Journal of Orthopedics Research and Rehabilitation

Review

DOI: 10.51271/JORR-0075

Objectively measured physical activity after anterior cruciate ligament reconstruction: evidence from adult populations and critical gaps in pediatric patients

Božo Topalović

Department of Orthopedics and Traumatology, Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia

Cite this article as: Topalović B. Objectively measured physical activity after anterior cruciate ligament reconstruction: evidence from adult populations and critical gaps in pediatric patients. *J Orthop Res Rehabil.* 2026;4(3):72-77. doi:10.51271/JORR-0075

Received: 28.04.2026 ◆ **Accepted**: 22.07.2026 ◆ **Published**: 31.07.2026

ABSTRACT

Anterior cruciate ligament (ACL) injuries are increasingly common among children and adolescents, raising concerns regarding long-term joint health and physical activity behavior. Traditional outcome measures, particularly return-to-sport (RTS), do not adequately reflect habitual physical activity levels following ACL reconstruction (ACLR). This review aimed to evaluate existing evidence on objectively measured physical activity after ACLR, with a particular focus on pediatric populations. A narrative review of the literature was conducted using major electronic databases, including studies employing objective measurement tools such as accelerometers and pedometers. Current evidence demonstrates that adults following ACLR frequently exhibit reduced physical activity levels despite successful RTS. In contrast, there is a substantial lack of studies specifically investigating objectively measured long-term physical activity in pediatric populations. Available studies are limited by mixed age cohorts, short follow-up periods, and methodological heterogeneity. Overall, the findings highlight a significant gap in the literature and emphasize the need for longitudinal studies focusing exclusively on pediatric patients in order to better understand recovery trajectories and optimize long-term outcomes.

Keywords: Physical activity monitoring, accelerometry, pediatric orthopedics, motor activity, rehabilitation

INTRODUCTION

Rupture of the anterior cruciate ligament (ACL) has become increasingly common among physically active children and adolescents, with substantial implications for joint longevity and overall quality of life.[1] Over the past two decades, the incidence of ACL injuries and subsequent reconstructions in the pediatric population has risen markedly, with reports indicating a 40% to 55% increase in surgical procedures among young individuals.[2] This trend is largely attributed to early sports specialization, year-round participation in single-sport activities, increased intensity of youth competitive sports, and improved recognition of these injuries in skeletally immature patients.[3] Notably, female athletes exhibit a two- to sixfold higher risk of ACL injury compared to their male counterparts.[1]

Despite advances in surgical techniques, pediatric and adolescent patients remain at particularly high risk for secondary ACL injuries. Rates of graft failure and contralateral ACL rupture range from 17% to 30%, significantly exceeding those observed in older populations.[4,5] Furthermore, more than 30% of secondary injuries occur within the first 20 sport exposures following return to activity.[6] These findings suggest that many young athletes may not be adequately prepared-either physically or neuromuscularly-to tolerate the demands of high-level activity.[7]

Important biological and biomechanical differences distinguish pediatric patients from adults following ACL injury. Skeletally immature individuals possess open physes, ongoing musculoskeletal growth, and maturation-dependent neuromuscular characteristics that may influence both recovery and long-term physical activity behavior. Children and adolescents demonstrate age-specific movement strategies, evolving strength and coordination patterns, and growth-related changes in joint loading. In addition, psychological and social determinants of physical activity differ substantially from those observed in adults. These factors suggest that findings derived from adult ACLR populations cannot be directly extrapolated to pediatric patients and support the need for age-specific investigations.[8]

Traditionally, return-to-sport (RTS) has been considered the primary benchmark of successful recovery.[9,10] However, this binary outcome fails to capture actual daily physical activity (PA) behavior. RTS status does not necessarily reflect habitual movement patterns, and emerging evidence suggests that individuals following ACLR often fail to achieve recommended levels of physical activity despite successful return to sport.[9,11]

Furthermore, a marked disparity exists between adolescents and adults in postoperative activity profiles; while the majority

