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Original Research Article

Effect of hamstring injuries on athlete's season best performance at return-to-sport phase of rehabilitation: survey of track runners in high altitude training camps in Kenya

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ABSTRACT

Background: Hamstring injuries amongst runners are some of the most prevalent sports injuries. However, the actual impact of these injuries on athlete's best performance pre-injury is unknown. The objective of this study was to assess the impact of hamstring injury on athletes' performance at return to sport phase of rehabilitation amongst track runners in Western Kenya.
Methods: Observational longitudinal study utilizing quantitative methods were used. The study setting was in the high-altitude western Kenya regions with accredited training camps. The functional assessment scale for hamstring injuries (FASH) was used to screen injuries and an observational checklist to record the conventional rehabilitation strategies. A moderator effect analysis for the variables was conducted followed by a multi-linear regression analysis to establish the effect of injury on performance. The results were presented in summary tables and graphs.
Results: A total of 221 (53% response rate) athletes participated in the study as having a hamstring injury. The study found that athletes took more time after injury compared to their personal best and before injury time records. The average best time for full marathoners was 2:17:19.46 (SD±0:10:54.804), before injury 2:18:05.36 (SD±0:11:06.879) and after injury 2:22:12.02 (SD±0:12:45.174).
Conclusions: The study concludes that the prevalence of hamstring injuries among endurance runners in Kenya's Rift Valley region is still so high. The paper recommends emphasis on extensive strength training before return to sport to address deficits in muscle and eccentric strength on return to sport.

Keywords: Athletes, Hamstring injuries, Rehabilitation, Sports

INTRODUCTION

Hamstring injuries account for 37% of all sports injuries and 25% of athletes' absenteeism in games globally.[1] Hamstring strain injuries account for over 1/3 of all muscle injuries in sports and are the most prevalent injuries involving high-speed sprinting.[2,3] Researchers have classified risk factors of hamstring injury into: non-modifiable and modifiable risk factors. Some sports such as track that involve lengthening of hamstring muscle have a higher risk than court sports.[4] According to Askling the risk of injury is more observed in pre-season and competition and not during training. Running and sprinting are activities more likely to cause hamstring injuries affecting male more than female athletes. A study conducted in the United Kingdom (UK) by Woods et al amongst 91 professional football clubs in two seasons, found that hamstring strain injuries accounted for 12% of all the injuries, about 53% of these injuries were HSIs involved the biceps femoris muscle.[5]

The period of treatment of HSIs and the number of missed games result in a substantial cost.[6] Hamstring strain injuries result in considerable time loss from training and competition, which in turn translate to financial loss and diminished athletic performance. Raysmith and Drew estimated the cost of HSI in excess of 74.4 million in the English premier and football league clubs during the 1999-2000 seasons. Similar estimates for elite Australian football teams indicated that HSIs cost approximately $AU 1.5 million in the 2009 season, which represented 1.2% of the salary cap in the Australian Football League. In addition to lost time and competition opportunities, the loss of income accrued during the peak seasons affect athletes' physically and mentally.[7]

This impact of hamstring injuries and their potential risk factors have motivated continuing research on hamstring injuries. For example, Opar et al observed that player performance was significantly reduced at return-to-sport (RTS) following rehabilitation.[8] Further, previous studies have not only surveyed on the incidence of HSIs but also on their relapse. Relapse of hamstring strain injuries (HSIs) is common in approximately 1/3 of the cases within the first two weeks after return-to-sports (RTS) (Erickson and Sherry, 2017). In over 13 seasons of a football league, Van et al observed that 27% of all recurrent injuries were hamstring strain injuries (HSIs).[9] Further, in a study conducted in Melbourne amongst professional footballers in the Australian football league found that the rate of relapse of hamstring injuries accounted for nearly 12% as compared to 7% of all other injuries.[10] It is not clear from previous studies whether the rate of relapse is due to intrinsic factors or extrinsic factors or due to poor rehabilitation strategies.[11] However, the high rate of relapse may be related to a combination of factors including: ineffective rehabilitation and inadequate criteria for return-to-sport.

