

# In Silico Comparative Evaluation of a Deterministic Structural-Load Monitoring Architecture in Simulated Athlete Careers

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**Scale:** canonical configuration of 250,000 athletes per arm across 30 declared trial seeds

**Research posture:** simulation-backed comparative study; no clinical, epidemiological, or deployment claim

## Abstract

**Background.** This manuscript asks whether the LAKANA SSI architecture outperforms the simulator's industry comparator on the primary comparative endpoints defined by the canonical outputs analyzed here.

**Methods.** A deterministic structural-load monitoring architecture was evaluated against an industry comparator in a step-level Monte Carlo simulator of athlete careers. The declared canonical configuration uses 250,000 athletes per arm and 30 trial seeds. The analyzed materials include aggregate summaries for paper-facing comparative endpoints, a survival-summary export, supplementary materials used for consistency checks and empirical-posture review, and arm-level exports used for descriptive exit composition and subgroup views. The engine models five competitive strata with stratum-specific exposure and event-propensity parameter families. The same materials indicate bounded empirical grounding while also showing that current external calibration remains partial and surrogate-assisted.

**Results.** Within the analyzed simulator outputs, SSI exceeds the industry comparator on the primary comparative endpoints emphasized in this paper: longer simulated careers (0.532 vs. 0.267 years), lower ACL burden (0.210 vs. 1.680 events), higher simulator-internal recognition ratio (0.968 vs. 0.777), faster simulated commotio recognition latency (0.372 vs. 3.817 s), fewer days missed per simulated career-year (80.9 vs. 844.8), and more completed seasons (0.098 vs. 0.009). The exported survival summary

also reports an industry-vs.-SSI hazard ratio of 2.685 [2.670, 2.700] in the analyzed run summary. These gains are not universal improvements. Secondary burden metrics are higher under SSI, including chronic days (33.3 vs. 9.60), restricted days (22.2 vs. 5.19), hard-stop days (0.494 vs. 0.000), heat-event burden (0.0759 vs. 0.0515), soft-tissue burden (0.0553 vs. 0.0245), and peak core heat (2.876 vs. 2.332). The arm-level exports also show a marked shift in exit composition from ACL-dominant exits in the industry comparator toward attritional exit under SSI.

**Conclusions.** Within this simulator configuration, SSI improves the primary comparative endpoints that define structural preservation while also increasing chronic, restriction, and attritional burden under longer monitored careers. The paper is therefore best read as a simulation-backed comparative study with explicit burden-shift disclosure, not as a claim of clinical validation, real-world efficacy, or universal superiority.

## 1 Introduction

Continuous physiological and biomechanical monitoring has become a prominent theme in sports medicine and athlete-performance technology, . Yet monitoring systems are often discussed as though their value could be summarized by a single endpoint such as injury reduction, workload reduction, or return-to-play timing. That framing is too coarse for the present study. In the analyzed materials, athlete careers terminate through multiple competing exit pathways, and an architecture that attenuates one dominant failure mode can reallocate burden into later chronic, restrictive, and attritional outcomes rather than uniformly improving every metric.

The central question is accordingly narrower and more technical: how does SSI perform relative to the simulator’s industry comparator within the declared canonical configuration? The answer supported by the analyzed outputs is comparative rather than universal. SSI outperforms the comparator on the primary endpoint family emphasized here: simulated career duration, ACL burden, simulator-internal recognition ratio, simulated commotio recognition latency, days missed per simulated career-year, and completed seasons. At the same time, the same outputs show higher chronic burden, higher restriction burden, nonzero hard-stop burden, higher heat burden, higher soft-tissue burden, higher peak core heat, and a marked shift in exit composition toward attritional exit.

That joint pattern is the manuscript’s main scientific value. The paper is strongest when it states the primary improvements precisely, reports the adverse burden shifts with equal visibility, defines the simulator metrics carefully, and remains explicit about what the evidence does not establish. Nothing in the analyzed materials supports a claim of clinical validation, external epidemiological calibration, or field readiness. The contribution is a source-constrained, simulation-backed comparative account of what this deterministic monitoring architecture does and does not improve inside the simulator.

