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How Much Do Hospitalized Adults Move? A Systematic Review and Meta-Analysis

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Abstract

Aim: To quantify the type and duration of physical activity performed by hospitalized adults.

Background: Inactivity is pervasive among hospitalized patients and is associated with increased mortality, functional decline, and cognitive impairment. Objective measurement of activity is necessary to examine associations with clinical outcomes and quantify optimal inpatient mobility interventions.

Methods: We used PRISMA guidelines to search three databases in December 2017 to retrieve original research evaluating activity type and duration among adult acute-care inpatients. We abstracted data on inpatient population, measurement method, monitoring time, activity duration, and study quality.

Results: Thirty-eight articles were included in the review and 7 articles were included in the meta-analysis. Study populations included geriatric (n=5), surgical (n=5), medical (n=12), post-stroke (n=10), psychiatric (n=2), and critical care inpatients (n=4). To measure activity, 29% of studies used human observation and 71% used activity monitors. Among inpatient populations, 87–100% of time was spent sitting or lying in-bed. Among medical inpatients monitored over a 24-hour period, 70 minutes per day was spent standing/walking (95% CI 57–83 minutes).

Conclusions: This review provides a baseline assessment and benchmark of inpatient activity, which can be used to compare inpatient mobility practices. While there is substantial

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heterogeneity in how researchers measure and define how much inpatients move, there is consistent evidence that patients are mostly inactive and in-bed during hospitalization. Future research is needed to establish standardized methods to accurately and consistently measure inpatient mobility over time.

Keywords

physical activity; early mobility; hospitalization; systematic review; fitness tracker

INTRODUCTION

Hospitalization frequently involves a period of prescribed bedrest until a patient is assessed as safe to mobilize. While bedrest promotes reduced oxygen consumption and metabolism, it also has molecular and physiologic effects that can adversely impact organ systems and physical functioning(1) and is associated with increased mortality, functional decline, and cognitive impairment(2, 3). Hospital inactivity can lead to muscle wasting with loss of up to 30% of muscle mass within the first 10 days of critical illness(4), and can lead to impaired cardiopulmonary function including orthostatic instability, increased risk of venous thromboembolism, atelectasis, and aspiration(5, 6). Amidst growing recognition of the adverse effects of bedrest on patient outcomes, widespread efforts have focused on developing new models of care to promote inpatient activity.

Interventions to promote early mobility and progressive physical activity are increasingly prescribed and implemented from the outset of critical illness to hospital discharge (7, 8). Activity related interventions in the hospital typically consist of a variety of prescribed physical therapy interventions—e.g. range of motion, resistance, and gait-training exercises — implemented by nurses, physical therapists, family members, and/or patients, depending on availability of resources, patient ability, and need(9). Obtaining objective and precise estimates of patient activity is fundamental to effectively assess, implement, and evaluate activity interventions during hospitalization.

In clinical practice, functional assessments and mobility interventions are documented in the electronic health record (EHR) roughly once per day, providing limited estimates of daily activity performed. Assessments typically measure a patient's highest level of functioning, ability to perform activities of daily living, or level of assistance required. Rarely do EHR clinical notes quantify activity in a location easily retrievable and readily available for clinicians to track over time, analogous to vital sign or fluid balance monitoring. In comparison, researchers traditionally use two measurement methods to capture and quantify the proportion of time spent performing physical activity in the hospital. Behavior mapping —a form of direct observation—involves a human observer systematically recording and coding patient behavior (10). While both detailed and precise, behavior mapping is labor intensive over extended time periods and may introduce observer bias(11). The second method uses wearable activity monitors embedded with wireless sensors to measure motion, orientation, joint angles, and/or step counts(12). With advances in device size, cost, and commercial availability, activity monitors are being increasingly implemented to measure activity among individuals with chronic health conditions and mobility limitations(13).

Over the past 10 years, mounting research suggests that engaging in progressive activity promotes recovery post-operatively and prevents adverse events during acute illness(7, 8). However, multiple challenges to effective hospital mobility implementation remain, including: identifying patient subgroups most likely to benefit; developing classification standards for quantitative assessment of inpatient activity; and defining the appropriate dose and timing of therapy in real-world settings. Key to addressing these issues is a baseline assessment of inpatient activity and how activity is measured across inpatient populations. While a number of recent reviews have examined activity levels among single inpatient subpopulations and measurement types(14–16), we conducted this systematic review and meta-analysis to quantify the type and duration of physical activity performed by hospitalized adults across multiple inpatient settings and measurement methods.

METHODS

This review followed guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)(Appendix A)(17). With the aid of a medical librarian, we used a systematic approach to search multiple databases for research studies using subject headings and text keywords related to inpatient condition, methods for measuring activity, and patient movement (Appendix B). Selected terms were informed by relevant literature and included keywords specific to previous published reviews. Article selection criteria included: original research; published in English between 1995–2017; adult patients; acute-care inpatient settings; and measurement of inpatient activity type and duration. Activity type and duration were chosen as the primary activity outcome metrics(18). Duration of physical activity can be calculated across both observational and sensor-based measurement methods and is more inclusive of low mobility populations, compared to ambulation-only metrics of activity such as step count. Exclusion criteria were studies that monitored patients for less than 6 hours, those that validated activity monitor algorithms, or were conducted in outpatient settings, long-term care, inpatient rehabilitation units, or with participants younger than 18 years old. Our search was conducted in December 2017 in PubMed, Cumulative Index to Nursing and Allied Health Literature, and SCOPUS databases. Additional articles were identified by reviewing references of identified studies.

Study Selection

The search yielded 1,916 published papers (Figure 1). After duplicates were removed, two reviewers independently screened titles and abstracts from 1,648 articles for eligibility using criteria previously specified. DisagreeMAments in selection were adjudicated by consensus. Seventy-eight full-text articles were retrieved and assessed. We excluded an additional 40 papers because they did not report duration of activity performed, or only reported frequency of activity milestones. After full-text review, we included 38 articles in our systematic review and 7 studies in our meta-analysis.

Data Extraction

We abstracted relevant data from 38 articles using a standardized data extraction template, organized by: first author; study design; year published; population; sample size; measurement method and monitoring period; activity outcome category measured; and activity duration results (Table 1). Two reviewers completed the data extraction independently and discrepancies were resolved by a third reviewer.

