The influence of playing surface on the loading response to soccer-specific activity

Adam Jones, Dr Richard Page, Dr Chris Brogden, Dr Ben Langley and Dr Matt Greig

Abstract

Context: The influence of playing surface on injury risk in soccer is contentious, and contemporary technologies permit an in-vivo assessment of mechanical loading on the player. ***Objective:*** To quantify the influence of playing surface on the PlayerLoad elicited during soccer-specific activity. ***Design:*** Repeated measures, field-based. ***Setting:*** Regulation soccer pitches. ***Participants:*** 15 amateur soccer players (22.1 ± 2.4 yrs), injury free with ≥ 6 yrs competitive experience. ***Interventions:*** Each player completed randomised order trials of a soccer-specific field test on natural turf, astroturf and third generation artificial turf. GPS units were located at C7 and the mid-tibia of each leg to measure triaxial acceleration (100Hz). ***Main Outcome Measures:*** Total accumulated PlayerLoad in each movement plane was calculated for each trial. Ratings of perceived exertion (RPE) and visual analogue scales (VAS) assessing lower-limb muscle soreness were measured as markers of fatigue. ***Results:*** ANOVA revealed no significant main effect for playing surface on total PlayerLoad ($P = 0.55$), distance covered ($P = 0.75$), or post-exercise measures of RPE ($P = 0.98$) and VAS ($P = 0.61$). There was a significant main effect for GPS location ($P < 0.001$), with lower total loading elicited at C7 than mid-tibia ($P < 0.001$), but with no difference between limbs ($P = 0.70$). There was no unit placement *x* surface interaction ($P = 0.98$). There was also a significant main effect for GPS location on the relative planar contributions to loading ($P < 0.001$). Relative planar contributions to loading in the AP:ML:V planes was 25:27:48 at C7 and 34:32:34 at mid-tibia. ***Conclusions:*** PlayerLoad metrics suggest that playing surface does not influence mechanical loading during soccer-specific activity (not including tackling). Clinical reasoning should consider that PlayerLoad magnitude and axial contributions were sensitive to unit placement, highlighting opportunities in the objective monitoring of load during rehabilitation.

Key Words: PlayerLoad, soccer, injury, playing surface

Introduction

Soccer is characterised by an irregular, intermittent, and multi-directional activity profile, increasing the complexity of its mechanical demands. The mechanical demands of soccer and subsequent injury risk might be further influenced by the nature of the playing surface,[1] an extrinsic risk factor for soccer injury that has received relatively little consideration. Soccer is traditionally performed on natural turf,[2] but artificial surfaces are increasingly being used for both training and match-play due to greater consistency of the playing surface, greater availability in respect to climatic challenges, and reduced maintenance costs. However, each variation of playing surface will having specific characteristics and mechanical properties,[3] with implications for mechanical loading and subsequent risk of injury.[4]

Reviews of the literature have typically reported no difference in overall incidence rates between natural and artificial playing surfaces.[5,6] However, the incidence of ankle injuries has been associated with an increased risk on artificial surfaces.[7-12] Increased ankle inversion and external rotation during cutting movements have been reported on artificial surfaces,[1] with the task chosen to reflect the common mechanism of injury in soccer. The influence of playing surface on injury risk might therefore be specific to injury site and type, in part explaining the equivocal nature of the epidemiology literature.

Contemporary developments in GPS-based micro-technologies such as the tri-axial accelerometer have provided an in-vivo measure of external loading in sports such as soccer.

[13,14] Brown and Greig used tri-axial accelerometry to retrospectively analyse the loading response to a lateral ankle sprain injury sustained by a professional soccer player.[15] When compared with the squad mean for the same training session, the injured player elicited increased magnitude of loading in the mediolateral plane. The loading pattern was consistent with the mechanism of lateral ankle sprain injury and highlights potential association between loading response and injury risk. Total loading as relates to accumulated workload via exposure to training and competition has also been strongly associated with injury occurrence in elite youth soccer,[16] and collegiate football.[17]