Whereas, the decision on RTS has legal, health and economic implications, no consensus or standard criteria exists in literature globally.[12] In current practice the guiding principles on RTS are pain resolution, normal strength, subjective feeling of full recovery as reported by the athlete, normal flexibility and achievement of sport specific tests. In addition, the relationship between the site of injury and the distance to the ischial tuberosity determine the duration it takes to heal and RTS.[13]

On the other hand, high sprinting sports are a challenge for athletes at RTS phase of rehabilitation thus determining the timing of RTS is even a bigger challenge. Some athletes may return-to-sports immediately while others take long, but may eventually return. Moreover, scientific knowledge about the injury and the therapeutic options is of paramount importance during designing of rehabilitation protocols.[14] Most of these studies have been conducted in developed countries such as Australia, UK and (USA). However, very few studies have been conducted in low- and medium-income countries more specifically in Africa on athlete's performance at the return-to-sport phase of rehabilitation. In Sub-Saharan Africa more specifically in Kenya, there is little information concerning, the effect of hamstring injuries on athlete's performance at the return-to-sport phase of rehabilitation amongst track runners. This study aims to fill this gap. The purpose of this study therefore is to determine the impact of hamstring injuries on athletes' season best performance at return-to-sport phase of rehabilitation amongst track runners in high altitude training camps in Kenya. The study was guided by the following specific objectives: i) to determine the prevalence and distribution of hamstring injuries among track runners training in accredited high altitude training camps in Kenya, ii) to determine the post rehabilitation deviation of performance at return-to-sport phase of rehabilitation amongst track runners training in accredited high altitude training camps in Kenya and, iii) to identify the conventional rehabilitation strategies used to rehabilitate hamstring injuries amongst track runners training at accredited high-altitude training camps in Kenya.

METHODS

Participants and study site

This study was a longitudinal study. The study adopted a longitudinal observational design utilizing the quantitative methods.[15] The longitudinal observational design is suitable for studies that seek to observe change impacted by a phenomenon over time. The population comprised of 221 athletes with hamstring injuries training in high altitude camps in Kenya. These camps are Nakuru, Keringet, Ole nguruone, Kericho, Kapsabet, Mosoriot, Eldoret, Nyahururu, Litein and Iten. All athletes reporting injuries occasioned by their engagement in sports and are present at the period of the study. They were screened subjectively for the complaint of posterior thigh pain. Further, those with posterior thigh pain were assessed for actual hamstring injury. Only those with hamstring injuries participated in the rest of the study. Only those who consent were included.

The subjects were screened for hamstring injury, then followed up for determination of best performance at the return-to-sports phase of rehabilitation. During the same period, the rehabilitation strategies used were observed. The study conducted this study from April 2019 to April 2022.

Data collection

Data was collected using firstly the functional assessment scale for hamstring injuries (FASH). The questionnaire comprises of 10 questions. Seven questions used 0-10 visual analogue numerical rating and the remaining three questions used a categorical rating system on an incremental range of values.

Secondly, an observational checklist was used to observe and record the conventional rehabilitation strategies that are being used in the training camps. Observed rehabilitation strategies were compared to standard rehabilitation strategies in the rehabilitation protocol for hamstring muscle injuries. The researcher also reviewed existing records for the purposes of determining the athlete's best performance before hamstring injury and the performance at the return to sport phase of rehabilitation.

Data analysis

The collected data was entered in statistical package for social sciences SPSS version 25. Descriptive statistics was calculated and compared between the data sets and errors corrected by re-entering data from the data collection instruments. A moderator effect analysis for the variables was conducted followed by a multi-linear regression analysis to establish the effect of injury on performance. Descriptive and inferential statistics were presented in tables and graphs.

The FASH questionnaire was analyzed as per the author's instructions. These are such that the best score is 100 and worst score is 0. FASH highest score is 100 meaning normal, while lowest score of 0 is interpreted as complete disability and no normal physical functioning.

RESULTS

Participant's response

Out of the targeted census of 1160 athletes in various training camps only 415 had a positive posterior thigh pain response. On further screening, 221 (53%) athletes were recruited into the study as having a hamstring injury. The results section focuses only on participants who had hamstring injuries.

Post rehabilitation deviation of performance

There was a marked deterioration of performance after hamstring injury among all the participants in their respective events. In 800 m event the average deviation of time after hamstring injury post rehabilitation was 24 seconds. The 1500 m participants recorded a deviation of 21 seconds after injury at their return to play. 3000 m runners recorded a deviation of 31.7 seconds after injury post rehabilitation.