Statistical Analysis

A meta-analysis was performed to estimate inpatient standing/walking time using a random effects model (k=7). Due to the differences in acute-care subpopulations and how inpatients were observed, we only included studies measuring activity over a continuous 24-hour period among medical inpatients. The effect sizes for the studies were combined using inverse variance weights. For studies that reported median and interquartile ranges, we estimated the standard error using the equation: [quartile3–quartile/1.35](19). Heterogeneity across studies was assessed using the I^2 statistic.

Quality Assessment

Twelve items selected from the Downs & Black checklist(20) related to observational studies were used the assess research quality (Appendix C). Studies were scored using a yes/no rating by a reviewer on a scale from 0–12. The highest possible quality score rating a study could receive based on the items selected was 12.

RESULTS

Study Characteristics

The 38 studies included in this review were conducted primarily in Europe (42%)(21–36), Australia or New Zealand (29%)(37–47), and the United States (21%)(48–54). Sample sizes ranged from 10–317 participants. Mean age of participants ranged from 25–85 years old. Eighty-nine percent of studies were performed in an acute-care setting (n=34), while 11% were conducted in an intensive care unit (ICU) (n=4). Quality assessment scores ranged from 7–12 (median=10). The highest scored items were related to reporting of study methods and findings. The lowest rated items were related to external validity, patient sampling, and recruitment methods.

Activity Definitions and Measurement Methods

All studies measured and reported activity duration during hospitalization, however given the range of definitions used to quantify activity types performed across studies (Table 2), meta-analysis for all activity duration outcomes was not possible. Most studied categorized activity by patient position (e.g. lying, sitting, standing and/or walking) (n=27). Methods for monitoring inpatient activity included direct observation with human observers (n=11) and activity monitors (n=27). Total monitoring time for observation ranged from 7.5–48 hours, while studies using activity monitors ranged from 6.5-hours up to 7 days. Four human observation(44, 46, 47, 52) and two activity monitor studies(55, 56) monitored patients for shorter time periods combined across multiple days, and though many activity monitor device studies recorded activity for longer than 24-hours, authors predominantly reported activity findings over the course of a 24-hour day.

Activity Among Hospitalized Adults

Among 7 studies that reported activity duration over a continuous 24-hour period(32, 33, 37, 53–56), hospitalized adults spent between 87–100% of time lying in-bed or sitting. For 12 studies that reported activity observed during daytime work hours, 10 reported that over 81% of monitored time was spent in-bed(23, 26, 35, 36, 41, 43–47), with two studies reporting 65% and 72% of time spent in-bed(42, 57). For the 11 studies that examined activity duration using an activity intensity categorization, between 60–100% of the day was spent inactive or engaged in light activities, such as turning or re-adjustment in-bed(25, 34, 36, 38, 39, 43, 46, 48, 51, 52, 58). When moderate-vigorous activity did occur, it lasted for less than 10 minutes according to 4 studies(28, 30, 39, 48), and between 30–95 minutes according to 5 studies(25, 34, 38, 44, 58).

In acute-care settings, time spent in lying or sitting positions was 89–99% for inpatients in medical or surgical units(26, 32, 37, 45, 47, 53–56), 81–94% for patients following stroke during daytime business hours(23, 35, 41, 44, 46, 57) and 100% for ICU patients(36, 43, 51, 52). Combined average standing/walking time among studies in acute-care was measured between 16–66 minutes for post-operative surgical inpatients(21, 26, 37, 40), 66–117 minutes for geriatric inpatients(22, 24, 32, 50), 1–184 minutes for medical inpatients(27, 42, 45, 47, 53–56), 107 minutes for psychiatric inpatients(33) and 10–86 minutes for post-stroke inpatients(23, 31, 35, 41, 44, 46, 57). In the 4 studies reporting ICU activity, no patients ambulated(36, 43, 51, 52). The weighted mean effect size for time spent standing/walking by medical inpatients was 70 minutes [95% CI 57–83 minutes] (Figure 2), however, there was substantial heterogeneity among studies (I^2=75%).

DISCUSSION

This review quantified the results of original research measuring the type and duration of physical activity performed by hospitalized adults, describes results across inpatient populations and measurement methods, and provides a point estimate for medical inpatient standing/walking time. Estimates of patient activity during hospitalization using both direct observation and activity monitors suggest patients are largely inactive during their hospital stay. The majority of the studies report between 87–100% of the day patients are inactive or in-bed, with patients in the ICU experiencing the highest level of inactivity. Our findings of low levels of activity among inpatients are supported by other recent reviews that also reported high rates of inactivity among specific inpatient subpopulations, including medical and surgical inpatients (93–98.8%)(15), patients post stroke (>78%)(14), and orthopedic surgery (76–99%)(16). Baldwin and colleagues also reviewed adult medical surgical inpatient activity, however they only reviewed studies that used activity monitor devices and found that medical and surgical adult inpatients spend between 1–6% of time per day standing/walking(15). Our study expands on previous single population or measurement method reviews, and is novel in its inclusion of studies that use both behavior mapping and activity monitors to measure inpatient activity across a broad spectrum of inpatient populations, its inclusion of studies published through December 2017, and in its conduct of a meta-analysis to identify a standing/walking duration point estimate of 70 minutes that can serve as a benchmark for performance results of standing/walking time across research and clinical sites that measure inpatient daily activity duration.

Across all populations examined, patients in the ICU had the highest rates of inactivity. While there were no reported episodes of standing/walking among the ICU studies we examined, low levels of physical activity have also been reported among large ICU point prevalence studies, with less than 54% of ICU patient days involving mobility in general and 0–24% of days involving out-of-bed mobility (59–61). Among acute-care inpatient populations, no specific patient population engaged in substantially more physical activity than others, with all subgroups exhibiting high rates of time spent inactive. Large differences in standing/walking time were present among studies within the same population subgroups, making direct comparisons challenging.