The GPS unit is typically worn in a customised vest which positions the accelerometer at approximately C7, a location primarily based upon enhancing satellite reception for the GPS-derived analysis metrics. However, recent studies have highlighted the sensitivity of loading magnitude to unit placement, with alternative sites being developed in response to specific injury risk.[18,19] In a sport-specific example, Greig and Nagy compared C7 vs L5 loading given the prevalence of lumbar injuries in cricket fast bowlers.[18] In relation to the high prevalence of ankle injuries in soccer, Greig et al. recently used a mid-tibia placement to quantify loading during functional rehabilitation tasks aligned to ankle sprain injury.[19] The mid-tibia site was selected as providing anatomical relevance to the ankle (given the prevalence of ankle sprain injury in soccer), without constraining movement. Furthermore, the PlayerLoad metric can be calculated in each axial plane, providing greater richness of data in respect to the mechanism and aetiology of ankle sprain injury, and with high ecological validity.[15,18,19] The aim of the current study was therefore to quantify the influence of playing surface on the loading response to soccer-specific activity, with loading quantified at C7 and mid-tibia.

Methods

Design

The study was a repeated-measures design. To increase the ecological validity of our study, all analyses were conducted on regulation soccer pitches. Three experimental trials were completed in a randomized order, dictated by playing surface: natural turf (Grass), 2nd generation 'astro-turf' (Astro) comprising a sand-based surface with short synthetic grass, and third-generation artificial turf (3G) comprising long synthetic grass with shock absorbent rubber crumb infill between the grass fibres.

The soccer-specific field test [20] was standardised between trials, so that the playing surface and the location of the GPS unit were the independent variables. The total accumulated PlayerLoad in the anteroposterior, mediolateral and vertical planes were the primary dependent variables. To account for confounding variables that might influence the loading response, test performance was quantified in terms of distance covered. Additional outcome measures in rating of perceived exertion (RPE) and a visual analogue scale (VAS) measure of lower-limb muscle soreness were also recorded to reflect the perceptual influence of playing surface.

Participants

Fifteen amateur male soccer players (22.13 ± 2.36 years) participated in the current study. Inclusion criteria specified that in addition to weekly matches players had typical training volumes ≥ 3 sessions·week^{-1}, had not suffered an injury in the 6 months prior to the commencement of the study, were outfield players with ≥ 6 years competitive experience. All bowlers provided written consent, and the project was approved by the departmental research ethics committee, in accord with the Helsinki Declaration.

Procedures

Players completed three experimental trials, interspersed by a minimum of 72 hours.[21] A familiarisation trial was completed with all players prior to testing to facilitate maximal effort on the soccer-specific field test. Players were requested to refrain from vigorous exercise, alcohol and caffeine for 48 hours prior to the testing. All sessions were conducted at the same time of day to avoid any confounding interference from circadian rhythms, and specifically between 12:00 to 15:00 hrs to reflect competition practice of this cohort. Given the focus on playing surface, meteorological conditions were assessed during testing [22] to ensure the sessions occurred on dry days with minimal wind (4 - 5 m/s) and consistent temperatures. The surfaces were dry prior to the sessions, with watering of the turfs occurring on the preceding day to the testing. Players completed a standardised pre-test warm-up reflecting match-day practice, and incorporating a further two familiarisation laps of the exercise protocol at a sub-maximal speed.

Each testing session comprised completion of a protocol designed to represent movements that are exhibited in soccer on a regular occurrence, shown schematically in Figure 1.[20] The test is of 16.5 min duration, with players completing 40 repetitions of 15 sec bouts of high intensity (HI) activity, interspersed with 10 sec bouts of low intensity (LI) active recovery. An auditory signal informed the participants of the start and end of each bout of activity. At the end of each bout of HI activity, the participant would stop at the nearest cone before commencing the 10 second period of active recovery. The LI active recovery phase comprised the completion of a walk to the recovery area and back to the cone where the participant finished the last bout of HI activity.