Table 1: Post rehabilitation time deviation before and after hamstring injury.

Event		Personal best	Time before	Time after
800 m	Mean	0:01:35:95	0:01:47:60	0:02:03:99
	N	20	20	20
	Std. deviation	0:00:09:679	0:00:05:884	0:00:24:137
1,500 m	Mean	0:03:35.20	0:03:47.97	0:04:08.60
	N	22	22	22
	Std. deviation	0:00:25.063	0:00:11.029	0:00:21.057
3,000 m	Mean	0:07:37.27	0:08:00.96	0:08:33.60
	N	25	25	25
	Std. deviation	0:00:29.833	0:00:26.865	0:00:31.714
5,000 m	Mean	0:13:55.25	0:14:22.92	0:14:49.50
	N	26	26	26
	Std. deviation	0:00:48.139	0:00:42.392	0:00:45.992
5,000 m RR	Mean	0:12:50.74	0:13:37.74	0:15:39.55
	N	30	30	30
	Std. deviation	0:01:21.842	0:01:05.472	0:04:00.700
10 000 m RR	Mean	0:31:30.70	0:31:58.26	0:33:08.08
	N	21	21	21
	Std. deviation	0:03:48.086	0:03:42.389	0:03:26.117
Half marathon (21 km)	Mean	1:14:00.24	1:16:07.52	1:17:30.31
	N	25	25	25
	Std. deviation	0:17:01.423	0:16:25.331	0:16:14.975
Full marathon (42 km)	Mean	2:17:19.46	2:18:05.36	2:22:12.02
	N	30	30	30
	Std. deviation	0:10:54.804	0:11:06.879	0:12:45.174
10,000 m track	Mean	0:30:53.92	0:31:50.10	0:34:16.73
	N	22	22	22
	Std. deviation	0:03:06.121	0:02:37.683	0:05:59.134

The 5000 m track runners recorded a deviation of 45 seconds while the 5000 m road race had a deviation of 4 minutes. 10000 m track runners had a deviation of 5 minutes as compared to the 10000 m road race who had a deviation of 3 minutes. The half marathon runners (21 km) had a deviation of 16 minutes after hamstring injury. Full marathon runners (42 km) had a deviation of 12 minutes at return to sport after rehabilitation as seen in Table 1.

Conventional rehabilitation strategies used to rehabilitate hamstring injuries

Observational checklist on hamstring injury treatment protocols

Rehabilitation protocol purpose describing the criteria to design the exercises in each phase, the goals and test to progress between phases and RTP criteria.

The observational checklist on hamstring injury was completed by eleven physiotherapists. They were required to indicate whether they execute the prescribed treatment regime per every phase of injury.

During the pain and inflammation stage, at the acute phase, PRICE mode of treatment was remotely executed. The components of pain and inflammation management that involved physical activities such as closed kinetic movements were preferred by therapists at 45% more than pain relief and elimination of inflammatory circle regimes.

At the proprioception stage, it was evident from this study that re-education of proprioception was not prioritized, only 36.4%of the therapists conducted activities like knee flexion on unstable surface and low unstable dynamic movements. The rest of the activities were performed by less than 1/3rd of the therapists.

Table 2: Observational checklist on hamstring injury treatment protocols.