The substantial heterogeneity in inpatient activity definitions and categorizations is a major barrier to mobility research, comparative analysis across studies, and its application to clinical practice. While the World Health Organization suggests quantifying physical activity by four main dimensions: frequency, intensity, duration, and type(18), these activity measurements are rarely all documented in clinical practice or reported in research. Most studies estimating translation of early mobility protocols report only point prevalence or percentage of patients who mobilized out of bed, but do not provide duration(59, 60). Randomized controlled trials often only provide intervention duration, or highest level of activity achieved, and do not track activity that occurs outside the prescribed intervention, such as patient or nurse initiated activity(62, 63). Further, studies that conflate activity type with patient position can be challenging to compare, limiting quantitative analysis across studies and populations. In clinical practice, activity is documented differently across clinicians groups using an assortment of assessment tools(64). Until there is standardization of definitions to measure and quantify inpatient activity longitudinally, across day, evening and night hours, advances in the study of inpatient activity, generalizability of findings, and the ability to track patient mobility in practice will be limited.

Researcher decisions related to data collection methods to estimate inpatient activity duration may also introduce bias in activity measurement. Use of only behavior mapping may either under or overestimate daily patient activity when observations are performed during business hours or are sampled at brief intervals, such as 1 minute every 10–15 minutes, as ambulation episodes are often less than 2 minutes in duration(65), potentially underestimating important but rare out-of-bed patient mobility events. Furthermore, given the labor involved in performing behavior mapping, most studies use human observers to measure activity during daytime hours only, potentially missing activity that occurs in the evening or overestimating total daily activity time. In this regard, our review of studies found that activity monitor device studies that measured activity over 24-hours, showed patients were lying or sitting greater than 87% of the total day, compared to behavior mapping studies, where 3 author groups found lower proportions of lying or sitting during daytime monitoring. In contrast, activity monitors allow for objective, longitudinal and continuous sampling of activity without need for human intervention and are increasingly used in research. Despite rapid advancements in automated monitoring of activity, sensor-based devices have not been widely integrated into clinical practice due to issues related to feasibility, validity, and reliability. Activity monitor accuracy may vary across device manufacturers, activity outcomes (e.g. step count versus classifying postures)(66, 67), body placement(68), and populations with limited mobility(66, 69). As a result, attention must be taken when applying activity monitors to new populations or activities where device accuracy has not been specifically tested(66, 70). While the rapid evolution of sensor-based technologies may hold great promise for both research and clinical applications, considerations around accuracy, standardization of activity outcomes, cost, and clinician workflow must be addressed before continuous activity monitoring is adopted routinely in practice.

Given the substantial heterogeneity in definitions and measurement strategies to estimate the amount of physical activity performed among hospitalized adults, we propose several recommendations related to inpatient activity measurement to encourage consistency in recording and reporting of activity outcomes data and improve the ability to translate research findings into practice (Figure 3). Independent of measurement methodology, standardization of inpatient activity monitoring and outcomes reporting will improve the ability to interpret and combine future studies and inpatient activity performance reported across institutions. The findings from our review and meta-analysis, while research focused, should also directly impact clinical practices around documentation of inpatient activity so that data routinely collected in clinical practice can better contribute to future research, quality and process improvement initiatives, and eventually, for use in real time clinical decision support.

This review has several important limitations worth consideration. By limiting search terms to acute-care populations and restricting activity outcome to activity type and duration, we may have excluded literature measuring other activity outcomes, such as steps taken. Second, we could not measure the effect of disease severity on inpatient activity type and duration performed across settings. Third, due to heterogeneity in definitions and measurement techniques, we were unable to examine point estimates of major activity subtypes and patient populations apart from standing/walking in medical inpatients, which will be an important aspect of future prospective research in hospitalized populations. Fourth, by including studies that utilized human observation and activity monitors, we may have introduced bias in our estimates of activity, as behavior mapping studies were shorter in duration than activity device studies but reported activity performed over the course of a “day”.

CONCLUSION

This review provides a baseline assessment of inpatient activity, which can be used to compare future research and inpatient physical activity practices. While there is substantial heterogeneity in how researchers measure and define how much hospitalized adults move, there is consistent evidence that patients are mostly inactive and in-bed during hospitalization. In order to improve inpatient mobility and progressive activity interventions, we must first be able to monitor activity in a way that is accurate, clinically meaningful, and does not add an increased burden on already heavy clinician workloads and documentation requirements. Future research should establish standardized methods for evaluating inpatient activity outcomes and a more complete view of inpatient mobility over time. Such efforts will advance the science of inpatient mobility and improve translation of data-driven care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Creditor MC. Hazards of hospitalization of the elderly. Annals of internal medicine 1993;118(3):219–23. [PubMed: 8417639]
2. Brown CJ, Friedkin RJ, Inouye SK. Prevalence and outcomes of low mobility in hospitalized older patients. Journal of the American Geriatrics Society 2004;52(8):1263–70. [PubMed: 15271112]
3. Zisberg A, Shadmi E, Sinoff G, Gur-Yaish N, Srulovici E, Admi H. Low mobility during hospitalization and functional decline in older adults. Journal of the American Geriatrics Society 2011;59(2):266–73. [PubMed: 21314647]
4. Griffiths RD, Hall JB. Intensive care unit-acquired weakness. Critical care medicine 2010;38(3):779–87. [PubMed: 20048676]
5. Winkelman C Bed rest in health and critical illness: a body systems approach. AACN advanced critical care 2009;20(3):254–66. [PubMed: 19638747]
6. Parry SM, Puthucheary ZA. The impact of extended bed rest on the musculoskeletal system in the critical care environment. Extrem Physiol Med 2015;4:16. [PubMed: 26457181]
7. Kalisch BJ, Lee S, Dabney BW. Outcomes of inpatient mobilization: a literature review. Journal of clinical nursing 2014;23(11–12):1486–501. [PubMed: 24028657]
8. Adler J, Malone D. Early mobilization in the intensive care unit: a systematic review. Cardiopulm Phys Ther J 2012;23(1):5–13.
9. Hodgson CL, Berney S, Harrold M, Saxena M, Bellomo R. Clinical review: early patient mobilization in the ICU. Crit Care 2013;17(1):207. [PubMed: 23672747]
10. Weick K Systematic observational methods In. Lindzey G & Aronson E (Eds.), The Handbook of Social Psychology New York: Random House; 1985.
11. Asan O, Montague E. Using video-based observation research methods in primary care health encounters to evaluate complex interactions. Inform Prim Care 2014;21(4):161–70. [PubMed: 25479346]
12. Mathie MJ, Coster AC, Lovell NH, Celler BG. Accelerometry: providing an integrated, practical method for long-term, ambulatory monitoring of human movement. Physiological measurement 2004;25(2):R1. [PubMed: 15132305]
13. McCullagh R, Brady NM, Dillon C, Horgan NF, Timmons S. A Review of the Accuracy and Utility of Motion Sensors to Measure Physical Activity of Frail, Older Hospitalized Patients. Journal of aging and physical activity. 2016;24(3):465–75. [PubMed: 26583827]
14. Fini NA, Holland AE, Keating J, Simek J, Bernhardt J. How Physically Active Are People Following Stroke? Systematic Review and Quantitative Synthesis. Physical therapy 2017;97(7):707–17. [PubMed: 28444348]