** Insert Figure 1 near here **

During each testing session the player was fitted with three GPS devices (MinimaxX S4, Catapult, Scoresby, Australia) located at C7 and the posterior aspect of the mid-tibia of the dominant leg (DL, defined as preferred kicking leg) and don-dominant leg (NDL). The accelerometer (Kionix KX94, Kionix, Ithaca, New York, USA) embedded within the GPS unit collects uni-axial data at a sampling frequency of 100 Hz. Subsequently, the total accumulated PlayerLoad™ is calculated based on the rate of change in acceleration.[23] In the current study PlayerLoad is calculated discretely in each of the mediolateral, anterioposterior and vertical planes of movement. Overall distance covered during each trial was obtained from the GPS devices to ensure standardised performance across the testing conditions.

Post-exercise, a rating of perceived exertion (RPE) was collected with the implementation of the Borg 6 – 20 scale to determine the participant's overall sense of exertion. A 100mm visual analogue scale (VAS) was used to assess the muscle soreness of the lower limbs, when in a squat position.[24] The 100mm scale was anchored via the phrases 'not sore at all' and 'worst pain'.

Statistical Analysis

A repeated-measures general linear model (GLM) was chosen as an appropriate parametric test to investigate main effects for playing surface and GPS location in uni-axial PlayerLoad in each plane. A surface x location interaction was also examined. This model was adapted to one-way ANOVAs for the assessment of the perceptual measures (RPE, VAS) and distance covered to quantify the main effect for playing surface. The assumptions of normality associated with the general linear model were assessed using the Shapiro-Wilk test to ensure model adequacy, with none of the variables violating any of the assumptions. Where significant main effects or interactions were observed, post-hoc pairwise comparisons with a Bonferroni correction factor were applied. Main effects were supported with partial eta squared (η^2) calculated as a measure of effect size and classified as small ($\leq$ 0.059), moderate (0.060 – 0.137), and large ($\geq$ 0.138). All data are subsequently presented as mean ± SD, with statistical significance accepted at $P \leq 0.05$. All statistical analysis was completed using PASW Statistics Editor 22.0 for Windows (SPSS Inc., Chicago, IL, USA). All statistical analysis was completed using PASW Statistics Editor 22.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

Figure 2 summarises the influence of playing surface and GPS location on total accumulated PlayerLoad, defined as the sum of the three planes. There was no main effect for surface ($P = 0.55$, $\eta^2 = 0.010$), but there was a significant main effect for unit location ($P < 0.001$, $\eta^2 = 0.823$). Post-hoc testing revealed that total loading was significantly higher at each mid-tibia than at C7 ($P < 0.001$), but no difference between the dominant and non-dominant limbs ($P = 0.70$). There was no surface *x* location interaction ($P = 0.98$, $\eta^2 = 0.003$).

** Insert Figure 2 near here **

This same pattern was evident in each axial plane, as summarised in Table 1. There was no main effect for surface in the anteroposterior ($P = 0.31$, $\eta^2 = 0.019$), mediolateral ($P = 0.70$, $\eta^2 = 0.006$), or vertical ($P = 0.76$, $\eta^2 = 0.004$) loading. There was a significant main effect for unit location, with loading significantly lower at mid-tibia than at C7 in all planes ($P < 0.001$), but with the two limbs no different to each other in all planes ($P \geq 0.27$). There was no surface *x* location interaction in any plane ($P \geq 0.83$, $\eta^2 \leq 0.012$).

** Insert Table 1 near here **

Figure 3 summarises the influence of playing surface and GPS location on the relative axial contributions to total load. There was no main effect for surface in the anteroposterior ($P = 0.60$, $\eta^2 = 0.008$), mediolateral ($P = 0.56$, $\eta^2 = 0.010$), or vertical ($P = 0.45$, $\eta^2 = 0.013$) relative planar contributions to loading. There was a significant main effect for unit location ($P < 0.001$) in all relative planar contributions (anteroposterior $\eta^2 = 0.777$; mediolateral $\eta^2 = 0.042$; vertical $\eta^2 = 0.081$). The vertical contribution to loading was significantly higher at C7 than mid-tibia ($P < 0.001$), with no difference between limbs ($P = 0.92$). In contrast, the anteroposterior and mediolateral contributions to loading were significantly lower at C7 than mid-tibia ($P < 0.001$), with no difference between limbs ($P = 0.20$ and $P = 0.13$ respectively). The average relative contributions to loading in the AP:ML:V planes was 25:27:48 at C7 and 34:32:34 at mid-tibia. There was no surface *x* location interaction in any plane ($P \geq 0.26$, $\eta^2 \leq 0.042$).