Exercise criteria		Yes n (%)	No n (%)	NI n (%)
Pain and inflammation				
Acute phase	Price	3 (27.3)	8 (72.7)	-
Sub-acute phase	Gentle movements	2 (18.2)	9 (81.8)	-
Functional phase	Closed kinetic chain movements	5 (45.5)	6 (54.5)	-
Proprioception				
Acute phase	Knee flexion 0-30 degrees	2 (18.2)	7 (63.6)	2 (18.2)
Acute phase	Static movements	4 (36.4)	7 (63.6)	
Acute phase	Low unstable dynamic movements	4 (36.4)	5 (45.5)	2 (18.2)
Sub-acute phase	Knee flexion 0-45 degrees	1 (9.1)	8 (72.7)	2 (18.2)
Sub-acute phase	Moderate reactive strength movements	1 (9.1)	8 (72.7)	2 (18.2)
Sub-acute phase	Active and wide movements	3 (27.3)	7 (63.6)	1 (9.1)
Functional phase	Knee flexion 0-90 degrees on unstable surface	4 (36.4)	6 (54.5)	1 (9.1)
Functional phase	Intense reactive movements	3 (27.3)	8 (72.7)	-
Core				
Acute phase	Static exercises (stable surface)	3 (27.3)	8 (72.7)	-
Sub-acute phase	Dynamic exercises in all planes (stable surface to unstable point)	3 (27.3)	8 (72.7)	-
Functional phase	Dynamic exercises on two unstable points	5 (45.5)	6 (54.5)	
Flexibility and ROM				
Acute phase	Stretch with ESH≤45 avoid pain	2 (18.2)	9 (81.8)	-
Acute phase	ESH≤45 isolated knee flexion or hip extension exercises	2 (18.2)	9 (81.8)	-
Acute phase	Combine both knee flexion and hip extension	3 (27.3)	8 (72.7)	-
Sub-acute phase	Stretch with ESH≤70 avoid pain	1 (9.1)	8 (72.7)	2 (18.2)
Sub-acute phase	ESH≤70	3 (27.3)	5 (45.5)	3 (27.3)
Sub-acute phase	Combined movements	2 (18.2)	8 (72.7)	1 (9.1)
Functional phase	Stretch with no limit	3 (27.3)	7 (63.6)	
Functional phase	ESH with no limit	3 (27.3)	6 (54.5)	2 (18.2)
Functional phase	length, joint, velocity, load and complexity	2 (18.2)	8 (72.7)	1 (9.1)
Strength and power				
Acute phase	Unipodal CKC exercises	5 (45.5)	4 (36.4)	2 (18.2)
Acute phase	Bipodal CKC exercises	4 (36.4)	3 (27.3)	4 (36.4)
Acute phase	ISOM, CONC and ECC	3 (27.3)	4 (36.4)	4 (36.4)
Sub-acute phase	OKC and CKC unipodal and bipodal exercises	3 (27.3)	6 (54.5)	2 (18.2)
Functional phase	Horizontal strength exercises	2 (18.2)	7 (63.6)	2 (18.2)
Neuromuscular and fitness				
Acute phase	ESH≤45 avoid pain (soft surface to hard surface)	4 (36.4)	7 (63.6)	-

Continued.

Exercise criteria		Yes n (%)	No n (%)	NI n (%)
Sub-acute phase	ESH≤70 (soft surface to hard surface)	4 (36.4)	7 (63.6)	-
Functional phase	No ESH limit, hard surface	2 (18.2)	9 (81.8)	-
Goals and test to progress				
Acute phase	Walking on treadmill	5 (45.5)	6 (54.5)	-
	No pain or discomfort during exercises (neutral position)	1 (9.1)	10 (90.9)	-
	Find and maintain neutral position in static	2 (18.2)	9 (81.8)	
	Isometric knee flexion strength	3 (27.3)	8 (72.7)	-
	Isometric hip extension strength	1 (9.1)	9 (81.8)	1 (9.1)
	Full knee and hip isolated tested ROM	1 (9.1)	9 (81.8)	1 (9.1)
Sub-acute phase	Run on treadmill	6 (54.5)	4 (36.4)	1 (9.1)
	No pain or discomfort during exercises	2 (18.2)	9 (81.8)	-
	Isometric knee flexion strength	1 (9.1)	10 (90.9)	-
	Isometric hip extension strength	1 (9.1)	10 (90.9)	-
	Active hip flexion strength	1 (9.1)	10 (90.9)	-
Functional phase	No pain or discomfort during exercise	1 (9.1)	10 (90.9)	-
	Correct spine control and strength transfer exercise	4 (36.4)	7 (63.6)	-
	Strength, neuromuscular and proprioception	2 (18.2)	9 (81.8)	-
	Hip strength tests	2 (18.2)	9 (81.8)	-

Table 3: Severity of hamstring injuries by demographics.