## 2 Study posture and scope

This paper should be read as a simulation-backed comparative study. The comparator is the simulator’s industry baseline. The intervention arm is SSI, a deterministic monitoring architecture that tracks structural-load and physiological status and can impose restriction and protective terminal states under higher-risk conditions. The canonical run manifest declares 30 trial seeds and 250,000 athletes per arm. Aggregate summaries provide the paper-facing numerical basis for the headline comparative table, while arm-level exports provide descriptive views of exit composition and subgroup contrasts. Those arm-level views improve interpretability but are not used here to elevate the study into a formal subgroup interaction analysis.

Four guardrails govern the manuscript. First, all findings are conditional on the analyzed simulator configuration. Second, simulator-internal alignment and recognition metrics are not clinical diagnostic-accuracy claims. Third, rare-event outputs remain secondary side-harness estimates under simulator priors rather than empirical validation. Fourth, the supplementary materials strengthen the empirical-language posture by documenting preserved empirical support records, but they do not convert bounded surrogate-assisted integration into external calibration or field proof.

## 3 Simulator and comparison design

LAKANA SSI v7.6 is implemented here as a step-level Monte Carlo simulator of athlete careers from draft entry to a bounded career horizon. Each simulated career evolves through repeated state updates spanning load, physiology, environment, fatigue, and competing exit hazards. Career termination is recorded under a small set of modeled exit categories, including structural failure, attritional exit, rare catastrophic heat-related and ECAST-like outcomes, and age limit. Those categories are available directly in the arm-level exports used for descriptive interpretation in this paper.

SSI and the industry comparator share the same exogenous environment and athlete-state framework, but the intervention logic differs. The industry arm follows the simulator’s baseline pathway. SSI applies a deterministic protective monitoring policy that can impose graded restriction and terminal stop states under higher-risk conditions. That distinction matters because the intervention can attenuate acute structural-failure pathways while also introducing restriction and stop burdens that the comparator does not structurally impose.

The simulator also models subgroup heterogeneity internally. Five competitive strata are represented in the analyzed materials, each with distinct exposure, biomechanical stress, and event-propensity parameter families. The pooled SSI-versus-industry contrasts are therefore not generated by a homogeneous athlete population. The arm-level exports preserve subgroup identity, permitting a descriptive subgroup view.

Empirical support is enabled in bounded form. The supplementary materials indicate that the analyzed materials preserve empirical support records and dataset provenance. The same materials also state that current integration remains surrogate-assisted for available structured datasets, and that some reference resources may be documented without direct numerical ingestion when no structured table is available. The proper methods posture is therefore bounded empirical support, not external validation.

## 4 Endpoint definitions and metric semantics

**Career duration / years.** Career duration records simulated years accumulated before terminal exit. It should be interpreted comparatively within the simulator, not as a literal mapping to professional sports careers. Because the configured hazard regime is intentionally severe, relative contrasts are more informative than absolute duration.

**Hazard ratio.** The exported survival summary reports an industry-vs.-SSI hazard ratio of 2.685 with a 95% interval [2.670, 2.700]. Within the simulator, this summarizes comparative exit-rate behavior between the industry and SSI arms under the modeled hazard structure. It is not a real-world hazard ratio for athlete populations, and the available materials do not include a separate Fine-Gray or cause-specific Cox analysis.

**ACL burden.** ACL burden is the mean number of simulator-defined ACL structural-failure events per athlete. It is a headline endpoint because ACL failure is the dominant early exit pathway in the industry comparator within the analyzed arm-level exports. It is not a real-world injury-prevention claim.

**Recognition ratio.** Recognition ratio is a simulator-internal state-alignment metric reflecting how often the monitoring pathway assigns supportive recognition on eligible opportunities. It should be interpreted as internal monitoring performance, not as clinical diagnostic correctness.

**Commotio recognition latency.** Commotio recognition latency is the mean delay for detected simulator-defined commotio-like events. When no such event is detected for a given athlete, the underlying record is undefined for that athlete and contributes only through the aggregate procedure used by the engine. The manuscript therefore treats this as a simulated system-latency metric rather than as a validated emergency-response time in real athletes.