** Insert Figure 3 near here **

There was no significant main effect for playing surface on the total distance covered during the soccer-specific field test ($P = 0.75$, $\eta^2 = 0.014$), with distance maintained at an average of 1890m across all trials. Similarly, there was no influence of playing surface on post-exercise RPE ($P = 0.98$, $\eta^2 = 0.001$) which was consistent at 15.6 across trials, or on post-exercise VAS scores consistent at 45.5mm ($P = 0.61$, $\eta^2 = 0.023$).

Discussion

The aim of the current study was to investigate the influence of playing surface on the mechanical loading response to soccer-specific exercise. Playing surface was found to have no effect on the loading response, when considered as a total accumulated value or when considered in each axial plane. Since loading magnitude has been associated with increased risk of injury,[15-17] this suggests no increased risk of injury when using artificial surfaces rather than natural turf, supporting the majority of epidemiological studies.[5,6]

Playing surface also had no influence on performance quantified as total distance covered, or on perceptual markers of effort and subsequent localised muscle soreness. Whilst previous research has identified no surface effect on prolonged soccer activity,[8,10,11] issues have been raised in terms of players' perceptions of an increased risk of injury when playing on artificial turf.[25] Players have specifically reported that artificial surfaces are more physically demanding,[24,26] which is contrary to the perceptions of the players in the current study. These differences might simply be founded in the relative exposure and familiarisation with artificial surfaces and the nature of the physical task, and therefore direct comparison between studies should be treated with caution. In the present study the lack of a surface effect in performance and perceptual measures were consistent with a lack of surface effect in the loading response.

A secondary aim of the current study was to compare the loading elicited at C7 in comparison with a lower-limb site used to generate greater validity in respect to injury incidence in soccer. In the current study the unit placement was sensitive to both the magnitude and pattern of loading, with the mid-tibia eliciting significantly higher total loading magnitudes in all planes, and greater relative contributions to loading in the anteroposterior and mediolateral planes. The reduced load at C7 might partly be attributed to the dissipation of load through the kinetic chain.[27] However, the calculation of PlayerLoad is based only on the rate of change of acceleration, and the different planar contributions of loading suggest a technical response. The soccer-specific exercise test used is designed to incorporate the multi-directional and high intensity activity characteristic of soccer. A lower relative loading at C7 most likely reflects running economy in these experienced players, maintaining a relatively constant displacement of the mass centre. In contrast, the displacement of the lower limb to facilitate changes in direction and speed will increase the relative frequency and magnitude of changes in acceleration. The foot is displaced relative to the mass centre to moderate direction and speed, and the mid-tibia unit is therefore likely to follow a more changeable trajectory than the unit at C7, thereby accumulating greater PlayerLoad. The greater relative mediolateral and anteroposterior contributions to loading at the mid-tibia highlight this technical response. This creates a location-specific loading pattern, and further highlights the limitations of C7 data in relation to the mechanism of lower limb injury. The C7 site is typically used with the unit placed in a customised neoprene vest and located so as to optimise satellite signal reception for the generation of GPS data and derivatives in distance, speed and acceleration. However the tri-axial accelerometer is not constrained by the same requirements, and has previously been used in indoor sports [28] and within a clinical rehabilitation context.[19] The placement of the accelerometer can then be tailored to a bespoke consideration of injury location. Previous applications have considered lumbar spine injury in cricket[18] and ankle sprain injury in soccer.[19]