Corresponding Author: Božo Topalović, 911013d22@mf.uns.ac.rs

of adults meet health-related activity recommendations after surgery, only 9.1% of adolescents achieve the recommended 60 minutes of daily moderate-to-vigorous physical activity (MVPA).[12] This discrepancy is frequently overlooked in clinical practice, as commonly used subjective assessment tools, such as the Tegner Activity Scale and the Marx Activity Rating Scale, are prone to recall bias and systematic overreporting.[13,14] These patient-reported measures primarily capture peak sport participation rather than the overall frequency, intensity, and duration of daily movement, as defined by the FITT principle. In contrast, objective physical activity monitoring using wearable technologies, such as accelerometers, provides a more accurate and comprehensive assessment of a patient's movement profile. Such approaches have demonstrated that individuals following ACLR often exhibit reduced step counts and spend less time in vigorous physical activity compared to healthy peers, even when subjective outcomes suggest satisfactory recovery.[15]

Objective monitoring is particularly important given the direct relationship between physical activity levels and long-term knee health.[16] Reduced activity and associated weight gain represent major risk factors for the development of post-traumatic osteoarthritis, which may affect more than 50% of patients within one to two decades following the initial injury.[16,17] Incorporating objective measures of physical activity into clinical evaluation may therefore enable a more comprehensive assessment of recovery, facilitating individualized rehabilitation strategies aimed at maintaining an active lifestyle and minimizing the risk of reinjury. The aim of this review was to evaluate existing evidence on objectively measured physical activity after ACL reconstruction and to assess the availability of data in pediatric populations.

METHODS

Study Design

A structured narrative review of the literature was performed to identify studies evaluating objectively measured physical activity following anterior cruciate ligament reconstruction (ACLR). Relevant articles were retrieved through electronic database searches in PubMed, Scopus, and Web of Science, covering the period from January 2000 to January 2026.

The search strategy included combinations of keywords related to ACL reconstruction and objective physical activity assessment, such as "anterior cruciate ligament reconstruction", "ACL reconstruction", "physical activity", "motor activity", "accelerometer", "objective measurement", and "step count". To specifically assess the availability of evidence in younger populations, additional terms including "pediatric", "children", and "adolescent" were incorporated into the search.

Studies were considered for inclusion if they reported physical activity outcomes following ACL reconstruction and utilized objective measurement methods, including accelerometers, pedometers, or wearable activity tracking devices. Only studies conducted in human subjects and published in English were considered. Studies based solely on subjective assessment tools or not reporting physical activity outcomes were excluded from further analysis.

Only studies with a minimum follow-up of one year after ACL reconstruction were considered eligible, as earlier assessments primarily reflect postoperative recovery rather than habitual physical activity behavior. Because this was a narrative review, study-specific accelerometer protocols were accepted; however, particular attention was paid to commonly reported validity criteria, including a minimum wear time of approximately 10 hours per day and at least four valid monitoring days when such information was available. Only full-text articles published in English were included.

The identified literature was reviewed with particular emphasis on distinguishing between adult and pediatric populations. Special attention was given to the presence, methodology, and scope of studies involving individuals younger than 18 years, in order to evaluate the extent to which objectively measured physical activity has been investigated in this group.

Due to the expected variability in study design, measurement techniques, and reported outcomes, the findings were synthesized descriptively. The available evidence was analyzed with the aim of summarizing current knowledge in adult populations and identifying gaps in the literature regarding pediatric patients.

Objective Physical Activity Monitoring Methods

The transition from traditional RTS metrics and subjective assessments toward objective monitoring represents an important shift in the evaluation of patients following ACLR. In the context of this review, objectively measured physical activity refers primarily to data obtained using research-grade monitoring devices, such as ActiGraph and activPAL accelerometers. These instruments provide standardized raw movement data and have been validated against criterion methods including indirect calorimetry and doubly labeled water.[18,19] Consumer wearables, such as commercial smartwatches and fitness trackers, were not considered equivalent because of proprietary algorithms, limited transparency regarding data processing, and reduced comparability across studies.[19] Conventional outcome measures often fail to capture actual daily movement patterns and adherence to health-related physical activity (PA) recommendations.[9] In contrast, objective monitoring enables quantification of PA in free-living conditions according to the frequency, intensity, time, and type of movement, as defined by the FITT principle.[13]

