Title: Do anterior cruciate ligament injury risk reduction exercises reflect common injury mechanisms? A scoping review of the exercises contained within ACL injury prevention programs

ABSTRACT

Context: ACL injury risk reduction programs have become increasingly popular. As ACL injuries continue to reflect high incidence rates, the continued optimization of current risk reduction programs, and the exercises contained within them, is warranted. The exercises must evolve to align with new etiology data, but there is concern that the exercises do not fully reflect the complexity of ACL injury mechanisms and inciting events.

Objective: To examine if exercises designed to reduce the risk of ACL injury reflect key injury mechanisms: multiplanar movement; single limb stance; trunk and hip dissociative control; and a flight phase.

Data Sources: A systematic search was performed in PubMed, Medline, EBSCO (CINAHL), SPORTSDiscus, PEDRO databases.

Study Selection: Eligibility Criteria: 1) RCTs or prospective cohort studies, 2) male and/or female participants of any age; 3) exercises were targeted interventions to prevent ACL/knee injuries; 4) individual exercises were listed and adequately detailed and excluded if program was unable to be replicated clinically.

Study Design: Scoping review

Level of Evidence: 4

Data Extraction: 35 studies were included, and 1019 exercises were extracted for analysis.

Results: The average Consensus on Exercise Reporting Template (CERT) score was 11 (range 0-14). The majority of exercises involved bilateral weight bearing (n=418/1019; 41.0%), followed by single limb (n=345/1019; 33.9%) and non-weight bearing (n=256/1019; 25.1%). Only 20% of exercises incorporated more than 1 plane of movement, and the majority of exercises had sagittal plane dominance. Although 50% of exercises incorporated a flight phase, only half of these also involved single leg weight bearing. Just 16% of exercises incorporated trunk and hip dissociation, and these were rarely combined with other key exercise elements. Only 13% of exercises challenged more than 2 key elements, and only 1% incorporated all 4 elements (multiplanar single limb; trunk and hip dissociation; flight) simultaneously.

Conclusions: Many risk reduction exercises do not reflect the task specific elements identified within ACL injury mechanisms. Addressing the underrepresentation of key elements (e.g. trunk hip dissociation, multiplanar movements) may optimize risk reduction in future trials.

Key Terms: Exercise; hip; knee; injury prevention; neuromuscular training

What we know:

- Exercise interventions can reduce ACL injury incidence, but there is no strong evidence outlining which specific exercises are optimal and in what combination.
- Most ACL injuries involve at least one of the following key events: multiplanar movement; single limb stance; altered trunk and hip dissociative control; and flight phase (phase when both feet are off the ground at the same time).
- Greater risk reduction may potentially be achieved if exercise interventions align with etiology data.

What this study adds:

- Many of the exercises used within injury prevention programs do not reflect the task specific elements identified within ACL injury mechanisms.
- Most exercises (67%) are undertaken in either non-weightbearing or bilateral stance.
- Exercises rarely incorporate multiplanar movements (20%) or trunk and hip dissociation (16%).
- Exercises that represent elements found within the injury mechanism are underrepresented with just 1 in 8 challenging >2 key elements simultaneously.

INTRODUCTION

Anterior cruciate ligament (ACL) injuries can be devasting to athletes. In the United states, 120,000 – 200,000 ACL injuries occur every year,[37] with surgical and related costs upwards of $1-3 billion. [36,54,64] ACL injury can have both significant short-term (time away from sport) and long-term implications.

They carry a high risk of re-injury,[58] with up to 50% of patients failing to return to their pre-injury level of athletic participation.[2,3,34,49] ACL injury is also associated with a significant increased risk for post-traumatic knee osteoarthritis, which may present as early as 2 years following initial ACL reconstruction.[58] In an effort to mitigate the effects of ACL injuries, for both society at large and for the female athlete particularly, ACL injury prevention programs have become increasingly popular. It is important to note, even though there have been tremendous resources placed into the research and development of ACL injury prevention programs, ACL injuries continue at a high rate.[1,25,37,54,56,71,75] As ACL injuries continue to reflect high incidence rates, the continued optimization of current injury prevention programs is warranted.[66]