Greig et al. recently highlighted the efficacy of lower-limb mounted GPS units to quantify the planar loading response to functional rehabilitation drills designed to challenge the mechanism of ankle sprain injury.[19] In the current study the soccer-specific test is both intermittent and multi-directional, and performed at high intensity. This is designed to replicate the physical challenge of soccer match-play,[20] but also presents relevance to common mechanism of injury.[1] The loading response will also be task-specific, and as such direct comparison between studies is limited and care should be taken when generalising beyond the experimental paradigm used. Furthermore, all players were injury free at the time of testing, and the sensitivity of this methodological approach to changes in loading in response to previous injury warrant consideration. The prospective screening for injury using this methodological approach, in addition to the influence of playing surface is also worthy of future investigation and longitudinal study. Artificial surfaces have been associated with a decreased risk of knee injury but an increased risk of ankle injury, [1,29] and thus specific tasks might be designed based on the mechanism of specific injuries. Brown and Greig further developed the planar loading metric to consider bilateral asymmetry in loading, but this retrospective study used data collected at C7.[30] The acceleration data collected at the lower limb might be able to identify bilateral and ipsi-lateral imbalances in loading, differentiating between inversion and eversion loading for example. The analysis might then also become increasingly aligned to the mechanism of injury, whilst retaining the high ecological validity provided in the experimental design. There is also suggestion that the increased risk from artificial surfaces might lie in the repeated exposure and subsequent increase in overuse injuries,[31] and thus longitudinal considerations of loading would also be beneficial.

Conclusion

A comparison of natural turf, second generation atsroturf and third generation artificial turf revealed no surface effect on the performance, perceived exertion, or mechanical loading elicited during a soccer-specific test. However, placement of the accelerometer was sensitive to the magnitude and pattern of loading. A mid-tibia placement (used to reflect the high incidence of ankle sprain injury in soccer) elicited higher absolute loading than the typical C7 placement, and greater relative contributions in the mediolateral and anteroposterior planes. Clinical reasoning is therefore dependent on unit placement. The sensitivity to planar loading patterns indicative of the task-specific technical challenge highlights potential in the management and monitoring of loading during training and rehabilitation.

References

1. Strutzenberger G, Cao H-M, Koussev J, Potthast W, Irwin G. Effect of turf on the cutting movement of female football players. *J Sport Health Sci*. 2014;3:314-319.
2. Rennie DJ, Vanrenterghem J, Littlewood M, Drust B. Can the natural turf pitch be viewed as a risk factor for injury within Association Football? *J Sci Med Sport.* 2016;19(7):547 - 552.
3. Dragoo JL, Braun HJ. The effect of playing surface on injury rate: a review of the current literature. *Sports Med*. 2010;40(11):981 - 990.
4. Encarnacion-Martinez A, Garcia-Gallart A, Gallardo AM, Sanchez-Saez JA, Sanchez-Sanchez J. Effects of structural components of artificial turf on the transmission of impacts in football players. *Sports Biomech.* 2018;17(2):251-260.
5. Ataabadi YA, Sadeghi H, Alizadeh MH. The effects of artificial turf on the performance of soccer players and evaluating the risk factors compared to natural grass. *Neurologic Res Therapy.* 2017;2(2):1-16.
6. Williams S, Hume PA, Kara S. A review of football injuries on third and fourth generation artificial turfs compared with natural turf. *Sports Med.* 2011;41(11):903-923.

7. Ekstrand J, Hagglund M, Fuller CW. Comparison of injuries sustained on artificial turf and grass by male and female elite football players. *Scand J Med Sci Sports.* 2011;21(6):824-832.

8. Steffen K, Andersen TE, Bahr R. Risk of injury on artificial turf and natural grass in young female football players. *Br J Sport Med*. 2007;41: i33-37.

9. Bjorneboe J, Bahr R, Andersen TE. Risk of injury on third generation artificial turf in Norwegian professional football. *Br J Sport Med.* 2010;44(11):794-798.

10. Fuller CW, Dick RW, Corlette J, Schmalz R. Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 1: match injuries. *Br J Sport Med*. 2007;41:i20-26.

11. Ekstrand J, Timpka T, Hagglund M. Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study. *Br J Sport Med*. 2006;40(12):975-80.

12. Fuller CW, Dick RW, Corlette J, Schmalz R. Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 2: training injuries. *Br J Sport Med*. 2007;41:27-32.