15. Baldwin C, van Kessel G, Phillips A, Johnston K. Accelerometry shows inpatients with acute medical or surgical conditions spend little time upright and are highly sedentary: Systematic review. Physical therapy 2017;97(11):1044–65. [PubMed: 29077906]
16. Ekegren CL, Beck B, Climie RE, Owen N, Dunstan DW, Gabbe BJ. Physical Activity and Sedentary Behavior Subsequent to Serious Orthopedic Injury: A Systematic Review. Archives of physical medicine and rehabilitation 2018;99(1):164–77 e6. [PubMed: 28629991]
17. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Journal of clinical epidemiology 2009;62(10):1006–12. [PubMed: 19631508]
18. Cavill N, Kahlmeier S, Racioppi F. Physical activity and health in Europe: evidence for action: World Health Organization; 2006.
19. Green S, Higgins J. Cochrane handbook for systematic reviews of interventions. Version; 2005.
20. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. Journal of epidemiology and community health 1998;52(6):377–84. [PubMed: 9764259]
21. Taraldsen K, Sletvold O, Thingstad P, Saltvedt I, Granat MH, Lydersen S, et al. Physical behavior and function early after hip fracture surgery in patients receiving comprehensive geriatric care or orthopedic care--a randomized controlled trial. The journals of gerontology Series A, Biological sciences and medical sciences 2014;69(3):338–45.
22. Evensen S, Sletvold O, Lydersen S, Taraldsen K. Physical activity among hospitalized older adults - an observational study. BMC geriatrics 2017;17(1):110. [PubMed: 28511639]
23. Kunkel D, Fitton C, Burnett M, Ashburn A. Physical inactivity post-stroke: a 3-year longitudinal study. Disability and rehabilitation 2015;37(4):304–10. [PubMed: 24828312]
24. Villumsen M, Jorgensen MG, Andreasen J, Rathleff MS, Molgaard CM. Very Low Levels of Physical Activity in Older Patients During Hospitalization at an Acute Geriatric Ward: A Prospective Cohort Study. Journal of aging and physical activity 2015;23(4):542–9. [PubMed: 25415513]
25. Kruisdijk F, Deenik J, Tenback D, Tak E, Beekman AJ, van Harten P, et al. Accelerometer-measured sedentary behaviour and physical activity of inpatients with severe mental illness. Psychiatry research 2017;254:67–74. [PubMed: 28456024]
26. van der Peijl ID, Vliet Vlieland TP, Versteegh MI, Lok JJ, Munneke M, Dion RA. Exercise therapy after coronary artery bypass graft surgery: a randomized comparison of a high and low frequency exercise therapy program. The Annals of thoracic surgery 2004;77(5):1535–41. [PubMed: 15111138]
27. Pitta F, Troosters T, Probst VS, Spruit MA, Decramer M, Gosselink R. Physical activity and hospitalization for exacerbation of COPD. Chest 2006;129(3):536–44. [PubMed: 16537849]
28. Burtin C, Van Remoortel H, Vrijsen B, Langer D, Colpaert K, Gosselink R, et al. Impact of exacerbations of cystic fibrosis on muscle strength. Respir Res 2013;14:46. [PubMed: 23601143]
29. Pezzino S, Florenty S, Fagour C, Gin H, Rigalleau V. Remedial actions for the physical inactivity of hospitalized patients with type 2 diabetes. Diabetes Care 2010;33(9):1960–1. [PubMed: 20551016]
30. Agostini PJ, Naidu B, Rajesh P, Steyn R, Bishay E, Kalkat M, et al. Potentially modifiable factors contribute to limitation in physical activity following thoracotomy and lung resection: a prospective observational study. Journal of cardiothoracic surgery 2014;9:128. [PubMed: 25262229]
31. Askim T, Bernhardt J, Churilov L, Fredriksen KR, Indredavik B. Changes in physical activity and related functional and disability levels in the first six months after stroke: a longitudinal follow-up study. Journal of rehabilitation medicine 2013;45(5):423–8. [PubMed: 23571658]
32. Pedersen MM, Bodilsen AC, Petersen J, Beyer N, Andersen O, Lawson-Smith L, et al. Twenty-four-hour mobility during acute hospitalization in older medical patients. The journals of gerontology Series A, Biological sciences and medical sciences 2013;68(3):331–7.