**Days missed per simulated career-year.** Days missed per simulated career-year is a normalized burden rate obtained by dividing total missed days by accumulated simulated career years. For that reason, values can exceed 365 when missed-day accumulation is divided by a short simulated career. It is a rate internal to the simulator, not a literal count of calendar days in a real season.

**Completed seasons.** Completed seasons is a simulator-specific measure of near-season completion and should be read as a career-completeness metric

internal to the model rather than as a direct count of real sports seasons.

**Chronic days, restricted days, and hard-stop days.** Chronic days and restricted days represent simulator-defined burden accumulation. Hard-stop days represent intervention-imposed terminal stop states. The industry comparator records zero hard-stop days in these materials because it does not apply the same protective intervention class.

**Heat burden, soft-tissue burden, and peak core heat.** These metrics quantify simulator-defined heat-event counts, soft-tissue event counts, and maximal core-heat excursion. They matter because an architecture can improve acute structural outcomes while still exposing longer-lived simulated careers to more chronic and environmental burden.

**Exit composition.** Exit composition is reported descriptively from the arm-level exports. In this manuscript, cause-share is not used as a formal competing-risks regression result. It is an explicit descriptive view of how careers end in each arm and is central to interpreting why the primary endpoint improvements coexist with increased chronic and attritional burden.

## 5 Evidence base and reproducibility posture

The manuscript uses only the analyzed source materials. The main paper-facing numerical base is the aggregate comparative summary plus the exported survival-summary JSON. Supplementary materials provide consistency checks on file presence, summary alignment, required metrics, empirical-posture indicators, and rare-event side outputs. The run manifest provides the canonical configuration, including the 30-seed setup and empirical-study posture. The arm-level exports are used for descriptive exit composition and subgroup views because they contain per-athlete exit-category and stratum fields that are not visible in the compact aggregate table alone.

This evidence structure matters for interpretive discipline. The headline comparative table is derived from the aggregate summary file. The exit composition and subgroup descriptive figures are derived from the arm-level exports. The rare-event CSV is retained as secondary evidence only. The supplementary materials support internal consistency and confirm the presence of empirical support records. They do not validate the simulator externally. Reproducibility in this manuscript is therefore artifact-constrained rather than full-engine-open.

## 6 Primary comparative results

Table 1 reports the main comparative endpoint family from the aggregate summary file. The pattern is coherent and one-sided on the outcomes treated here as primary. SSI careers are longer, ACL burden is markedly lower, simulator-internal recognition is higher, commotio-like recognition latency is faster, days

Table 1: Primary comparative endpoints from the aggregate summary file.

Metric	SSI	Industry	Delta (SSI – Industry)
Career duration (years)	0.532	0.267	0.266
ACL burden	0.210	1.680	-1.470
Recognition ratio	0.968	0.777	0.191
Commotio latency (s)	0.372	3.817	-3.445
Days missed per simulated year	80.86	844.8	-764.0
Completed seasons	0.098	0.0095	0.089

missed per simulated career-year are much lower, and completed seasons are more frequent. Figure 1 makes this visually explicit.

The ACL contrast deserves special emphasis because it is both large and structurally important to the simulator’s exit structure. The aggregate summary reports a reduction from 1.680 ACL events per athlete under the industry comparator to 0.210 under SSI. This is consistent with the architecture’s comparative role in attenuating acute structural-failure pathways. The days-missed-per-year result is equally important because it shows that the burden rate normalized by career duration also favors SSI despite longer careers. The recognition-ratio and commotio-latency improvements require more careful wording: they indicate stronger simulator-internal monitoring performance, not validated diagnostic accuracy.

The exported survival summary reinforces the same story. It reports an industry-vs.-SSI hazard ratio of 2.685 with a narrow interval [2.670, 2.700]. Within the simulator, that means the industry comparator exits more quickly than SSI under the modeled hazard structure. Because the available materials do not include a full competing-risks regression or a separate per-seed hazard table, we treat this as a simulator-emitted comparative survival summary rather than as a richer survival-modeling contribution.