13. Barron DJ, Atkins S, Edmundson C, Fewtrell D, Accelerometer derived load according to playing position in competitive youth soccer. *Int J Perf Analysis Sport.* 2014;14:734 - 743.

14. Nedergaard NJ, Kersting U, Lake M. Using accelerometry to quantify deceleration during a high-intensity soccer turning manoeuvre. *J Sports Sci.* 2014;32(20):1897 - 1905.

15. Brown W, Greig M. Tri-axial accelerometry as an injury predictor tool in elite soccer. *Int J Athl Therapy Train.* 2017;22(5):44-48.

16. Bowen L, Gross AS, Gimpel M, Li FX. Accumulated workloads and the acute:chronic workload ratio relate to injury risk in elite youth football players. *Br J Sports Med*. 2017;51:452-459.

17. Wilkerson GB, Gupta A, Allen JR, Keith CM, Colston MA. Utilization of practice session average inertial load to quantify college football injury risk. *J Strength Cond Res.* 2016;30(9),2369-2374.

18. Greig M, Nagy P. Lumbar and cervico-thoracic spine loading during a fast bowling spell. *J Sport Rehabil.* 2017;26(4):257-262.

19. Greig M, Emmerson H, McCreadie J. Is there a role for GPS in determining functional ankle rehabilitation progression criteria? A preliminary study. *J Sport Rehabil.* 2019;28(7):729-734.

20. Bangsbo J, Lindquist F. Comparison of various exercise tests with endurance performance during soccer in professional players. *Int J Sports Med.* 1992;13(2):125 - 132.

21. Page RM, Marrin K, Brogden CM, Greig M. 2015. Biomechanical and physiology response to a contemporary soccer match-play simulation. *J Strength Cond Res.* 2015;29(10):2860 - 2866.

22. Di Mechele R, Di Renzo AM, Ammazzalorso S, Merni F. Comparison of physiological responses to an incremental running test on treadmill, natural grass, and synthetic turf in young soccer players. *J Strength Cond Res.* 2009;23:939 - 945.

23. Boyd LJ, Ball K, Aughey RJ. The reliability of MinimaxX accelerometers for measuring physical activity in Australian football. *Int J Sports Physiol Perf.* 2011;6:311 - 321.

24. Andersson H, Ekblom B, Krustrup P. Elite football on artificial turf versus natural grass: movement patterns, technical standards, and player impressions. *J Sports Sci.* 2008;26:113 – 122.

25. Poulos CCN, Gallucci Jr. J, Gage WH, Baker J, Buitrago S, Macpherson AK. The perceptions of professional soccer players on the risk of injury from competition and training on natural grass and 3rd generation artificial turf. *BMC Sports Sci Med Rehab.* 2014;6(11):1-12.

26. Akkurt S, Sucan S, Gumus A, Karakus M, Yilmaz A, Saka T. Comparison of muscle damage in Turkish collegian soccer players after playing matches on artificial and natural turf fields. *Anthropol.* 2015;20(3):423-429.

27. Zhang S, Derrick TR, Evans W, Yu YJ. Shock and impact reduction in moderate and strenuous landing activities. *Sports Biomechanics.* 2008;7(2):296-309.

28. Fish K, Greig M. The influence of playing position on the biomechanical demands of netball match-play. *J Athl Enhanc.* 2015;3(5).

29. Fujitaka K, Taniguchi A, Kumai T, Otuki S, Okubo M, Tanaka Y. Effect of changes in artificial turf on sports injuries in male university soccer players. *Ortop J Sports Med.* 2017;5(8),1-9.

30. Kristenson K, Bjorneboe J, Walden M, Andersen TE, Ekstrand J, Hagglund M. The Nordic football injury audit: higher injury rates for professional football clubs with third-generation artificial turf at their home venue. *Br J Sports Med.* 2013;47:775-781.