33. Fleiner T, Haussermann P, Mellone S, Zijlstra W. Sensor-based assessment of mobility-related behavior in dementia: feasibility and relevance in a hospital context. International psychogeriatrics / IPA 2016;28(10):1687–94.
34. Åstrand A, Saxin C, Sjöholm A, Skarin M, Linden T, Stoker A, et al. Poststroke Physical Activity Levels No Higher in Rehabilitation than in the Acute Hospital. Journal of Stroke and Cerebrovascular Diseases 2016;25(4):938–45. [PubMed: 26851969]
35. Hokstad A, Indredavik B, Bernhardt J, Ihle-Hansen H, Salvesen O, Seljeseth YM, et al. Hospital differences in motor activity early after stroke: a comparison of 11 Norwegian stroke units. Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association 2015;24(6):1333–40. [PubMed: 25906937]
36. Connolly BA, Mortimore JL, Douiri A, Rose JW, Hart N, Berney SC. Low Levels of Physical Activity During Critical Illness and Weaning: The Evidence-Reality Gap. J Intensive Care Med 2017:885066617716377.
37. Davenport SJ, Arnold M, Hua C, Schenck A, Batten S, Taylor NF. Physical Activity Levels During Acute Inpatient Admission After Hip Fracture are Very Low. Physiotherapy research international : the journal for researchers and clinicians in physical therapy 2015;20(3):174–81. [PubMed: 25475700]
38. Ward N, White D, Rowe H, Stiller K, Sullivan T. Physical activity levels of patients with cystic fibrosis hospitalised with an acute respiratory exacerbation. Respiratory medicine 2013;107(7):1014–20. [PubMed: 23601566]
39. Chaboyer W, Mills PM, Roberts S, Latimer S. Physical activity levels and torso orientations of hospitalized patients at risk of developing a pressure injury: An observational study. International journal of nursing practice 2015;21(1):11–7. [PubMed: 24118408]
40. Browning L, Denehy L, Scholes RL. The quantity of early upright mobilisation performed following upper abdominal surgery is low: an observational study. The Australian journal of physiotherapy 2007;53(1):47–52. [PubMed: 17326738]
41. Kramer SF, Churilov L, Kroeders R, Pang MY, Bernhardt J. Changes in activity levels in the first month after stroke. Journal of physical therapy science 2013;25(5):599–604. [PubMed: 24259811]
42. Kuys SS, Dolecka UE, Guard A. Activity level of hospital medical inpatients: an observational study. Archives of gerontology and geriatrics 2012;55(2):417–21. [PubMed: 22417401]
43. Berney SC, Rose JW, Bernhardt J, Denehy L. Prospective observation of physical activity in critically ill patients who were intubated for more than 48 hours. Journal of critical care 2015;30(4):658–63. [PubMed: 25813549]
44. Bernhardt J, Dewey H, Thrift A, Donnan G. Inactive and alone: physical activity within the first 14 days of acute stroke unit care. Stroke 2004;35(4):1005–9. [PubMed: 14988574]
45. Cattanach N, Sheedy R, Gill S, Hughes A. Physical activity levels and patients' expectations of physical activity during acute general medical admission. Internal medicine journal 2014;44(5):501–4. [PubMed: 24816309]
46. King A, McCluskey A, Schurr K. The time use and activity levels of inpatients in a co-located acute and rehabilitation stroke unit: an observational study. Topics in stroke rehabilitation 2011;18 Suppl 1:654–65. [PubMed: 22120034]
47. Mudge AM, McRae P, McHugh K, Griffin L, Hitchen A, Walker J, et al. Poor mobility in hospitalized adults of all ages. Journal of hospital medicine : an official publication of the Society of Hospital Medicine 2016;11(4):289–91.
48. Mattlage AE, Redlin SA, Rippee MA, Abraham MG, Rymer MM, Billinger SA. Use of Accelerometers to Examine Sedentary Time on an Acute Stroke Unit. Journal of neurologic physical therapy : JNPT 2015;39(3):166–71. [PubMed: 26035120]
49. Ostir GV, Berges IM, Kuo YF, Goodwin JS, Fisher SR, Guralnik JM. Mobility activity and its value as a prognostic indicator of survival in hospitalized older adults. Journal of the American Geriatrics Society 2013;61(4):551–7. [PubMed: 23527951]
50. Fisher SR, Goodwin JS, Protas EJ, Kuo YF, Graham JE, Ottenbacher KJ, et al. Ambulatory activity of older adults hospitalized with acute medical illness. Journal of the American Geriatrics Society 2011;59(1):91–5. [PubMed: 21158744]

51. Winkelman C Investigating activity in hospitalized patients with chronic obstructive pulmonary disease: a pilot study. Heart & lung : the journal of critical care 2010;39(4):319–30. [PubMed: 20561844]
52. Winkelman C, Higgins PA, Chen YJ, Levine AD. Cytokines in chronically critically ill patients after activity and rest. Biological research for nursing 2007;8(4):261–71. [PubMed: 17456587]
53. Brown CJ, Redden DT, Flood KL, Allman RM. The underrecognized epidemic of low mobility during hospitalization of older adults. Journal of the American Geriatrics Society 2009;57(9):1660–5. [PubMed: 19682121]
54. Howie-Esquivel J, Zaharias E. Using Novel Technology to Determine Mobility Among Hospitalized Heart Failure Patients: A Pilot Study. Cardiology research 2013;4(1):15–25. [PubMed: 28348698]
55. Borges RC, Carvalho CR. Physical activity in daily life in Brazilian COPD patients during and after exacerbation. Copd 2012;9(6):596–602. [PubMed: 23244169]
56. Borges RC, Carvalho CR, Colombo AS, da Silva Borges MP, Soriano FG. Physical activity, muscle strength, and exercise capacity 3 months after severe sepsis and septic shock. Intensive Care Med 2015;41(8):1433–44. [PubMed: 26109398]
57. Prakash V, Shah MA, Hariohm K. Family's presence associated with increased physical activity in patients with acute stroke: an observational study. Brazilian journal of physical therapy 2016;20(4):306–11. [PubMed: 27556386]
58. Nozoe M, Kitamura Y, Kanai M, Kubo H, Mase K, Shimada S. Physical activity in acute ischemic stroke patients during hospitalization. International journal of cardiology 2016;202:624–6. [PubMed: 26447676]
59. Nydahl P, Ruhl AP, Bartoszek G, Dubb R, Filipovic S, Flohr HJ, et al. Early mobilization of mechanically ventilated patients: a 1-day point-prevalence study in Germany. Critical care medicine 2014;42(5):1178–86. [PubMed: 24351373]
60. Berney SC, Harrold M, Webb SA, Seppelt I, Patman S, Thomas PJ, et al. Intensive care unit mobility practices in Australia and New Zealand: a point prevalence study. Crit Care Resusc 2013;15(4):260–5. [PubMed: 24289506]
61. Jolley SE, Moss M, Needham DM, Caldwell E, Morris PE, Miller RR, et al. Point Prevalence Study of Mobilization Practices for Acute Respiratory Failure Patients in the United States. Critical care medicine 2017;45(2):205–15. [PubMed: 27661864]
62. Hodgson CL, Bailey M, Bellomo R, Berney S, Buhr H, Denehy L, et al. A Binational Multicenter Pilot Feasibility Randomized Controlled Trial of Early Goal-Directed Mobilization in the ICU. Critical care medicine 2016;44(6):1145–52. [PubMed: 26968024]
63. Schweickert WD, Pohlman MC, Pohlman AS, Nigos C, Pawlik AJ, Esbrook CL, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial. Lancet 2009;373(9678):1874–82. [PubMed: 19446324]
64. Tipping CJ, Young PJ, Romero L, Saxena MK, Dulhunty J, Hodgson CL. A systematic review of measurements of physical function in critically ill adults. Crit Care Resusc 2012;14(4):302–11. [PubMed: 23230880]
65. Doherty-King B, Yoon JY, Pecanac K, Brown R, Mahoney J. Frequency and duration of nursing care related to older patient mobility. J Nurs Scholarsh 2014;46(1):20–7. [PubMed: 24112775]
66. Lim SER, Ibrahim K, Sayer AA, Roberts HC. Assessment of Physical Activity of Hospitalised Older Adults: A Systematic Review. The journal of nutrition, health & aging 2018;22(3):377–86.
67. Taraldsen K, Askim T, Sletvold O, Einarsen EK, BjÃ¥stad KG, Indredavik B, et al. Evaluation of a Body-Worn Sensor System to Measure Physical Activity in Older People With Impaired Function. Physical therapy 2011;91(2):277–85. [PubMed: 21212377]
68. Kamdar BB, Kadden DJ, Vangala S, Elashoff DA, Ong MK, Martin JL, et al. Feasibility of Continuous Actigraphy in Patients in a Medical Intensive Care Unit. American journal of critical care : an official publication, American Association of Critical-Care Nurses 2017;26(4):329–35.
69. Verceles AC, Hager ER. Use of Accelerometry to Monitor Physical Activity in Critically Ill Subjects: A Systematic Review. Respir Care 2015;60(9):1330–6. [PubMed: 25852167]

