Trials

<table>
<thead>
<tr>
<th>Movement Pattern</th>
<th>Age Group (y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30-39</td>
</tr>
<tr>
<td></td>
<td>40-49</td>
</tr>
<tr>
<td></td>
<td>50-59</td>
</tr>
<tr>
<td>Left upper limb</td>
<td>N=320</td>
</tr>
<tr>
<td>1—Lateral lift and push</td>
<td>0</td>
</tr>
<tr>
<td>2—Push</td>
<td>36</td>
</tr>
<tr>
<td>3—Double push</td>
<td>44</td>
</tr>
<tr>
<td>4—Lift and push</td>
<td>10</td>
</tr>
<tr>
<td>5—Lift or lift and reach</td>
<td>10</td>
</tr>
<tr>
<td>Right upper limb</td>
<td>N=330</td>
</tr>
<tr>
<td>1—Lateral lift and push</td>
<td>10</td>
</tr>
<tr>
<td>2—Grasp and push</td>
<td>61</td>
</tr>
<tr>
<td>3—Push</td>
<td>29</td>
</tr>
<tr>
<td>Head and trunk</td>
<td>N=330</td>
</tr>
<tr>
<td>1—Pelvis leading</td>
<td>1</td>
</tr>
<tr>
<td>2—Lateral roll</td>
<td>4</td>
</tr>
<tr>
<td>3—Roll off</td>
<td>29</td>
</tr>
<tr>
<td>4—Come to sit</td>
<td>66</td>
</tr>
<tr>
<td>Lower limbs</td>
<td>N=311</td>
</tr>
<tr>
<td>1—Stop off</td>
<td>10</td>
</tr>
<tr>
<td>2—Asynchronous with leg extension</td>
<td>22</td>
</tr>
<tr>
<td>3—Asynchronous</td>
<td>41</td>
</tr>
<tr>
<td>4—Synchronous</td>
<td>27</td>
</tr>
</tbody>
</table>

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**Most common movement pattern combinations.** The most common combinations of RUL, LUL, H-T, and LL movement patterns were determined for each age group using all trials of the age group. The most frequent combinations of movement patterns were inspected for age differences.
The most common form of rising for subjects in the 30- to 39-year-old age group usually involved a double-push pattern with the LUL, as the RUL grasped and then pushed off the edge of the bed. A come-to-sit pattern was demonstrated in the H-T region as the LLs were lifted asynchronously off the bed and moved across the bed with either the left LL extended in front of the right LL (Fig. 5) or with the LLs aligned as they were lowered to the floor. These forms of rising were observed on approximately 12% of this group’s trials.

The most common form of rising for subjects in their forties and fifties varied only in LL action from that seen in the 30- to 39-year-old age group. The older groups used a synchronous lifting pattern with both LLs being lifted synchronously, moved across the bed, and lowered to the floor simultaneously. This movement pattern combination (Fig. 6) was observed in approximately 8% and 14% of the trials of subjects in their forties and fifties, respectively.

The most frequent combinations of LUL, RUL, H-T, and LL movement patterns are reported in Table 4. The common movement pattern combina-
tions varied across age groups, as did interindividual variability. Subjects in their thirties demonstrated 57 of a possible 248 movement pattern combinations. Only three movement pattern combinations occurred in more than 5% of this group's trials. Subjects in their forties and fifties demonstrated 49 and 47 different movement pattern combinations, respectively. Three combinations occurred in more than 5% of the trials of the subjects in their forties, and only four combinations were observed in more than 5% of the trials of those in their fifties.

**Discussion**

Our subjects demonstrated high movement pattern variability. The number of movement pattern combinations seen in our middle-aged adults, however, declined with increasing age. Subjects in our study exhibited a form of rising action similar to that reported by Sarnacki for her young adult subjects. Sarnacki's subjects pushed on the bed with the LUL, grasped the edge and pushed on the bed with the RUL, rolled the H-T to the side while moving off the bed, and brought the LLs to the floor by moving them asynchronously over the edge of the bed. This form of rising was demonstrated by 30% of Sarnacki's young subjects on at least one trial. This movement pattern combination was the second most common in our 30- to 39-year-old subjects.

We suggest that age-related trends in movement patterns in the task of getting out of bed were demonstrated in this study. These trends were evidenced in the varying incidence of movement patterns within all four regions of the body. The age-related trends observed in this study lent support to the assumptions that developmental changes in movement patterns may continue across adulthood and that these changes are occurring within various body regions.