## 7 Secondary burden, exit composition, and burden-shift results

The adverse findings are neither minor nor optional. Table 2 reports the burden metrics that worsen under SSI in the aggregate summaries. Figure 2 makes the same pattern graphically explicit.

These increases are consistent with a simulator regime in which acute catastrophic structural failure is attenuated while longer monitored careers accumulate more chronic and attritional burden. Hard-stop burden appears only in SSI because the intervention arm includes a protective terminal-state class absent from the industry comparator. Restricted and chronic burden can rise for the same reason that completed seasons and career years rise: the simulator is allowing more

Primary comparative endpoints from the attached simulator-emitted summaries

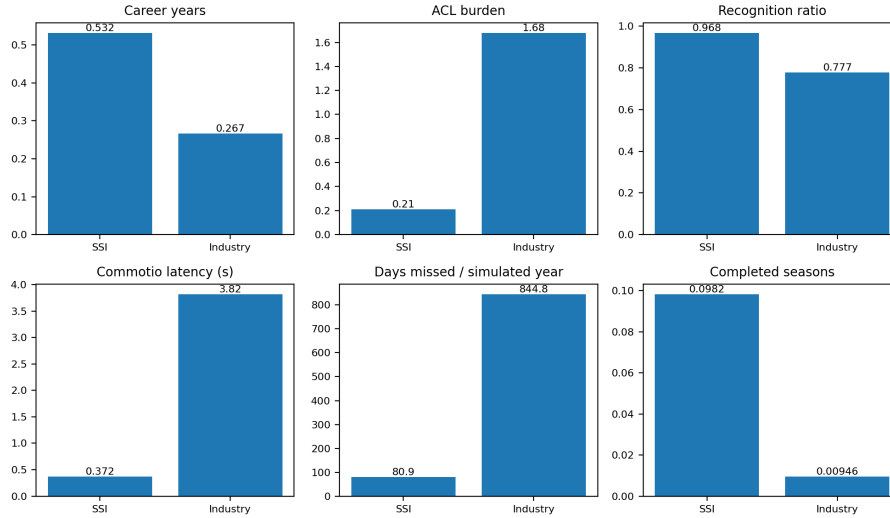


Figure 1: Primary comparative endpoints from the simulator-emitted summaries. The figure leads with the metrics that define the paper’s headline comparative claim: SSI exceeds the industry comparator on career duration, ACL burden reduction, simulator-internal recognition ratio, simulated commotio latency, days missed per simulated career-year, and completed seasons. These are simulator-defined outputs and should not be read as clinical or field-efficacy estimates.

careers to persist under monitored restriction rather than terminating them early through ACL-dominant exit.

The shift in exit composition is the clearest descriptive expression of that burden transition. Table 3 and Figure 3 show that the arm-level exports are ACL-dominant in the industry comparator and attritional-exit dominant in SSI. In the analyzed exports, ACL failure accounts for 79.156% of industry exits but only 5.637% of SSI exits. The attritional-exit category moves in the opposite direction, rising from 20.844% in the industry comparator to 94.271% under SSI. Rare catastrophic categories remain rare, but the exports show a heat-catastrophe signal only under SSI and one ECAST-like catastrophe only under SSI. Those rare catastrophic asymmetries must be disclosed explicitly because a skeptical reviewer will notice them immediately.

The point is not that chronic or heat-related metrics are harmless. They are part of the simulated intervention’s cost structure. What matters scientifically is that the primary endpoint gains and the secondary burden increases coexist in a coherent pattern. The simulator is consistent with attenuation of acute structural-failure pathways and an accompanying increase in chronic degradation,

Table 2: Secondary or adverse burden metrics from the aggregate summary file. Positive deltas indicate higher burden under SSI.

Metric	SSI	Industry	Delta (SSI – Industry)
Chronic days	33.31	9.600	23.71
Restricted days	22.24	5.194	17.04
Hard-stop days	0.494	0.0000	0.494
Heat-event burden	0.076	0.052	0.024
Soft-tissue burden	0.055	0.024	0.031
Peak core heat	2.876	2.332	0.544

Table 3: Overall exit composition shares from the arm-level simulator exports. These shares are descriptive within the analyzed exports and are used to interpret burden structure rather than to claim formal competing-risks regression.