70. Thorup CB, Andreasen JJ, Sorensen EE, Gronkjaer M, Dinesen BI, Hansen J. Accuracy of a step counter during treadmill and daily life walking by healthy adults and patients with cardiac disease. BMJ open 2017;7(3):e011742.

Highlights

- Objective estimates of activity are necessary to optimize inpatient mobility interventions
- Key to addressing these issues is a baseline assessment of inpatient activity
- We reviewed studies measuring type and duration of activity performed by hospitalized adults
- There is consistent evidence that hospitalized adults are mostly inactive and in-bed
- There is substantial heterogeneity in how researchers measure and define how much inpatients move

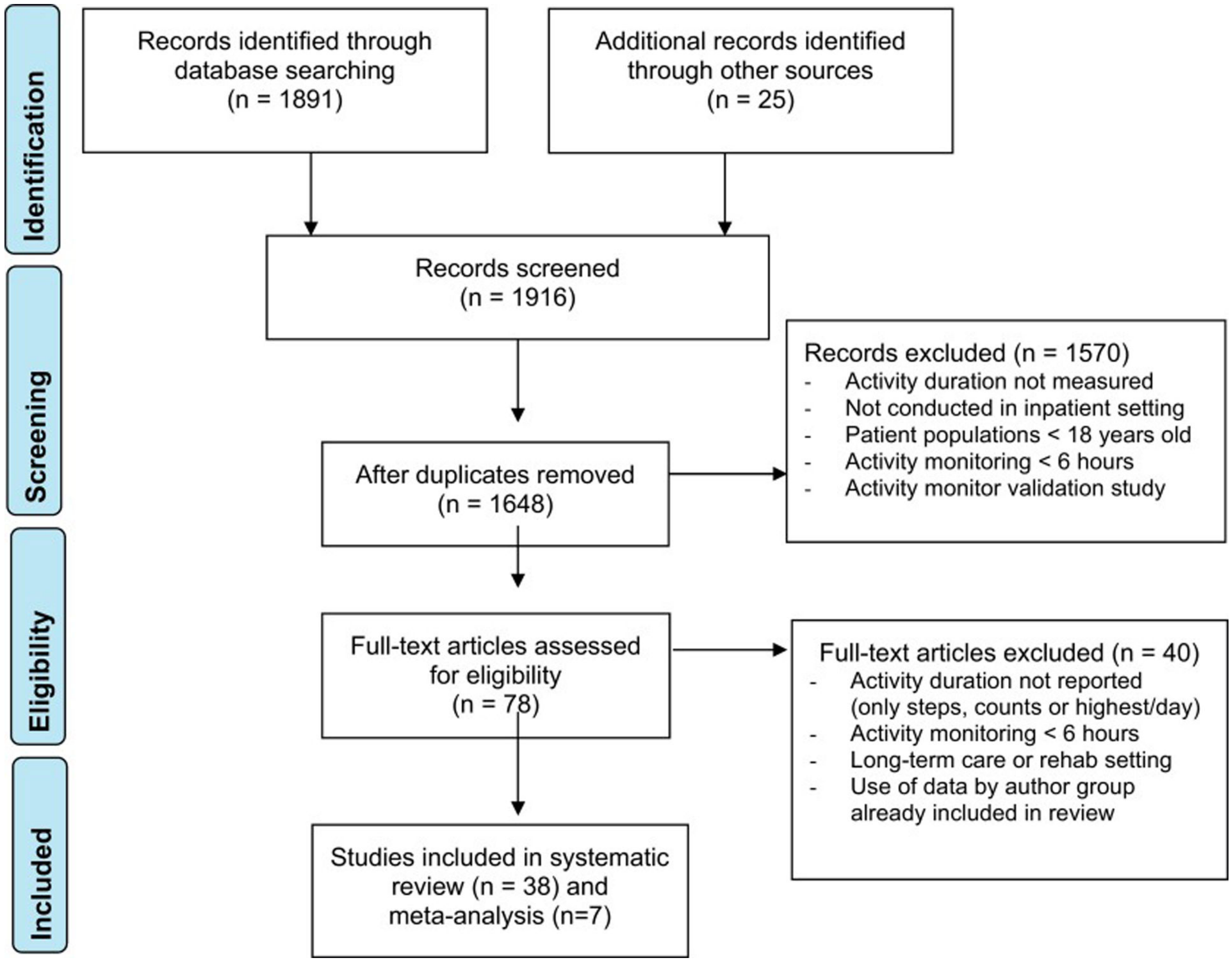

Figure 1. PRIMSA Flow Diagram

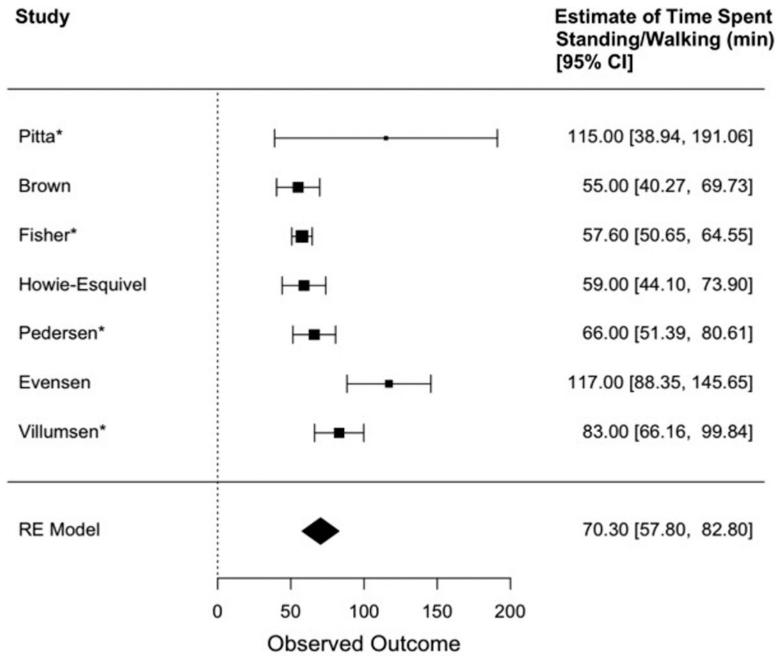

Figure 2. Forest plot of minutes spent standing/walking for medical inpatients monitored for at least 24 hours weighted by study sample size

*Denotes studies that reported median and/or interquartile range.

The equation Q3-Q1/1.35 was used to estimate the standard error for these studies.

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Research

1. Develop standardized definitions for measuring and documenting activity outcomes related to activity type, frequency, duration, and intensity
2. Develop consistent methods for inpatient activity monitoring related to data collection technology, sampling strategy, and monitoring duration
3. Quantitative estimates of physical activity should strive to record data during daytime, evening, and nighttime hours to obtain more generalizable estimates of mobility and avoid combination of shorter measurement periods across multiple days to equate to a single day of monitoring

Clinical Practice

1. Modify documentation practices around physical activity that specifically record structured information related to type, frequency, duration, and intensity so that routinely acquired activity data can be used for benchmarking and care planning, retrospective study, and real time clinical decision support

Figure 3. Recommendations for Measurement and Reporting of Inpatient Physical Activity Monitoring in Research and Clinical Practice

Table 1.

Synthesis of Studies in Review, Organized by Measurement Method Type

Study Author	Study Design & Year	Population & Sample Size, n	Method & Monitoring Period	Activity Outcome Measures	Activity Type & Outcomes (time or percentage)	Quality Score
Taraldsen(21)	RCT, 2014	Surgery (ortho), 317	ActivPal AM, 24 hr	Position/activity duration	Upright (standing/walking) (52 min)	12