Research-grade accelerometers are currently considered the most practical and valid tools for objective assessment of habitual physical activity.[19] Devices such as the ActiGraph (e.g., wGT3X-BT, GT9X Link) use triaxial sensors to capture body acceleration and convert it into activity counts reflecting movement intensity. These monitors are typically worn at the hip, allowing accurate assessment of whole-body movement.[13] The activPAL device, worn on the thigh, enables precise differentiation between sitting, standing, and stepping, providing additional insight into sedentary behavior and postural transitions.[20]

Physical activity data are most commonly expressed through MVPA and daily step count. MVPA represents time spent in activities ≥3 metabolic equivalents and is the primary indicator for meeting health-related guidelines.[9] Importantly, the use of age-specific cut-points is required in pediatric populations to avoid misclassification of activity intensity.

Daily step count provides a simple measure of total activity volume and has been shown to be reduced in patients following ACLR compared to healthy controls, with reported deficits of approximately 1,600-2,000 steps per day.[11]

The validity of accelerometry has been confirmed against gold-standard methods such as indirect calorimetry and doubly labeled water.[18] In addition, high adherence to device wear has been reported, supporting the feasibility of this approach in clinical and research settings.[21]

Compared to subjective questionnaires, objective monitoring offers clear advantages. Patient-reported measures, such as the Tegner Activity Scale, Marx Activity Rating Scale, and IPAQ, are prone to recall bias and frequently overestimate physical activity levels.[13] Moreover, they primarily reflect perceived or peak activity rather than total daily movement, and often show poor correlation with objectively measured outcomes such as MVPA and step count.[14]

Overall, objective monitoring provides a more accurate representation of habitual physical activity following ACL reconstruction, enabling the identification of reduced activity levels that may not be apparent through traditional clinical assessment.[22]

Evidence in Adult Population

The transition from clinical RTS clearance to habitual movement behavior remains a significant challenge in the adult population following ACLR. Although RTS is frequently achieved, objective monitoring indicates that many adults fail to reach physical activity (PA) levels required for long-term joint and overall health.[9]

Device-based evidence demonstrates that adults with a history of ACLR are 2.36 times less likely to meet recommended aerobic physical activity guidelines, such as 150 minutes of MVPA per week, compared to healthy individuals of similar age and self-reported activity levels.[9] This disparity is particularly pronounced in female patients, who show significantly lower odds of meeting MVPA recommendations compared to both healthy controls and male counterparts.[23] Objective measurements have identified consistent and clinically relevant deficits in both the volume and intensity of daily movement. Individuals following ACLR take significantly fewer steps than matched controls, with reported deficits of approximately 1,611 steps per day. In addition, patients accumulate around 65 fewer minutes of MVPA per week compared to uninjured peers.[9,11] On a daily level, ACLR patients achieve approximately 79 minutes of MVPA, whereas healthy controls reach around 93 minutes.[13] When expressed on a weekly basis, this corresponds to approximately 553 versus 651 minutes of MVPA per week, illustrating a cumulative deficit of nearly 100 minutes per week in individuals following ACL reconstruction. Beyond total activity volume, qualitative aspects of movement are also altered. Adults following ACLR spend approximately 42.7 fewer minutes per week in ambulatory activities performed at a cadence of ≥100 steps per minute, indicative of brisk walking.[11] Furthermore, alterations in gait mechanics have been observed, including a reduced ability to attenuate higher-frequency oscillations during walking, suggesting that the impact of ACL injury extends to whole-body movement control.[24]

Long-term data indicate that these deficits may persist over time. In cohorts assessed 32-37 years post-injury, approximately 71% of individuals meet the minimum recommended 150 minutes of MVPA per week; however, only 35% achieve higher recommended levels of 300 minutes per week.[20] Additionally, nearly one-third of individuals adopt a persistently inactive lifestyle regardless of treatment modality.[20] In older populations, mean daily step counts of approximately 5,415 steps further illustrate the long-term decline in total physical activity.[20]

A consistent finding across studies is the poor agreement between subjective and objective measures of physical activity. Commonly used scales, such as the Tegner Activity Scale and Marx Activity Rating Scale, demonstrate weak to non-significant correlations with objectively measured MVPA ($\rho \leq 0.31$).[14] Moreover, self-reported measures frequently overestimate activity levels by 36% to 173% compared to accelerometer-based data.[9] This discrepancy indicates that perceived activity levels or successful return to sport do not necessarily reflect a healthy habitual movement profile.