Terminal cause	SSI share	Industry share	Delta share
ACL failure	5.637%	79.156%	-73.519%
Degenerative attrition	94.271%	20.844%	73.427%
Heat catastrophe	0.091%	0.000%	0.091%
ECAST catastrophe	0.000%	0.000%	0.000%

restriction, and attritional exit burden under longer monitored exposure.

## 8 Descriptive subgroup view from the arm-level export

Because the engine models five competitive strata and the arm-level exports preserve subgroup identity, the analyzed materials permit a descriptive subgroup view. This matters because it shows that the pooled results are not generated by a homogeneous athlete population. However, the current materials do not provide a formal subgroup interaction analysis or a complete cross-seed subgroup panel, so the subgroup material remains secondary and descriptive rather than a new primary estimand.

Table 4 summarizes the arm-level export by stratum. SSI improves career years and reduces ACL burden in every modeled stratum in this descriptive view. The days-missed-per-year delta also favors SSI in every stratum. Chronic burden increases in every stratum, with particularly large chronic-day increases in some speed-oriented strata. Figure 5 visualizes the same directional pattern.

The shift in exit composition is also visible by stratum. In the arm-level export, every stratum moves away from industry ACL-dominant exit toward SSI attritional-exit dominance, although the magnitude differs. RB retains the highest residual SSI ACL share (29.39%), while several other strata become

Secondary/adverse burden metrics from the attached simulator-emitted summaries

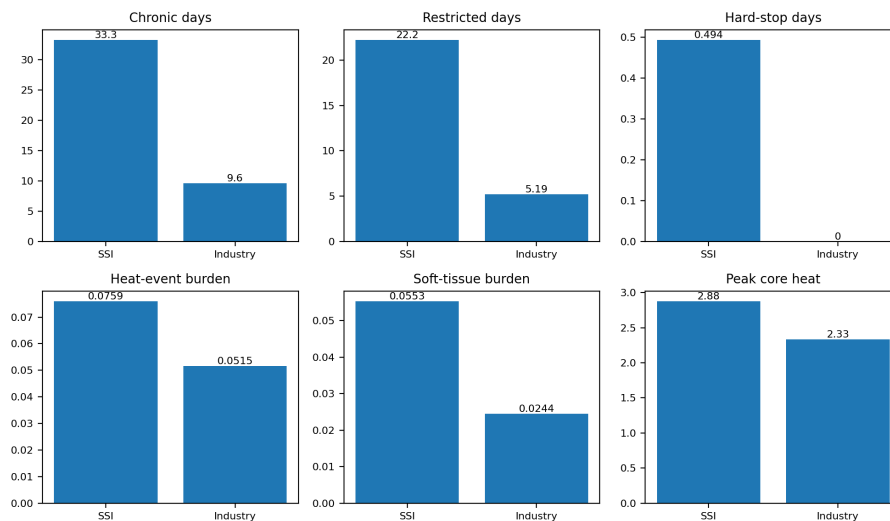


Figure 2: Secondary/adverse burden metrics from the simulator-emitted summaries. SSI carries higher chronic, restricted, hard-stop, heat-event, soft-tissue, and peak-core-heat burden. These negative findings are part of the central interpretation of the manuscript and are not relegated to a footnote or supplement.

almost entirely attritional-exit dominated. That pattern does not warrant a strong causal subgroup claim, but it does strengthen the interpretation that the pooled shift in exit composition is not a single-position artifact.

## 9 Discussion

The strongest honest claim this paper can make is comparative: within the analyzed simulator configuration, SSI outperforms the industry comparator on the primary endpoints that matter most for structural preservation. Careers are longer. ACL burden is much lower. Simulator-internal recognition is stronger. Commotio-like latency is faster. Burden normalized by career-year is lower. Completed seasons are more frequent. But that is not the whole story.