Davenport(37)	Obs., 2015	Surgery (ortho), 20	ActivPal AM, 1–7 days	Position/activity duration; distance	Lying or sitting (23.7 hr); standing/walking time (16 min); 36 steps	11
Evensen(22)	Obs., 2017	Geriatrics, 38	ActivPal AM, 5 days	Position/activity duration	Standing/walking (117 min)	9
Kunkel(23)	Obs., 2015	Stroke, 61	ActivPal AM, 6.5 hr	Position/activity duration	Lying or sitting (6.1 hr); standing (15.7 min); walking (7.9 min)	11
Villumsen(24)	Obs., 2015	Geriatrics, 100	ActivPal AM, entire hospitalization	Position/activity duration; distance	Standing/walking (83); 424 steps	12
Kruisdijk(25)	Obs., 2017	Psychiatry, 184	ActivPal AM, 5 days	Intensity duration	No activity (84%); Light activity (10%); Moderate-vigorous activity (6%)	8
van der Peijl(26)	RCT, 2004	Surgery (cards), 170	Dynaport AM, 10 hr	Position/activity duration	Lying (2 hr); sitting (6.9 hr); standing/walking: (66 min)	11
Pitta(27)	Obs., 2006	Pulmonary (COPD), 17	Dynaport AM, up to 7 days	Position/activity duration	Lying (2.9 hr); sitting (7.9 hr); standing/walking: (115 min)	10
Borges(55)	Obs., 2012	Pulmonary (COPD), 20	Dynaport AM, 2, 12-hr time periods over 2 days, total of 24 hr	Position/activity duration; distance	Lying (13.8 hr); sitting (7 hr); standing: (85 min); walking (7.2 min); 602 steps	10
Borges(56)	Obs., 2015	Sepsis, 72	Dynaport AM, 2, 12-hr time periods over 2 days, total of 24 hr	Position/activity duration	Lying (15.6 hr); sitting (6 hr); standing/walking: (144 min)	12
Burtin(28)	Obs., 2013	Pulmonary (CF), 10	SenseWear AM, up to 14 days	Intensity duration; distance	Moderate-vigorous activity (6 min); 4,654 steps	10
Pezzino(29)	Quasi-ex, 2010	Medicine (diabetes), 36	SenseWear AM, up to 7 days	Intensity duration; distance	Light activity (45 min); 4,381 steps	8
Agostini(30)	Obs., 2014	Surgery (pulm), 99	SenseWear AM, 72 hr	Intensity duration; distance	Light activity (35.6 hr); moderate-vigorous activity (6 min); 233 steps	12
Ward(38)	Obs., 2013	Pulmonary (CF), 24	SenseWear AM, 24 hr	Position/activity duration; intensity duration	Lying (9.7 hr); no activity (22.1 hr); moderate-vigorous activity (95 min)	11
Chaboyer(39)	Obs., 2015	Gen medicine, 84	ActiGraph AM, 24 hr	Intensity duration	No activity (95%); Light activity (5%); Moderate-vigorous activity (0%)	7
Mattlage(48)	Obs., 2015	Stroke, 32	ActiGraph AM, 60 hr	Intensity duration; distance	No activity (94%); Light activity (5%); Mod-vigorous activity (1%); 1,907 steps	10
Ostir(49)	Obs., 2013	Geriatrics, 224	StepWatch AM, 24 hr	Intensity duration; distance	Light activity (6%); 478 steps	11