Evidence in Pediatric Population

Despite the rising incidence of ACL injuries in children and adolescents, no studies were identified that objectively quantified long-term habitual physical activity in strictly pediatric or skeletally immature patients following ACLR. Existing evidence is derived from mixed “youth and young adult” cohorts, including individuals up to 25 or 35 years of age, which limits the ability to draw conclusions specific to the pediatric population.

Only a limited number of studies have utilized accelerometry to evaluate physical activity (PA) in cohorts that include younger patients, and these are restricted to short-term or early medium-term outcomes. Ezzat et al.[10] assessed 51 female athletes aged 15-23 years at 1 to 2 years following ACLR and found no significant differences in daily MVPA compared to healthy controls. However, the ACLR group reported higher levels of knee pain, reduced quality of life, and poorer functional performance.

Similarly, Romero-Padron et al.[17] evaluated 61 individuals aged 13-35 years during early (10 weeks) and mid-phase (6 months) recovery, demonstrating that lower levels of daily step count and MVPA were associated with clinically significant weight gain following surgery. Wellsandt et al.[21] in a cohort of 30 participants (mean age 19.6 years), reported significant sex-based differences, with females demonstrating lower daily step counts (7,003 vs. 10,406) and reduced MVPA (31.3 vs. 54.9 minutes per day), corresponding to approximately 219 versus 384 minutes of MVPA per week at 6 months post-surgery. However, because physical activity was evaluated only at this early post-operative stage, these findings fail to reflect long-term activity trajectories or sustained behavioral deficits. A notable contribution is the study by Kuenze et al.,[12] which specifically analyzed adolescents (15.9±1.2 years) as a separate subgroup approximately 8 months following ACLR. The authors reported that only 9.1% of adolescents met recommended aerobic physical activity guidelines, compared to 83% of adults. However, the study compared adolescents to adult ACLR patients rather than to age-matched healthy controls. As a result, it remains unclear whether the observed differences reflect the impact of ACLR or are attributable to age-related factors. Crucially, in a broader historical cohort of youth and young adults evaluated 3 to 12 years following a sport-related knee injury sustained during childhood (<18 years), Toomey et al.[25] demonstrated that previously injured individuals spent 13.5 fewer minutes per day in MVPA (~94.5 minutes per week fewer) compared to matched uninjured controls. Interestingly, injured youth substituted this lost MVPA time with light-intensity physical activity (+29.4 adjusted min/day), while sedentary time remained unchanged. Furthermore, lower MVPA participation was directly associated with worse self-reported knee function during sport and recreation. However, it is critical to emphasize that Toomey et al.[25] evaluated a heterogeneous sample encompassing all types of intra-articular knee injuries broadly, rather than an isolated, homogeneous ACLR cohort. Consequently, although informative, these findings cannot be directly extrapolated to children and adolescents undergoing ACL reconstruction.

The interpretation of these findings is limited by several methodological weaknesses. A primary concern is age heterogeneity, as most studies combine skeletally immature adolescents with adults, potentially masking age-specific biological and behavioral responses to ACLR.[1,8] Furthermore, objective data are largely restricted to short-term follow-up periods (6-12 months), providing only a snapshot of early recovery and preventing assessment of long-term behavioral adaptations after ACLR.[9,15] This limitation is particularly relevant because adult studies suggest that reductions in habitual physical activity may persist for decades after injury and reconstruction.[20] Consequently, the period during which long-term behavioral adaptations, sustained reductions in activity levels, and early risk factors for post-traumatic osteoarthritis may emerge remains largely unexplored in children and adolescents.

Additional methodological concerns include small sample sizes, potential selection bias toward higher-functioning individuals, lack of pre-injury physical activity data, and absence of assessor blinding in functional testing. Moreover, many commonly used functional tests and subjective outcome measures have been developed for adult populations and are not fully validated for pediatric patients.[26] A notable discrepancy also exists between RTS clearance and actual physical activity behavior. Although a high proportion of pediatric patients are cleared for RTS, only a subset return to their pre-injury level, and many fail to meet recommended levels of daily physical activity.[4] This indicates that successful RTS does not necessarily reflect restoration of a healthy habitual activity profile.