	Severity				
Gender	**Severe**	**Moderate**	**χ^2-statistic**	**Df**	**P value**
Male	61	135	2.442	1	0.118
Female	4	21			
Total	65	156			
Age					
16-24 years	27	50	6.336	3	0.96
25-30 years	13	49			
31-35 years	19	32			
>35 years	6	25			
Total	65	156			
Participation in sport					
Currently taking part in sport	29	143	65.385	1	<0.001
Currently not taking part in sport	36	10			
Not indicated	0	3			
Total	65	156			

Table 4: Impact of HI on return to sport time.

All track events	Mean	N	SD	Std. error mean	Correlation	Sig.
Time before	0:38:33.18	221	0:45:30.68	0:03:03.67	0.998	<0.001
Time after	0:40:04.16	221	0:46:39.05	0:03:08.29		

paired samples test

Full marathon paired differences

	Mean	SD	SE mean	95% CI of the difference		t	df	P
				Lower	Upper			
Time before: Time after	-0:01:30.97	0:03:20.44	0:00:13.48	-0:01:57.55	-0:01:04.4	-6.747	220	.000

Full marathon	Mean	N	SD	Std. error mean	Correlation	Sig.
Time before	2:18:05.36	30	0:11:06.88	0:02:01.76	0.874	<0.001
Time after	2:22:12.02	30	0:12:45.17	0:02:19.70		

paired samples test

Full marathon paired differences

	Mean	SD	SE mean	95% CI of the difference		t	df	P
				Lower	Upper			
Time before: Time after	-0:04:06.66	0:06:12.25	0:01:07.96	-0:06:25.66	-0:01:47.66	-3.629	29	0.001

Over 50% of the therapists did not give focus on active physiological movements to re-educate to full range dynamic exercises in all planes as preferred for the hamstring muscle treatment.

Intervention which focuses on flexibility and ROM during the acute, subacute and functional phase of recovery was not keenly practiced by the therapists.

Strength and power intervention in all the phases of recovery process was fairly applied. More emphasis was directed on neuromuscular and fitness training such as walking on treadmill which was at 45.5% at the acute phase and 54.5% in sub-acute phase. Less emphasis was given to the goals and test to progress by therapists in acute sub-acute and functional phase.

Association between independent and dependent variables

Most of the males suffered (93.8%, n=61) severe hamstring injury compared to females. A chi-square test of association did not show any relation between gender and severity of hamstring injury (p>0.05). More than a half of the participants (54.0%, n=27) who aged between 16 to 24 years and 31-35 years (59.4%, n=19) had severe hamstring injury. However, a chi-square test of association did not show significant relationship between severity of injury and age. Twenty-nine (44.6%) athletes out of 65 who had severe hamstring injury were taking part in sport by the time when the study was conducted. Majority of the participants (91.7%, n=143) who had moderate injury were taking part in sport when the study was conducted. There was a statistically significant association between severity of injury and taking part in sport, χ^2 (65.385, df=1, p<0.001) (Table 3).

Paired t-test to assess the impact of HI on return to sport time

Results of the dependent (paired) sample t-test indicated that there were significant differences in time taken before and after acquiring hamstring injury. The average athlete performance time for all the events increased from 0:38:33.18 to 0:40:04.16. This implies that athletes took 0:01:30.97 more time to complete track upon return to sport, t (220 df) = -6.747, p<0.001. Ideally, increased time to complete track event was observed across athletes participating in the different track events. A high time deviation of 0:04:06.66 was observed among full marathon athletes, t (29 df) = -3.629, p=0.001 (Table 4).

Relationship between determinants of injury and time difference pre- and post-injury

Results of the Pearson correlation indicated that there was a significant positive relationship between pain during sprinting for 30 meters, pain or discomfort when performing partial weight bearing lunge, pain or discomfort when performing full weight bearing lunge and the time difference pre- and post- injury (p<0.05).

Table 5: Relationship between functional assessment activities and time difference pre- and post-injury.

	Pearson Correlation	Sig. (2-tailed)
Pain during walking	-0.058	0.389
Pain during jogging	0.123	0.067
Pain during sprinting for 30 meters	0.151*	0.025
Pain on static stretching your hamstrings	0.100	0.140
Pain or discomfort when performing partial weight bearing lunge	0.219**	0.001
Pain or discomfort when performing full weight bearing lunge	0.206**	0.002

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Table 6: Regression on time records.