The same outputs also show more chronic days, more restriction days, nonzero hard-stop burden, more heat burden, more soft-tissue burden, and higher peak core heat. Exit composition shifts accordingly. The industry comparator exits early and catastrophically through ACL failure. SSI suppresses that pathway and leaves more careers exposed to longer attritional trajectories. The simulator therefore does not support a universal-improvement story. It supports a more disciplined statement: the architecture attenuates acute structural-failure

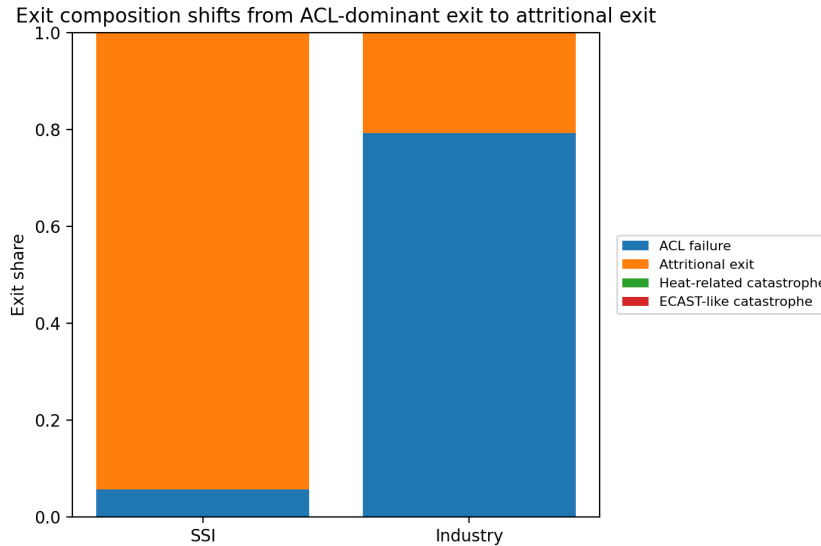


Figure 3: Exit composition in the arm-level simulator exports. Industry exits are ACL-dominant, whereas SSI exits are overwhelmingly attritional-exit dominant. This figure does not establish a formal competing-risks regression result; it makes the burden-shift structure of the simulator output legible.

pathways while allowing more chronic and attritional burden to accumulate over longer monitored careers.

That interpretation also clarifies the hard-stop metric. Hard-stop burden is not merely an adverse side effect; it reflects a more protective intervention class than the comparator. Within the simulator, part of the structural-preservation advantage is achieved through restrictions and terminal protective states that the comparator does not apply. The manuscript should therefore disclose that trade directly and allow readers to judge whether the exchange is favorable within the simulator.

The subgroup descriptive view supports this interpretation without overextending it. Because every modeled stratum in the analyzed export shows the same directional pattern on the most important primary endpoints, the pooled comparative story does not look like an artifact of any single competitive stratum. At the same time, the subgroup evidence remains descriptive because the available materials do not include a full interaction analysis or a complete per-seed subgroup panel.

The empirical-support posture also becomes clearer when stated conservatively. The supplementary materials improve the methods posture by documenting preserved empirical support records and dataset provenance. But their warnings remain binding. Empirical integration is bounded and surrogate-assisted. Rare-

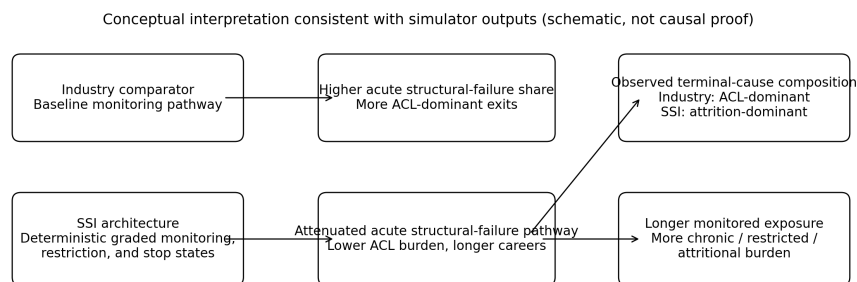


Figure 4: Conceptual schematic consistent with the simulator outputs. The schematic is explanatory rather than inferential: it shows one disciplined interpretation of how deterministic protective monitoring can reduce ACL-dominant early exit while allowing longer careers to accumulate chronic, restriction, and attritional burden. It is not a causal proof beyond the simulator outputs themselves.