In a meta-analysis of meta-analyses, Webster and Hewett[71] found conclusive evidence that injury prevention programs reduce the risk of ACL injury by half in the female athlete. However, the risk reduction varies considerably across individual studies and it has been reported that there is insufficient data to make conclusions on the effectiveness of injury prevention programs in male athletes.[71] This inconsistency may be driven by several factors, but variations in injury prevention programs content seem to be important; with published research comprising wide combinations of strength, balance, flexibility and jump training elements. Reviews that have tried to identify which training elements are most associated with prophylactic effectiveness, have found greatest effectiveness in programs, specifically from controlled studies, emphasizing strengthening and proximal control training,[63] and some have failed to find strong evidence for an optimal and specific exercise combination.[20,34,54]

Understanding the global three-dimensional position of the athlete's body and the mechanisms which lead to ACL injuries is crucial to effectively design specific preventative exercises.[14,21] Video analysis studies[14] provide insight into the situational patterns most associated with ACL injury in sport. An analysis of 107 ACL injuries in men's soccer emphasizes the large proportion associated with: mechanical perturbation to the upper body; single leg landings; and high horizontal speeds.[14] Studies have also found that multi-directional, reactive phases of play (e.g. pressing/defending/tackling) or high speed jumping and landing events[43] were the most common inciting events.[14] These patterns largely corroborate previous research from male[70] and female[12] soccer; American Football[35] and Rugby Union.[46] There is also consistent evidence that a large proportion of ACL injury events involve large base of support to center of mass distance,[57] excessive or aberrant movements of the trunk,[33] creating knee valgus moments,[59] particularly when the lower extremity is fixed on the ground (e.g. timing related to landing from a jump).[31,43]

There is concern that current ACL prevention exercises lack complexity.[26,28,30,42,43,50,70] Although basic exercise programs are easily replicated in clinical trials, they may not adequately challenge motor learning in the athlete, and may lack context and specificity, when juxtaposed to complex injury mechanisms.[9,27,28,30] Adopting a complex approach to exercise design may invoke a non-linear interaction between varying risk-factors, ultimately preparing the athlete across multiple constructs simultaneously.[29]

Although it is injury risk reduction that is the overarching goal of these programs,[71] the name "injury prevention programs" will be used to reflect the term most often utilized in the literature that was scoped. Our primary objective was to quantify the extent to which injury prevention programs incorporate tasks which reflect common ACL injury mechanisms based on the presence or absence of: multiplanar movements; single limb stance; trunk and hip dissociative control; and a flight phase (phase of gait when both feet are off the ground at the same time).

METHODS

A systematic literature search was conducted after consulting the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) statement and the checklist completed.[69] The final protocol was registered with the Open Science

Framework on 8 April 2020 (https://osf.io/wvqxp). A scoping review design and methodology was used due to the exploratory nature of the research question. Scoping reviews aim to report concepts and theories related to knowledge gaps on a specific topic and key factors related to a concept.[47,69] Due to the nature of scoping reviews, the risk of bias assessment is not applicable and does not influence scoping review outcomes.[69] However, a measure of the quality of the reported injury prevention programs was relevant to this review. The assessment tool utilized was the Consensus on Exercise Reporting Template (CERT).[60,61] A score for each included paper on the quality of reporting the listed exercise program was recorded.

Search Strategy

A systematic literature search of the PubMed, EBSCOhost (CINAHL), Medline, Physiotherapy Evidence Database (PEDro) and SPORTDiscus databases was performed from inception to 8 April 2020, to obtain relevant studies for the review. Language was limited to English and study participants were all human. Electronic databases were searched using a combination of generalized keywords related to ACL injury prevention programs in an effort to obtain a broad search of injury prevention programs (anterior cruciate ligament* or knee injur* and prevent*). The search results are presented in the PRISMA-ScR flow diagram [Fig. 1]. A manual search of the reference lists from articles gathered during the primary search, as well as from related systematic reviews was also performed.

Eligibility Criteria

The inclusion criteria was as follows: 1) randomized controlled trials, prospective cohort studies, 2) the authors clearly stated that the exercises in the reported program were targeted interventions to prevent ACL/knee injuries or explicitly part of an ACL injury prevention program; 3) male and/or female participants of any age; 4) exercises contained in the ACL injury prevention programs must be specifically listed and the program explicitly detailed.