Overall, while preliminary evidence suggests that adolescents may be at increased risk of reduced physical activity following ACLR, current literature remains insufficient to fully characterize habitual movement patterns in this population. Consequently, the long-term influence of ACLR on physical activity trajectories from adolescence into adulthood remains unclear, with important implications for joint health and the prevention of early-onset osteoarthritis.

This gap highlights a critical need for longitudinal studies focusing exclusively on pediatric populations, incorporating objective monitoring of physical activity beyond the early postoperative period. Addressing these limitations will be essential for developing evidence-based strategies to optimize long-term recovery and physical activity levels in this high-risk population.

Clinical Implications

The findings of current research highlight the need to reconsider how recovery is evaluated following ACLR, particularly in pediatric and adolescent populations. Rather than focusing solely on RTS, greater emphasis should be placed on long-term functional recovery and habitual physical activity behavior.

Pediatric and adolescent patients face a markedly elevated risk of secondary ACL injuries, with reinjury rates ranging from 17% to 30%.[4] A substantial proportion of these injuries occur shortly after RTS, indicating that traditional clearance criteria may not adequately reflect true recovery status.[7] Furthermore, a history of ACLR significantly increases the likelihood of subsequent injury within the first two years after return to activity.[6] An important clinical consideration is that participation in sport does not necessarily indicate sufficient overall physical activity. Objective data demonstrate that many individuals fail to achieve recommended activity levels despite returning to sport participation.[9,11] This has important implications for long-term joint and general health. The absence of long-term objective monitoring data in pediatric populations further limits the ability to determine whether activity levels are successfully maintained into adulthood or progressively decline over time. Such information is essential for identifying patients at risk of inactivity, weight gain, recurrent injury, and the development of post-traumatic osteoarthritis.

Current RTS decision-making is further limited by a lack of standardized, validated criteria for pediatric populations. Time-based benchmarks (e.g., 6-9 months) are still widely used despite poor correlation with functional recovery.[27] Similarly, reliance on limb symmetry indices (LSI), often derived from adult populations, may be misleading in adolescents. Functional decline in the contralateral limb following injury may result in overestimation of recovery when using LSI thresholds.[5,28] In addition, psychological readiness-an important determinant of both RTS success and reinjury risk-is assessed in only a small proportion of pediatric studies (approximately 6%-8%).[29]

These limitations support a shift toward continuous monitoring of recovery. The integration of objective physical activity assessment using wearable technology may provide valuable insight into real-world movement patterns.

In addition, more comprehensive evaluation frameworks that include functional, behavioral, and psychological components may improve clinical decision-making and support the development of more effective, individualized rehabilitation strategies.

Future Directions

Future research should focus on addressing the limited availability of data on objectively measured physical activity following ACL reconstruction in pediatric populations. There is a need for well-designed prospective studies involving clearly defined pediatric cohorts, with follow-up extending beyond the early postoperative period in order to capture long-term changes in habitual physical activity. Standardization of objective measurement approaches, including device selection and age-specific thresholds, is necessary to improve comparability across studies.

In addition, integrating objective monitoring with functional and patient-reported outcomes may provide a more comprehensive understanding of recovery. The use of wearable technologies offers an opportunity for continuous monitoring of real-world activity patterns and may support more individualized rehabilitation strategies.

Finally, establishing clinically meaningful thresholds for physical activity in pediatric patients following ACLR remains an important objective for future research.

CONCLUSION

Current evidence demonstrates that, despite successful return to sport, adults following anterior cruciate ligament reconstruction frequently exhibit lower levels of objectively measured physical activity than healthy individuals. Research-grade accelerometry has revealed deficits in both total activity volume and moderate-to-vigorous physical activity that are not adequately captured by traditional subjective assessment tools. In contrast, evidence in pediatric populations remains extremely limited. No studies have objectively evaluated long-term habitual physical activity specifically following ACL reconstruction in strictly pediatric cohorts, and available data are largely derived from mixed-age populations with substantial methodological heterogeneity. The absence of long-term objective monitoring data represents a major gap in the literature and limits understanding of how ACL reconstruction influences physical activity trajectories from adolescence into adulthood. Future prospective studies incorporating standardized objective monitoring and age-matched control groups are needed to optimize rehabilitation strategies and improve long-term joint health outcomes in young patients.