Table 4: Descriptive subgroup contrasts from the arm-level simulator export. Negative deltas for ACL and days missed/year favor SSI; positive chronic-day deltas indicate higher chronic burden under SSI.

Stratum	SSI yrs	Ind yrs	$\Delta$ yrs	SSI ACL	Ind ACL	$\Delta$ ACL	$\Delta$ missed/yr	$\Delta$ chronic
QB	0.601	0.394	0.208	0.003	1.476	-1.472	-371.1	22.9
WR	0.493	0.186	0.307	0.306	1.884	-1.578	-978.2	25.3
RB	0.413	0.136	0.277	0.880	1.947	-1.067	-1364.3	20.3
DB	0.545	0.235	0.310	0.034	1.820	-1.786	-728.9	27.6
OL/DL	0.601	0.413	0.189	0.003	1.243	-1.240	-381.8	19.7

event outputs are side-harness estimates under simulator priors. Recognition-like metrics remain simulator-internal. Nothing in the analyzed evidence turns this into a clinically validated or field-validated system.

## 10 Limitations

This manuscript deliberately preserves the study’s real limitations rather than softening them. All claims are conditional on the analyzed LAKANA SSI v7.6 simulator outputs and do not constitute clinical validation, epidemiological calibration, or field validation. The absolute scale of simulated career duration remains configuration specific. A mean career duration of roughly 0.27–0.53 simulator-years is not a literal mapping to real professional careers; it reflects the configured hazard regime. For the same reason, normalized burden metrics such as days missed per simulated career-year must not be read as calendar days

Descriptive subgroup contrasts from the attached arm-level simulator export

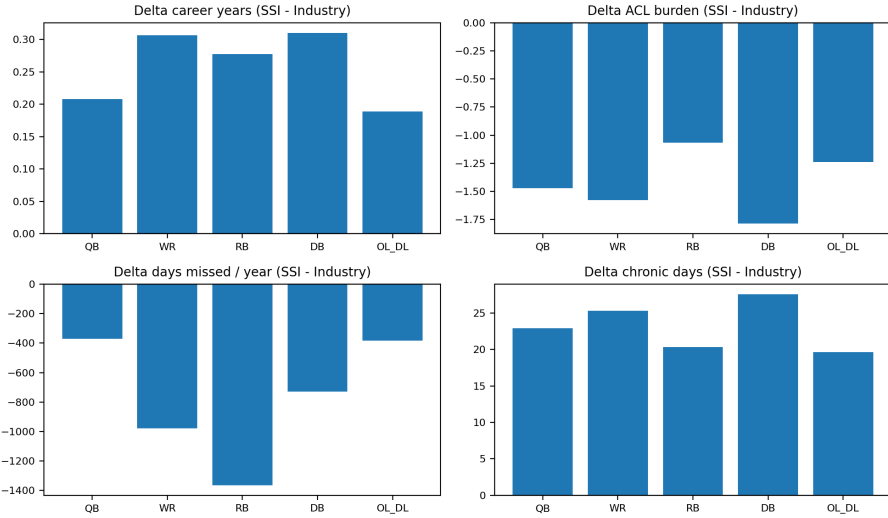


Figure 5: Descriptive subgroup contrasts from the arm-level simulator export. The subgroup view remains secondary because the available materials do not include a formal subgroup interaction analysis or a complete per-seed subgroup table. Its value is interpretive: every modeled stratum shows longer careers and lower ACL burden under SSI, while chronic burden increases across strata.

in real seasons.

The survival comparison is descriptive rather than maximally formal. The exported summary provides a hazard-ratio style survival contrast, and the cited methodological literature discusses proper competing-risks analysis , , , . However, the available materials do not include a formal Fine–Gray subdistribution hazard model or a cause-specific Cox model. Cause-share results are therefore descriptive and interpretive rather than formal competing-risks regression outputs.