Study Author	Study Design & Year	Population & Sample Size, n	Method & Monitoring Period	Activity Outcome Measures	Activity Type & Outcomes (time or percentage)	Quality Score
Fisher(50)	Obs., 2011	Geriatrics, 239	StepWatch AM, 24 hr	Position/activity duration	Standing/walking (57.6 min)	10
Askim(31)	Obs., 2013	Stroke, 79	Positional Activity Logger, 24 hr	Position/activity duration	Lying (15.4 hr); standing (92 min)	11
Browning(40)	Obs., 2007	Surgery (abdo), 50	Positional Activity Logger, 96 hr	Position/activity duration	Standing/walking (14.6 min)	10
Kramer(41)	Obs., 2013	Stroke, 2013	Positional Activity Logger, 8 hr	Position/activity duration	Lying (2.9 hr); sitting (4.1 hr); dynamic (standing/walking): (9.6 min)	9
Nozoe(58)	Obs., 2016	Stroke, 30	Fitbit One AM, up to 7 days	Intensity duration; distance	Light activity (103 min); moderate-vigorous activity (33 min); 4354 steps	10
Winkelman(51)	Obs., 2010	ICU, 17	Mini Mitter ActiWatch, 24–48 hr	Intensity duration	Therapeutic activity duration (18.8 min)	10
Pedersen(32)	Obs., 2013	Geriatrics, 43	Augmentive Inc. AM, 24 hr	Position/activity duration	Lying (17 hr); sitting (5.1 hr); standing/walking: (66 min)	12
Brown(53)	Obs., 2009	Gen medicine (male), 45	AM (type not specified), up to 7 days	Position/activity duration	Lying (20 hr); sitting (3.1 hr); standing/walking time: (55 min)	9
Howie-Esquivel(54)	Obs., 2013	Cardiology (HF), 32	Micro Care Timeline AM, 72 hr	Position/activity duration	Lying (16.8 hr); sitting (5.5 hr); standing/walking: (59 min)	10
Fleiner(33)	Obs., 2016	Psychiatry, 45	uSense Motion Sensor, 72 hr	Position/activity duration; distance	Lying (10.9 hr); sitting/standing (11.4 hr); walking: (102 min); 8,829 steps	9
Kuys(42)	Obs., 2012	Gen medicine, 76	Observation, 10-min intervals, 7.5 hr	Position/activity duration; activity level duration	Lying (5.3 hr); sitting (0.1 hr); standing/walking: (1 min); No activity (56%)	7
Cattanach(45)	Obs., 2014	Gen medicine, 24	Observation, 10-min intervals, 9 hr	Position/activity duration	Lying (4.6 hr); sitting (3.9 hr); standing: (5.4 min); walking (27 min)	7
Bernhardt(44)	Obs., 2004	Stroke, 58	Observation, 10-min intervals, 8 hr over 2 days, total of 16 hr	Position/activity duration; intensity duration	Lying (12.8 hr); sitting (6.7 hr); standing/walking: (65.3 min); Moderate-vigorous activity (13%)	10
Mudge(47)	Obs., 2016	Medical/surgical, 132	Observation, 12–18 min intervals, 4, 4 hr time periods, total of 16 hr	Position/activity duration	Lying (9.2 hr); sitting (5.4 hr); standing/walking: (86.4 min)	8
King(46)	Obs., 2011	Stroke, 11	Observation, 15-min intervals, 12 hr over 4 days, total of 48 hr	Position/activity duration; Activity level duration	Lying (12.5 hr); sitting (10.8 hr); standing: (86.4 min); No activity (62%); Light activity (13%)	10
Hokstad(35)	Obs., 2015	Stroke, 393	Observation, 10-min intervals, 9 hr	Position/activity duration	Lying (4 hr); sitting (3.9 hr); upright activity: (44.8 min)	12
Astrand(34)	Obs., 2016	Stroke, 86	Observation, 10-min intervals, 9 hr	Activity level duration	No activity (33%); Light activity (27%); Moderate-vigorous activity (23%)	11
Prakash(57)	Obs., 2016	Stroke, 47	Observation, 10-min intervals, 9.5 hr	Position/activity duration	Lying (3 hr); sitting (3.1 hr); standing/walking: (81 min)	9
Winkelman(52)	Obs., 2007	ICU, 10	Observation, 10-min intervals, 2, 4 hr periods, total of 8 hr	Activity level duration	Therapeutic activity duration (14.7 min)	11

Study Author	Study Design & Year	Population & Sample Size, n	Method & Monitoring Period	Activity Outcome Measures	Activity Type & Outcomes (time or percentage)	Quality Score
Berney(43)	Obs., 2017	ICU, 41	Observation, 10-min intervals, 8 hr	Position/activity duration	Lying (8 hr); sitting (0 hr); standing/walking (0 min)	10
Connolly(36)	Obs., 2017	ICU, 42	Observation, 10-min intervals, 9 hr	Position/activity duration	Lying (7.7 hr); sitting (0 hr); standing/marching (0 min); walking (0 min)	10

NOTE: Abbreviations: randomized controlled trial (RCT), observational (obs.), quasi-experimental (quasi-ex), orthopedics (ortho), cardiology (cards), chronic obstructive pulmonary disease (COPD), pulmonary (pulm), abdominal (abdo), general (gen), intensive care (ICU), activity monitor (AM), hour (hr), minute (min)

Table 2.

Comparison of Activity Duration Definitions

Activity Category	Activities and Positions Reported	Heterogeneity Challenges	Number of Studies	References
Position	Time spent: lying, sitting, standing, walking, other, upright, sitting in bed, sitting out of bed	Not all studies report all categories. Some positional categories are combined.	27	(21–24, 26, 27, 31–33, 35–38, 40–47, 50, 53–57)
Activity Intensity	Time spent: sedentary, or performing light, moderate, or vigorous activity	Defined by assigning cutoffs to raw data counts or energy expenditures. Thresholds vary across studies.	9	(25, 28–30, 38, 39, 48, 49, 58)
Activity Level	Time spent: no activity, minimal activity, non-therapeutic activity, therapeutic activity	Assigns a ‘level’ based on patient activity types. Studies mix positions and intensity.	7	(34, 42, 44, 46, 51, 52, 57)
Combination	Time spent: lying & active, sitting & sedentary, sitting & active	Difficult to compare to other studies due to combinations.	4	(38, 42, 44, 46)