The last in-first out hypothesis predicts that the neural and muscular capability to perform movements that develop early in life remain with advancing age, whereas movements...
developed later decrease in frequency with advancing age. When Sarnacki\textsuperscript{5} described the movements used by young adults, she also proposed a developmental sequence for each body region. If Sarnacki's hypotheses of the order of predominance of movement patterns for each body region were correct, the regression hypothesis was supported only for movement patterns of the RUL. For the other three components of body action, it appears that our subjects were still progressing toward what Sarnacki identified as the most advanced or later-appearing developmental steps in her proposed sequence. If our assumption that Sarnacki's sequences are correctly ordered is valid, then it appears that the most advanced forms of movement in this task are just becoming predominant in middle adulthood. This finding is contrary to that reported previously for the task of rising to a standing position from the floor.\textsuperscript{1}

Using children and young and older adult subjects as comparison groups, adults in their thirties, forties, and fifties demonstrated an orderly sequence of regression of movement patterns for the task of rising from the floor.\textsuperscript{8} There are two possible reasons for why our study failed to support the regression hypothesis. First, the task of rising from bed, unlike rising from the floor, is performed on a daily basis across a large portion of the life span. Individuals may still be refining their performance of this task well into adulthood. Regression of the movement patterns observed in the task of rising from the floor may be related to the decreasing frequency with which the task is performed with advancing age.

Second, our assumption that Sarnacki's sequences\textsuperscript{5} are correctly ordered may be invalid. A study of the age differences in movement patterns of teenage subjects during rising\textsuperscript{12} suggests that Sarnacki's proposed developmental order of movement patterns may not be correct. Further study of performance in this task using larger numbers of individuals of

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Most frequent movement patterns demonstrated by the 30- to 39-year-old subjects.}
\end{figure}
different ages or a longitudinal research design will help clarify the developmental order of movement patterns.

Rising action variability could also have been influenced by gender and body dimensions. VanSant et al determined that there is a relationship among body dimensions, gender and age, and movement patterns used to right the body from a supine position when comparing subjects aged 4 through 82 years. Twenty percent to 40% of movement pattern variability within subgroups resulted from different combinations of body dimensions.

Conclusions and Clinical Considerations

The age-related trends in movement patterns found in this study can be used as guidelines for selecting age-appropriate movement patterns for the task of getting out of bed. Physical therapists should know that adults exhibit a variety of movement patterns in different combinations in accomplishing this rising task. The varying incidence of movement patterns could likely result from age-related neuromuscular and musculoskeletal changes (eg, decreased number of neurons in the brain, decreased number of myelinated fibers in the spinal roots, decreased bone and muscle density) coupled with varying amounts of practice or performance of the task.

We noticed that in the older age groups, the task of getting out of bed appeared to consist of two separate tasks: coming to a sitting position from a supine position and coming to a standing position from a sitting position. This observation is substantiated in part by the rise in frequency of the H-T come-to-sit pattern in the older age groups. This finding lends support to the suggestion of Carr and Shepherd to teach older patients the task of getting out of bed in two parts. Their suggestion, however, may not be appropriate for younger patients because young adults more com-

Figure 6. Most frequent movement patterns demonstrated by the 40- to 49-year-old and 50- to 59-year-old subjects.
In our experience, patients commonly grasp the edge of the bed with their right hand if rising toward the right (or with their left hand if rising toward the left) and then push on the bed with that hand. Patients are often told that this is an improper way to rise from bed. We found the grasp-and-push pattern to be quite common in our subjects, and we suggest that the reasons why patients are not encouraged to grasp the edge of the bed before pushing on the bed should be carefully examined.

Further cross-sectional studies of older individuals could reveal the influence of body dimensions and gender on the functional task of getting out of bed. In order to determine whether the sequences proposed in this study of subjects in the third through fifth decades of age for each body region are correct, a longitudinal study of young and middle-aged adults is needed.

References

Appendix 1. Movement Pattern Categories for the Task of Rising from Bed

**Left Upper Limb Movement Patterns**

1. **Lateral Lift and Push**
   - The left upper limb lifts or slides on the supporting surface toward the head of the bed. The entire limb, or some part of it, is placed on the bed and pushes. The limb extends until the hand is the only part of the limb remaining on the bed. The hand lifts, and the limb may be used as a balance assist.

2. **Push**
   - The entire limb, or some part of it, pushes into the bed. The limb extends until the hand or elbow is the only part of the limb remaining on the bed. The hand or elbow lifts, and the limb may be used as a balance assist.

3. **Double Push**
   - The entire limb lifts toward the head of the bed and pushes or pushes into the bed without lifting. The limb extends until the hand or elbow is the only part of the limb remaining on the bed. The hand or elbow lifts, and the hand is placed on the bed, usually near the edge, and pushes. The hand lifts, and the limb may be used as a balance assist.

4. **Lift and Push**
   - The limb lifts off the bed to position the hand to grasp the edge of the bed. The entire limb, or some part of it, pushes down on the bed while the hand grips on the edge. The limb lifts and may be used as a balance assist.