Empirical integration is present but bounded. The supplementary materials indicate preserved empirical support records, yet they also warn that integration is surrogate-assisted for available structured datasets and does not by itself establish external validation. Rare-event outputs remain secondary side-harness estimates under simulator priors and should not be promoted into headline efficacy claims.

The subgroup material is informative but secondary. The engine models strata internally and the arm-level exports support a descriptive subgroup view, but the available materials do not provide a complete formal subgroup interaction analysis. Subgroup results should therefore be interpreted as descriptive evidence of heterogeneity rather than as a definitive ranking of subgroup-specific

Table 5: ACL-failure and degenerative-attribution shares by stratum from the arm-level simulator export.

Stratum	SSI ACL	Industry ACL	SSI degenerative	Industry degenerative
QB	0.00%	64.95%	99.92%	35.05%
WR	5.48%	91.88%	94.45%	8.12%
RB	29.39%	96.08%	70.53%	3.92%
DB	0.08%	87.90%	99.86%	12.10%
OL/DL	0.00%	51.93%	99.85%	48.07%

performance.

Finally, the exit composition and catastrophic-event asymmetries require caution. The arm-level exports show heat catastrophe and a single ECAST catastrophe only under SSI. These outputs are too rare to support broad real-world inference, but they are too important to omit. The correct posture is explicit disclosure with simulator-grounded interpretation rather than either suppression or overstatement.

## 11 Conclusion

Within the analyzed simulator outputs, SSI outperforms the industry comparator on the primary comparative endpoints that define this paper: career duration, ACL burden, simulator-internal recognition ratio, simulated commotio recognition latency, days missed per simulated career-year, and completed seasons. Those gains are substantial and structurally coherent. They are also incomplete as a story unless the secondary burdens are stated with equal clarity. The same outputs show more chronic burden, more restriction burden, nonzero hard-stop burden, more heat burden, more soft-tissue burden, higher peak core heat, and a shift in exit composition from ACL-dominant exit toward attritional exit.

The strongest truthful interpretation is therefore not universal improvement but acute structural preservation accompanied by increased chronic and attritional burden under longer monitored careers. That burden-shift pattern is the central finding supported by the current simulator evidence. The paper is strongest when it makes that pattern easy to see, hard to misread, and impossible to confuse with clinical validation or field proof.

## Author and disclosure statements

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**Use of generative AI language tools.** Generative AI language tools, including ChatGPT, Gemini, and Claude, were used during manuscript preparation for

drafting support, wording refinement, structural editing, and editorial hardening. These tools were also used, where applicable, to assist with workflow tasks in the broader Monte Carlo reporting process. All manuscript text, references, numerical claims, and source-linked statements were reviewed by the author against the analyzed materials before inclusion. The author retained full responsibility for scientific content, interpretation, verification, and final approval of the manuscript. The reported manuscript metrics, tables, and figures were emitted by the simulator and were not generated by the language model.

**Author contributions.** M.F. conceived the study, defined the analysis posture, reviewed the analyzed materials, verified the reported claims against those materials, wrote and revised the manuscript, and approved the final version.

**Data availability.** The manuscript is based on the analyzed source materials, including canonical simulator-emitted aggregate summaries, summary outputs, figure files, supplementary materials, and arm-level exports. The headline comparative metrics reported in the main text come from the canonical paper-facing simulator outputs. Secondary descriptive cause-share and subgroup views use the arm-level exports and are labeled as such.

**Code and materials availability.** The reported tables and figures are derived from the analyzed LAKANA SSI v7.6 source materials. The released materials are sufficient to recheck the reported calculations and provenance statements. Full engine source and protected implementation details sufficient to reconstruct the proprietary decision process are not released in this manuscript. That boundary limits independent rerun reproducibility of the full engine, but it does not alter the source-constrained claim set reported here.

**Conflict of interest.** The author reports an affiliation with LAKANA Systems, the organization associated with the simulated architecture studied in this manuscript.

**Ethics and human-participant scope.** This work reports simulator-generated outputs only. It did not involve human participants, identifiable personal data, or intervention on human subjects.

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