Study Selection

The identification of relevant articles, titles and abstracts were downloaded into EndNote X8.2 (Thomson Reuters, USA), where duplicates were removed. All relevant articles, titles, and abstracts were captured and independently screened by five authors ( ) applying the *a priori* inclusion criteria. If the abstract provided insufficient information to determine eligibility for inclusion, full text articles were then retrieved. In the case of differing assessments of the retrieved studies between the reviewing authors, the specific study was collaboratively discussed amongst the assigned author and the principal investigator ( ) and a consensus was reached. All criteria were again independently applied by the authors ( ) to the full-text articles that passed the initial screening process. If a consensus could not be reached on the decision for final inclusion, another senior author ( ) was consulted. If multiple studies included the same ACL injury prevention program, only one study was included that detailed all the specific exercises. The authors of any duplicated programs were also acknowledged in the analysis.

Quality Assessment

Consensus on Exercise Reporting Template (CERT)

The lead author ( ) randomly assigned the studies to the co-authors ( ) who extracted the intervention data and scored each program using the CERT reporting form with guidance from the Explanation and Elaboration Statement document.[60] The CERT is a 16-item checklist developed and endorsed by an international panel of exercise experts designed to assess the quality/comprehensiveness of reporting of exercise and contains seven categories: materials, provider, delivery, location, dosage, tailoring and compliance.[61] Following data extraction, any differences between reviewers were discussed and a final score was reached via a consensus meeting between the assessing author and the lead author ( ). A third reviewer ( ) was consulted when consensus could not be met initially.

Data Extraction, Analysis, and Definitions

All therapeutic exercises were extracted for data analysis from the included studies. The elements of each exercise were chosen to assess commonly reported events occurring during an ACL injury [Table 1]. In instances where the listed exercise was not clear, it was marked with an asterisk and the senior authors collaborated to determine how the exercise should be analyzed. Two senior reviewers ( ) initially analyzed all the exercises, and exercises that needed another senior reviewer, ( ) facilitated a final decision. A priori definitions were used to categorize each exercise element into the appropriate column, signifying if the element was present or not. It is acknowledged by the authors that many human movements can be argued to be multiplanar in nature, but it was the motive and intent of the prescribing author that was attempted to be captured, allowing the definitions to be as pragmatic and as relatable to a clinical context as possible. The exercise elements were defined as follows:

1. <u>Plane of Movement</u>

The exercise was analyzed to see how many planes of movement occurred to achieve the primary purpose. The knee joint has been reported to move in all three planes,[33] so this analysis sought to score if the exercises challenged the knee in multiple planes. There were three subcategories including sagittal, frontal, and transverse planes. If an exercise was identified as multiplanar, the multiplanar box was checked, and then the two or three planes were then also identified in the analysis. This analysis focused on identifying if the exercise reflected a progression to multi- or triplanar movements, which is reflective of sporting movements.[68] The highest level of complexity in this category would be an exercise that captured a multiplanar movement that included rotation in the transverse plane.

a. Sagittal Plane

The primary intent of the exercise utilized movement that occurred primarily within the sagittal plane. Exercises such as forward and backward running, jumping or hopping, and forward lunges were considered to occur primarily in the sagittal plane.

b. Frontal Plane

The primary movement of the exercise occurred within the frontal plane. An example would be a sidelying straight leg raise, and more functional type exercises such as a side shuffle or lateral hops and jumps. If a frontal plane movement occurred with a coupled movement into another plane, the additional planes of movement were credited.

c. Transverse Plane

The primary movement of the exercise occurred within the transverse plane. Seated external rotation with a band is an isolated transverse plane exercise. Exercises where the author reported at least a ¼ turn or a 90 degree rotational change of direction, was included as movement on the transverse plane.

2. Weight Bearing Status

The primary movement of the exercise was analyzed to determine how the lower extremities were contacting the ground. The analysis sought to determine if the target lower extremity was in a position of extension with the acetabulum oriented vertically over the femur in a long axis full weight-bearing position. This position rules out exercises such as bridging or quadruped as weight bearing in the context of preventing an ACL injury. The highest level of complexity in this category was single limb stance. When illustrations or written details were not provided, the authors conferred and agreed on how to score the exercise.

a. Unilateral Weight Bearing

The primary movement of the exercise had a single lower extremity contacting the ground, where the hip was in a position of extension and the acetabulum positioned over the femur in an long axis full weight bearing position. The subject performing the exercise must have been in an upright vertical position. A single limb plank, although the hip is in extension, was not considered unilateral weight bearing for this reason.