Predictors	R	R square	Adjusted R^2	Std. error of the estimate	F	P value
Difference between time before and after injury	0.218[a]	0.048	0.039	10.873	5.852	0.017
Difference between personal best and time before	0.061[a]	0.004	-0.005	11.120	2.386	0.125
Difference between personal best and time after	0.141[a]	0.020	0.012	11.029	0.440	0.508
Coefficients						
Model	**Unstandardized coefficients**			**Standardized coefficients**	**t**	**Sig.**
	B		**Std. error**	**Beta**		
(Constant)	25.863		1.334		19.384	0.000
Difference between TB and TA	0.048		0.020	0.218	2.419	0.017

Dependent variable: Total FASH score

Table 7: Association between severity of injury and events.

Event	Severe	Moderate	χ^2-statistic	df	P value
800 m	0	20	123.070	8	<0.001
1,500 m	13	49			
3,000 m	11	11			
5000 m	20	6			
10 km RR	16	5			
10,000 m track	0	22			
Half marathon (21 km)	0	25			
Full marathon (42 km)	1	29			
Total	65	156			

Regression on time records

A simple linear regression was used to assess whether the FASH total scores (severity of injury) significantly predicts the time deviation pre- and post-injury. Results of a regression analysis showed a 4.8% variation between the pre- and post-injury time differences implying that 4.8% of the change in athlete performance time after injury can be explained by the model obtained from the data. Severity of the injury increase the amount of time that athletes took to complete track running event, R^2=0.048, F (1, 117) =5.85, p≤0.017. Severity of injury significantly predicted the performance time of athlete on return to sport injury (β=0.048, t=2.419, p=0.017.

Severity of injury did not predict time change between athlete's personal best and time before injury (p>0.05). Similarly, severity of injury did not predict time change between personal best and time taken at sport after injury (p>0.05).

Association between severity of injury and event

Majority of the 5000 m track athletes (76.9%, n=20) had sustained severe hamstring injury. Most of the athletes who participated in other track events had sustained moderate hamstring injury. A chi-square test of association showed a statistically significant relation between severity of injury and events χ^2 (1df) =65.385, p<0.001.

DISCUSSION

The study findings showed a high prevalence of hamstring injury (53%, n=221) among athletes. These results are in line with findings obtained from a study conducted by Eirale et al in Qatar about epidemiology of football injuries in asia: a prospective study in Qatar where a higher incidence rate of 54.4% hamstring injuries was recorded out of the 217 injuries observed.[16] Hamstring injuries have for a long time been the dominant reason for prolonged pauses from participation in sport. In American football, hamstring injury rate per 1000 hours of exposure is 0.47 for trainings and 2.7 for matches, with relative match-training risk of 5.74. Also, muscle strains account for 46% of practice injuries and 22% of pre-season game injury.[17]

The study findings showed that athletes slightly took more time before injury compared to their personal best time records (personal goal). These findings are in line to those from a study done in the US by Anderson and Green about personal best as reference points for chess players.[18] Findings from the chess study showed that players were far from their personal best ratings. As much as personal best ratings among athletes mediate performance achievements, the athletes post injury ratings do not undermine personal goals to improve competitive performance. Instead, they also help runners achieve their best possible ratings.[19]

Athletes had a significantly lower performance rating upon return to sport when compared to ratings before injury (p<0.001). These findings are in line with those from a prospective study carried out in Australia to assess player performance following return to sport after hamstring muscle strain injury. The average performance of the two games which players participated in was 6.8 before hamstring injury which reduced to 5.4 after hamstring injury. Significant low performance was observed on return to sport compared to sport performance for the entire season (p<0.001) and when compared to sport performance from the two games before hamstring injury (p<0.001).[20] This can be explained by some athletes returning to sport before a complete resolution of the injury where the athlete exhibits mechanical alterations such as change in muscle length at different levels of force production.[21]

CONCLUSION

The study concludes that the prevalence of hamstring injuries among endurance runners in Kenya's rift valley region is still so high. A rate of 29.4% acute hamstring injuries insinuates a lifetime impact in runners health more so the physical well-being. The fact that most athletes come from this region forms the basis for future research to further investigate factors contributing to hamstring injuries and interventions to prevent re-injury or and lower injury rates. The observational checklist of hamstring injury treatment protocols was not adequately used. Lower numbers of use were observed across all the domains of the guideline.

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