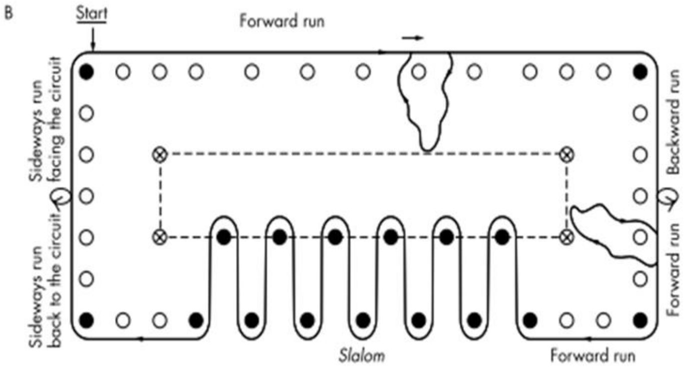

Figure 1. Schematic representation of the soccer-specific exercise test (Bangsbo and Lindquist, 1992).

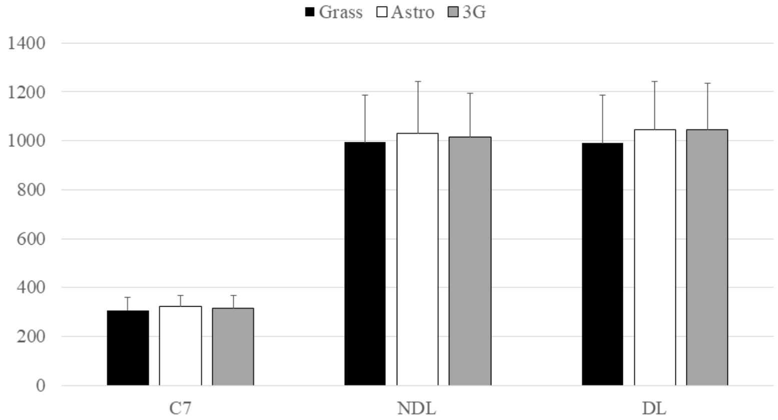

Figure 2. The influence of playing surface and GPS location on Total PlayerLoad.

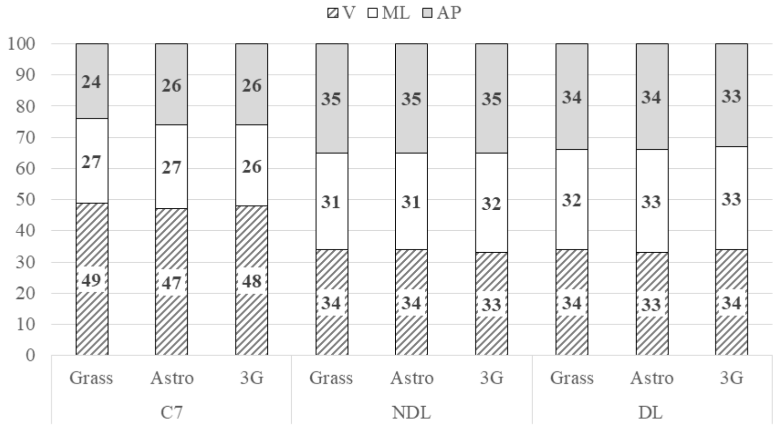

Figure 3. The influence of playing surface and GPS location on planar contributions to Total PlayerLoad.

Table 1. The influence of playing surface and GPS location on planar loading.

Axial Plane	GPS Location	Playing Surface		
		Grass	Astro	3G
V	C7	148.90 ± 24.67	152.66 ± 28.21	152.47 ± 25.82
	DL	336.39 ± 55.47	347.39 ± 57.71	347.56 ± 52.68
	NDL	337.84 ± 59.01	344.82 ± 61.21	340.41 ± 54.54
ML	C7	76.35 ± 19.39	84.20 ± 11.81	81.92 ± 21.21
	DL	342.77 ± 76.86	354.15 ± 86.94	353.80 ± 76.62
	NDL	345.54 ± 80.48	361.18 ± 88.63	351.26 ± 69.40
AP	C7	82.47 ± 19.05	87.82 ± 19.12	82.20 ± 20.55
	DL	311.84 ± 69.40	343.95 ± 59.54	342.81 ± 71.60
	NDL	311.39 ± 60.03	324.03 ± 70.77	323.66 ± 65.86