b. Bilateral Weight Bearing

The primary intent of the exercise occurred when both of the lower extremities were contacting the ground in the acetabulum over femur orientation of closed chain movement. All variations of lunges were considered to be bilateral weight bearing exercises because both feet were on the ground during the intentional phase of the exercise.

c. Non-Weight Bearing

The exercise was carried out while neither lower extremity was in a functional upright acetabulum over femur position with the feet on the ground. The category was analyzed to determine if the weight bearing position is reflective of the specific upright tasks encountered during the injury mechanism. Quadruped exercises, planks, Nordic hamstring curls and bridging were not considered weight-bearing since the method and position of delivery was not reflective of the upright position identified in the injury mechanism.

3. Trunk & Hip Dissociative Control

The authors of this review acknowledge that most any exercise or movement involves the trunk. This analysis seeks to assess if the trunk is deliberately and purposefully being involved in dissociative movements related to the pelvifemoral complex and lower extremity. The analysis was focused on the identified task, and if the exercise involved the dissociation of trunk. This element was scored as being present if there was a specific task of the trunk and pelvis, so essentially the acetabulum, is moving in a dissociative relationship with the femur. For example, how the trunk moves during single limb balance exercises on an unstable surface or during an exercise where the trunk is being utilized as a lever to dissociate its movement on a stable weight bearing extremity, as in a single limb dead lift, the trunk is purposefully moving in relation to a stable femur. The analysis was designed to identify how the trunk was moving over the femur because exercises aimed at improving trunk control may reduce ACL injury risk.[33,62,73,74]

4. *Flight Phase*

The exercise must include a phase where both lower extremities are simultaneously off the ground during the exercise. This would include any running, jumping, or hopping variations. The purpose was to identify if the exercise included a specific element of the injury mechanism, which would be a deceleratory landing phase. Injuries often occur during the landing phase, following running (which can occur in 30-100ms), thus incorporating a landing element and focusing on lower limb and trunk alignment may induce neuromuscular adaptations and activation strategies to reduce ACL injury risk.[20,65]

RESULTS

Exercise Analysis

N=1019 exercises were extracted from the 35 included studies [Table 1]. The number of exercises employed within each study varied considerably, with a median of 24 exercises per program (range 4-104). The majority of exercises involved bilateral weight bearing (n=418/1019; 41.0%), followed by single limb (n=345/1019; 33.9%) and non-weight bearing (n=256/1019; 25.1%) [Fig. 2a]. Non weightbearing exercises typically involved variations of pelvic bridges, abdominal crunches and planks. Most exercises (834/1019; 81.8%) involved movements in the sagittal plane, with just 27.3% and 10.6% involving the frontal or transverse planes respectively [Fig. 2b].

Furthermore, only 1 in 5 exercises (19.5%) incorporated more than one plane of movement. The majority of multiplanar exercises (~94%) combined movements in either the sagittal/transverse (n=86/199; 43.2%) such as jumps or lunges with a 90 or 180 degree turn in position or movements in the sagittal/frontal (n=101/199; 50.7%) such as a squat to a lateral hop or jump or single limb balance on an unstable surface. Just 2 exercises (< 0.1%), both versions of the T-test, simultaneously challenged movement in all three planes. N=518/1019 (50.8%) exercises incorporated a flight phase component, of which, just under half involved a single leg landing (n=251). The most under represented exercise element was trunk and hip dissociative control which was present in just 16.1% of all exercises (n=164/1019). 33.7% of exercises (344/1019) did not feature any of the core elements: A. multiplanar movements; B. single limb stance; C. trunk and hip dissociative control; and D. flight phase.

The Venn diagram [Fig. 3] categorizes 675 exercises, with 41.6% (281/675) challenging a single element, represented by sections A,B,C and D. The overlapping sections represent the various combinations of exercise elements. 58.3% of exercises (394/675) involved more than one element, but there is a general trend that as more elements are combined, the values in the Venn decrease. 38.5% (260/675) of exercises combined 2 elements, 16.4% (111/675) combined 3 elements, and just 3.4% (23/675) combined all four exercise elements. The most common combinations were BD (flight and single leg stance) and ABD (multi-planar, single limb stance and flight). Exercises involving trunk and hip dissociation were underrepresented.