ETHICAL DECLARATIONS

Peer Review Process

This review was externally peer-reviewed.

Conflict of Interest

The author declare no conflicts of interest.

Financial Disclosure

No financial support was received for the preparation or publication of this article.

Author Contributions

The author is solely responsible for the entirety of conception, execution, analysis, and writing of the manuscript.

REFERENCES

1. Engebretsen L, Møller M, Kooy C, Yamaguchi T, Moatshe G. The gender and sex data gap in anterior cruciate ligament injuries in paediatric patients. *Knee Surg Sports Traumatol Arthrosc.* 2024;32(10):2500-2504. doi:10.1002/ksa.12397
2. Winkler PW, Thorolfsson B, Piussi R, et al. Sport-specific concomitant injuries, return-to-sport rates and second anterior cruciate ligament injuries in adolescents with ACL reconstruction. *Br J Sports Med.* 2025; 59(13):931-940. doi:10.1136/bjsports-2024-108694
3. Brenner JS, LaBella CR, Brooks MA, et al. Sports specialization and intensive training in young athletes. *Pediatrics.* 2016;138:3. doi:10.1542/peds.2016-2148
4. Romanchuk NJ, Livock H, Lukas KJ, Del Bel MJ, Benoit DL, Carsen S. Criteria used to determine unrestricted return to activity after ACL reconstruction in pediatric and adolescent patients: a systematic review. *Orthop J Sports Med.* 2023;11(3):23259671231154540. doi:10.1177/23259671231154540
5. Magill JR, Myers HS, Lentz TA, et al. Healthy pediatric athletes have significant baseline limb asymmetries on common return-to-sport physical performance tests. *Orthop J Sports Med.* 2021;9(1): 2325967120982309. doi:10.1177/2325967120982309
6. Paterno MV, Rauh MJ, Schmitt LC, Ford KR, Hewett TE. Incidence of second ACL injuries 2 years after primary ACL reconstruction and return to sport. *Am J Sports Med.* 2014;42(7):1567-1573. doi:10.1177/0363546514530088
7. Taylor JB, Owen E, Ford KR. Incorporating workload measures into rehabilitation after anterior cruciate ligament reconstruction: a case report. *Int J Sports Phys Ther.* 2020;15(5):823-831. doi:10.26603/ijspt 20200823
8. Longo UG, Villa Corta M, Valente F, et al. Skeletal maturity assessment in pediatric ACL reconstruction. *Children (Basel).* 2025;12(9):1186. doi:10.3390/children12091186
9. Kuenze C, Collins K, Pfeiffer KA, Lisee C. Assessing physical activity after ACL injury: moving beyond return to sport. *Sports Health.* 2022; 14(2):197-204. doi:10.1177/19417381211025307
10. Ezzat AM, Brussoni M, Mâsse LC, Emery CA. Effect of anterior cruciate ligament rupture on physical activity, sports participation, patient-reported health outcomes, and physical function in young female athletes. *Am J Sports Med.* 2021;49(6):1460-1469. doi:10.1177/03635465211002530
11. Lisee CM, Montoye AHK, Lewallen NF, Hernandez M, Bell DR, Kuenze CM. Assessment of free-living cadence using ActiGraph accelerometers between individuals with and without anterior cruciate ligament reconstruction. *J Athl Train.* 2020;55(9):994-1000. doi:10.4085/1062-6050-425-19
12. Kuenze C, Collins K, Triplett A, et al. Adolescents are less physically active than adults after anterior cruciate ligament reconstruction. *Orthop J Sports Med.* 2022;10(2):23259671221075658. doi:10.1177/23259671221075658
13. Bell DR, Pfeiffer KA, Cadmus-Bertram LA, et al. Objectively measured physical activity in patients after anterior cruciate ligament reconstruction. *Am J Sports Med.* 2017;45(8):1893-1900. doi:10.1177/0363546517698940
14. Kuenze C, Cadmus-Bertram L, Pfeiffer KA, et al. Relationship between physical activity and clinical outcomes after ACL reconstruction. *J Sport Rehabil.* 2019;28(2):180-187. doi:10.1123/jsr.2017-0186
15. Manojlovic M, Roklicer R, Trivic T, et al. Objectively evaluated physical activity among individuals following anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *BMJ Open Sport Exerc Med.* 2024;10:1. doi:10.1136/bmjsem-2023-001682
16. Werner DM, Golightly YM, Rosenthal MD, et al. Relationship between changes in physical activity and knee health 18 months after ACL reconstruction. *Med Sci Sports Exerc.* 2025;57(11):2460-2467. doi:10.1249/MSS.0000000000003787
17. Romero-Padron MA, Fuentes-Rivera Tau L, Jorgensen A, Tao MA, Wellsandt EA. Body-weight changes and physical activity after anterior cruciate ligament reconstruction. *J Athl Train.* 2026;61(3):223-230. doi:10.4085/1062-6050-0124.25
18. Chomistek AK, Yuan C, Matthews CE, et al. Physical activity assessment with the ActiGraph GT3X and doubly labeled water. *Med Sci Sports Exerc.* 2017;49(9):1935-1944. doi:10.1249/MSS.0000000000001299
19. Montoye AHK, Moore RW, Bowles HR, Korycinski R, Pfeiffer KA. Reporting accelerometer methods in physical activity intervention studies: a systematic review and recommendations for authors. *Br J Sports Med.* 2018;52(23):1507-1516. doi:10.1136/bjsports-2015-095947
20. Filbay SR, Sonesson S, Kuster RP, Grooten WJA, Kvist J. Accelerometer-assessed physical activity levels 32-37 years after anterior cruciate ligament rupture: does initial treatment strategy or the presence of osteoarthritis matter? *J Sci Med Sport.* 2025;28(10):813-820. doi:10.1016/j.jsams.2025.05.001
21. Wellsandt E, Werner D, Tao M, Michaud K, Wichman C, Golightly YM. Physical activity and sedentary behavior differ by sex during the first six months after anterior cruciate ligament reconstruction. *Med Sci Sports Exerc.* 2025;57(8):1617-1625. doi:10.1249/MSS.0000000000003714
22. Shephard RJ. The objective monitoring of physical activity. *Prog Prev Med.* 2017;2:4. doi:10.1097/pp9.0000000000000007