5. **Lift or Lift and Reach**
   - The limb lifts off the bed and may reach across the body. The limb may be used as a balance assist.

**Right Upper Limb Movement Patterns**

1. **Lateral Lift and Push**
   - The right upper limb lifts or slides on the supporting surface toward the head of the bed. The entire limb, or some part of it, is placed on the bed and pushes until the limb is in the extended or nearly extended position and the hand is the only part of the limb remaining on the bed. The hand lifts, and the limb may be used as a balance assist.

2. **Grasp and Push**
   - The limb slides or lifts to position the hand to grasp the edge of the bed. The entire limb, or some part of it, pushes down on the bed while the hand grips on the edge. The limb lifts and may be used as a balance assist.

3. **Push**
   - The entire limb, or some part of it, pushes into the bed. The limb lifts from the bed and may be used as a balance assist.

**Head and Trunk Movement Patterns**

1. **Pelvis Leading**
   - The lower trunk rotates to the side. In the side-lying position, the upper side of the pelvis drops to the bed, and the trunk lifts and turns toward the side-facing position. The subject may be in a symmetrical sitting posture before standing.

2. **Lateral Roll**
   - The head and trunk turn toward the side-facing position with minimal flexion toward the foot of the bed. In the side-facing position, one buttock is off the bed and the shoulders and pelvis are aligned and displaced toward the head of the bed. Just before the buttock comes off the bed, the head and trunk are displaced toward the head of the bed through lateral flexion or rotation.

3. **Roll Off**
   - The head and trunk flex and turn toward the side-facing position with the weight shifted to one buttock. In the side-facing position, the pelvis may drop to a level position. Just before both buttocks come off the bed, the head and trunk are displaced toward the head of the bed through lateral flexion or rotation.

4. **Come to Sit**
   - The head and trunk flex symmetrically or flex and turn toward the side-facing position by pivoting on one or both buttocks. If the trunk pivots on one buttock, the pelvis may drop to a level position before standing. Just before both buttocks come off the bed, the trunk is in a symmetrical sitting posture, though it may be flexed forward.

**Lower Limb Movement Patterns**

1. **Step Off**
   - The lower limbs are lifted asynchronously off the bed. The left limb may push on the bed before lifting. The left limb flexes toward the chest so that the thigh is above the thigh of the right lower limb. The feet are usually placed on the floor asynchronously, and the right lower limb may begin to extend before the left lower limb if placed on the floor.

2. **Asynchronous with Leg Extension**
   - The lower limbs are lifted asynchronously off the bed. The left lower limb may push on the bed prior to lifting. The thighs remain parallel as they move across the bed. The left lower limb may be extended as it moves across and over the edge of the bed. The left foot is in front of the right leg as the feet descend to the floor. The feet are placed on the floor, and the lower limbs extend to the upright position.

3. **Asynchronous**
   - The lower limbs are lifted asynchronously off the bed. The left lower limb may push on the bed before lifting and is usually medially rotated. The thighs are parallel as they move across the bed, and the legs are parallel as they descend to the floor. The feet are placed on the floor simultaneously, and the lower limbs extend to the upright position.

4. **Synchronous**
   - The lower limbs are lifted or slid simultaneously off the bed. A brief push on the bed may proceed the lifting. The lower limbs move together over the edge of the bed. The feet are placed on the floor simultaneously. The lower limbs extend to the upright position.

*The movement pattern categories have been renamed from Sarnacki's original titles. The descriptions are written to portray individuals moving from a supine position toward their right side in the process of rising from bed. Sarnacki's original descriptions referred to the right and left sides of the body as the near and far sides, respectively.*
**Appendix 2. Sarnacki's Proposed Developmental Sequences for the Task of Rising from Bed**

<table>
<thead>
<tr>
<th>Body Region</th>
<th>Developmental Step</th>
<th>Movement Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Upper Limb</td>
<td>1</td>
<td>Lateral Lift and Push</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Push</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Double Push</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Lift and Push</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Lift or Lift and Reach</td>
</tr>
<tr>
<td>Right Upper Limb</td>
<td>1</td>
<td>Lateral Lift and Push</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Grasp and Push</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Push</td>
</tr>
<tr>
<td>Head-Trunk</td>
<td>1</td>
<td>Pelvis Leading</td>
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<td></td>
<td>2</td>
<td>Lateral Roll</td>
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<tr>
<td></td>
<td>3</td>
<td>Roll Off</td>
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<tr>
<td></td>
<td>4</td>
<td>Come to Sit</td>
</tr>
<tr>
<td>Lower Limbs</td>
<td>1</td>
<td>Step Off</td>
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<td>2</td>
<td>Asynchronous with Leg Extension</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Asynchronous</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Synchronous</td>
</tr>
</tbody>
</table>

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