Quality Assessment

Consensus on Exercise Reporting Template (CERT):

The CERT reporting form results [Table 2] ranged from 0 to 14 (19 total possible points) with an average score of 11.0. Most shortcomings concerned items 7a, 9, 10, 11, 14a, and 15 [Figure 4]. For calculation of the completeness of the exercise descriptions, a single score was calculated for CERT for each study. Items 1, 3, and 14a scored the highest; exercise equipment described, exercises performed individually or in a group and generic or individually tailored, each scoring affirmative in 35 of the 35 studies. None of the studies completed all items in the checklist, for a score of 19, the highest score for an individual CERT was 14, with three papers achieving the highest score.[19,23,25]

DISCUSSION

This scoping review analyzes exercises contained within ACL injury risk reduction programs. Previous reviews in this field have categorized exercise-based training components using macro elements based on the presence of absence of things such as: proximal control exercises, strength training, plyometrics, balance exercises, agility training, and flexibility.[4,34,54,56,63,67] To our knowledge, this is the first review to quantify the extent to which individual exercises comprise task-specific elements (multiplanar movements; single limb stance; trunk and hip dissociative control; and a flight phase) closely associated with ACL injury mechanism and inciting events. We analyzed an aggregate of 1019 exercises extracted from 35 studies. Overall, we found that few programs exposed athletes to the task specific injury mechanism elements identified specifically contained within this review. It was also noted that representation diminished as multiple elements were combined into a singular exercise. Incorporating multiple elements, which may increase the complexity of the exercises, has the potential to improve motor learning strategies needed to control various interactions between multiple different risk factors.

The large majority of exercises in the ACL injury prevention program literature have sagittal plane dominance (81.8%). Common examples were straight line running, squats, forward/reverse lunges, and forward/backward jumping/hopping. We acknowledge that straight ahead running was potentially used as a "warm-up" strategy versus an exercise for risk reduction. That said, if running/sprinting was listed as a clear part of the injury prevention program it was analyzed as it was reported. It could not be assumed that running exercises were only utilized as non-risk reducing activities. Adopting a shallow knee flexion angle on landing or side cutting is a key risk factor associated with ACL injuries[14] and sagittal plane exercises may help to optimize landing mechanics, allowing athletes to better absorb ground reaction forces.[6,40,51] However, we would suggest that sagittal plane movements are over represented in the current literature. ACL injuries typically involve a multiplanar event, yet only 19.5% exercises challenged athletes in more than one movement plane. The majority of multiplanar movements (~94%), utilized the sagittal/frontal plane or sagittal/transverse plane. The fewest multiplanar exercises utilized the coupling of the frontal and transverse planes. It is often reported that a primary mechanism of the ACL injury is a valgus collapse about the frontal plane coupled with a rotational component.[5,14,39,41,44,45] yet this multiplanar combination was only included in 1% (N=10/1019) of the exercises analyzed. These exercises were primarily running sideways with a carioca or crossover type of movement or stationary exercises such as a lateral lunge with a rotational twist. These exercises met the definition of a multiplanar movement, but we would suggest that they are not fully representative of a high speed deceleratory landing observed during sports.[14] Furthermore, these exercises were often in isolation and were rarely combined with the other exercise elements recognized as being present during an ACL injury (flight, single leg stance or trunk and hip control)[18] This seems to represent a reductionist approach common to many areas of musculoskeletal rehabilitation, whereby simplistic frameworks are applied to complex injury pathologies.[7,8,10,15,16,29]

It is well documented that a large proportion of ACL injuries occur in unilateral weight bearing, some authors report as high as 70% of ACL injuries.[38,46,50,70] This is not yet fully reflected in current injury prevention program literature, with 25% of exercises undertaken in non-weight bearing and 41% in bilateral weight bearing. Furthermore, many of these exercises focused on developing strength in various muscle groups, such as the quadriceps, hamstrings, hip abductors and core musculature. Although strengthening exercises remain important, we must be cognizant that isolated strengthening does not fully address many of the aberrant biomechanical patterns associated with injury.[5,55,72] Replicating the specificity of a task has been reported to potentially improve neuromotor planning.[27,28] As single leg landings with a rotary component are a commonly reported mechanism of a non-contact ACL injury,[46,50,70] it was surprising that there were so few exercises with these elements simultaneously represented.