23. Kuenze C, Lisee C, Pfeiffer KA, et al. Sex differences in physical activity engagement after ACL reconstruction. *Phys Ther Sport.* 2019;35:12-17. doi:10.1016/j.ptsp.2018.10.016
24. Armitano CN, Morrison S, Russell DM. Upper body accelerations during walking are altered in adults with ACL reconstruction. *Gait Posture.* 2017;58:401-408. doi:10.1016/j.gaitpost.2017.08.034
25. Toomey CM, Whittaker JL, Doyle-Baker PK, Emery CA. Does a history of youth sport-related knee injury still impact accelerometer-measured levels of physical activity after 3-12 years? *Phys Ther Sport.* 2022;55:90-97. doi:10.1016/j.ptsp.2022.03.003
26. Fabricant PD, Brusalis CM, Schachne JM, et al. Which metrics are being used to evaluate children and adolescents after ACL reconstruction? A systematic review. *Arthrosc Sports Med Rehabil.* 2020;2:4. doi:10.1016/j.asmr.2020.04.006
27. Forrester LA, Schweppe EA, Popkin CA. Variability in rehabilitation protocols following pediatric anterior cruciate ligament reconstruction. *Phys Sportsmed.* 2019;47(4):448-454. doi:10.1080/00913847.2019.1622472
28. Davies WT, Myer GD, Read PJ. Is it time we better understood the tests we are using for return to sport decision making following ACL reconstruction? A critical review of the hop tests. *Sports Med.* 2020;50(3):485-495. doi:10.1007/s40279-019-01221-7
29. Pauw AHJ, Buck TMF, Gokeler A, Tak IJR. Reconsideration of return-to-sport decision-making after pediatric ACL injury: a scoping review. *Sports Health.* 2023;15(6):898-907. doi:10.1177/19417381221146538