Only 16.1% (164/1019) of exercises in ACL injury prevention programs incorporated trunk and hip dissociative control. This was also surprising as excessive or aberrant trunk movement is present in 34%-83% of ACL injuries.[14] It is postulated that aberrant trunk position alters muscle performance leading to, stiffer landings,[32] increased knee abduction moments, dynamic valgus, and ultimately excessive loading of the ACL.[31] In the current review, most trunk and hip dissociation exercises were limited to catching and throwing or single leg dead lifts. Future injury prevention programs should consider hip focused progressions training to reduce the mediolateral landing posture, aligning foot contact with trunk position,[59] whereby allowing athletes to learn to control trunk perturbations, ipsilateral lean, and counter-trunk rotation movements.[14,17]

Optimal injury reduction methods require a task specific approach, whereby exercises are progressed via specificity and optimal loading principles.[11] This means that injury prevention programs should eventually expose athletes to non-linear and task-specific challenges that are representative of the forces and loads that may occur within open-systems, such as an injury event.[53] A multidimensional exercise approach will utilize principles of dynamic systems and motor learning principles to engage the athlete in movements that complex, yet safe and achievable.[11] The exercises should progress the athlete towards movements that will be encountered during sport, while ensuring a high quality of task performance with a criteria based approach.[11,18] This review clearly identifies that the current literature lacks many important exercise progressions and does not fully reflect the elements found within ACL injury mechanisms and inciting events. The progression from uniplanar to multiplanar movements, and from bilateral to unilateral stance were underrepresented. The collective integration of all key exercise elements was rare, and we found just <1% of exercises incorporating flight, single leg rotary loading, whilst simultaneously challenging the trunk, pelvis, and hip control beyond the sagittal plane.[13,19,23-25,48,51]

Lastly, when reporting and developing exercise-based interventions, the Consensus on Exercise Reporting Template (CERT) is an available tool.[60] Programs designed to reduce the numbers of ACL injuries have inherent limitations that have been highlighted by utilizing the CERT scoring method. Programs to prevent ACL injuries are typically generically implemented to large groups, lacking individualization, without progression decisions being reported. Improved reporting of programs is critical to move forward in the quality and completeness of ACL injury prevention programs. A key limitation of the existing injury prevention program literature, however, is that few papers have published programs that are considered thoroughly reported according to the CERT scoring guidelines. This contributes to the known implementation challenges of intervention, individuality, adaptation, and fidelity.[22] Since many of the injury prevention programs reported here were published prior to the development of the CERT, there should be an improvement with the reporting of exercise programs moving forward.

Limitations

The authors of this review acknowledge the multidimensional nature of an ACL injury, and the complex interactions between both modifiable and non-modifiable risk factors as well as considering other infinite combinations of complex variables such as feedback, dosage, sport, age, and sex.[26,52] This review only focuses on a specific portion of the exercise prescription and methods which is based on core elements associated with ACL injury. The current literature is based primarily on more basic, preliminary exercises, we acknowledge the challenges associated with implementing task specific exercises. For example, these exercises may require increased supervision to ensure appropriate performance, potentially making it less desirable for coaches and clinicians to implement, consequently, affecting fidelity. It is also a consideration that exercises reflective of injury mechanisms should be added as optimizing adjunctive exercises, and should not be the sole focus of the program, which will avoid the program becoming so targeted they fail to provide a large enough “blanket effect” to reach a wide variety of sports.

CONCLUSION

Current injury prevention programs have reported reductions in injury, but the exact mechanism under which they reduce risk is unclear. Perhaps, optimal risk reduction in this field may require exercise progressions which culminate in movements that more closely resemble the mechanism of an ACL injury. This should ultimately include exercises which simultaneously integrate multiplanar movements, dissociative control between the trunk and hip, during single leg landings. Whilst it is pragmatic that more functionally task specific exercises would be associated with greater risk reduction, high quality prospective trials are warranted, prior to potential adoption and implementation.

Figure Legend:

Fig.1 PRISMA-ScR

Table 1. Exercise Analysis

Fig. 2a- Weight Bearing

Fig. 2b- Planes of Movement

Table 2. CERT Scoring

Fig. 3- Venn Diagram of Exercise Elements

Fig. 4 CERT Scoring Summary

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