SUMMARY
The main objective of this pilot study is to compare knee kinematics of runners to that of non-runners. Twelve runners and 12 non-runners participated in this study. Flexibility of lower limb muscle groups was assessed. Gait kinematic data were recorded at the knee using an electromagnetic motion tracking system. The following parameters were extracted and used for group comparison: knee angle at initial contact, peak knee flexion angle during loading response and angle range. No difference was found between the groups for flexibility of the lower limb muscles. As regards kinematic variables, runners had greater knee flexion and internal rotation angles at initial contact and during loading response compared to non-runners. Although participants in both groups had similar clinical profiles, runners exhibited different sagittal and transverse plane knee kinematics compared to non-runners. The observed gait pattern might be an adaptation inherited from the neuromuscular specificity of the sport itself.

INTRODUCTION
Many studies agree that mechanical knee loading, whether related to obesity, biomechanical alteration of the knee, exposure to heavy load occupational activities or intense sports, is an important factor in the development of knee osteoarthritis (OA) [1]. The subject of knee OA among runners has been the focus of numerous studies but the cause-effect relationship is still unclear. While Cheng et al. (2000) report that people who practice running intensively are more likely to develop knee OA, Chakravarty et al. (2008) [2] conclude that the regular practice of running does not accelerate the progression of radiographic knee OA. Knowing that knee OA is multi-factorial, exposure to repetitive loading associated with running is certainly not the unique factor contributing to the development of this disease in an individual. Many authors agree that dynamic knee kinematics and kinetics are important factors [3]. Kinematic parameters such as exaggerated knee adduction/abduction or internal/external rotation angles measured during walking can make a person vulnerable to knee OA. If these knee kinematic factors are observed in a runner’s knee when he walks, exposure to repetitive loading experienced when he is running might, unsurprisingly predisposed him to knee OA.

Gait analysis, performed and interpreted by individuals capable of doing so, has been recognized as a clinically useful tool for patients with neurological disorders such as cerebral palsy [4]. However, rarely is gait kinematic analysis used to help in therapeutic decision making or as a tool to assess treatment outcomes by clinicians working in the field of orthopaedics. We believe that gait kinematic analysis can provide information that, when combined with the data obtained from a thorough clinical examination, can help identify runners at risk of developing knee OA. The goals of this study are twofold: 1) compare the knee kinematic data of a group of asymptomatic runners to those of a group a sedentary persons to investigate whether the runners present a knee kinematic signature making them different from sedentary persons; 2) comment on the feasibility of using knee gait kinematics as an evaluation to identify runners that might be at risk of developing knee OA. Preliminary data focusing on objective 1 are presented here.

METHODS
Twelve healthy runners (4 women, 6 men) and 12 sedentary persons (8 women, 4 men) not exposed to mechanical loading related to sports or occupational activities, with no diagnosis of knee OA have participated in this study so far. Institutional ethics approvals were obtained and all patients signed the informed consent. To comment on the technical feasibility of integrating gait analysis outcomes with the clinical evaluation of workers presenting with a knee dysfunction, the study was not conducted in a laboratory but in a real clinical setting. Information on training intensity (frequency, distance/week and competition level) was obtained through a questionnaire. Flexibility of the hamstring was assessed with the Active Knee Extension (AKE) test [5] and the Thomas test [6] was used to measure the flexibility of the ilioiopsoas (hip flexion angle) and rectus femoris (knee extension angle) muscles. Ankle plantar flexors were assessed by measuring the dorsiflexion angle in a weight bearing position. Moreover, the presence or absence of iliobial band contracture was noted if the thigh was moving towards abduction while performing the Thomas test.

Three-dimensional position and orientation of the femur and the tibia were recorded with an electromagnetic motion tracking analysis system (Fasttrak, Polhemus, Vermont, USA) while the participants walked on a treadmill. The side to be evaluated was randomly assigned. After an 8-minute warm-up period, a knee sensor attachment system [7] (KneeKG™, EMovi Inc., Canada) was installed on the participant’s lower extremity. This system is composed of a femoral part, clamped non-invasively on the femoral condyles, and a tibial part, fixed with Velcro bands on the medial side of the tibia. Electromagnetic sensors were fixed onto both the femoral and tibial parts (rigid bodies). A third electromagnetic sensor was located on the sacrum via a sacral belt to help identify the hip
joint axis. For each participant, one 25-second trial was recorded and saved for data analysis. The center of the joint and the coordinate system were defined with reference to the functional and postural approach proposed by Hagemeister et al. [8]. The following parameters were extracted from the data and used for group comparison: knee angle at initial contact, peak knee angle during loading response, peak knee angle during the swing phase and angle range. Group comparison for clinical and kinematic variables of interest was performed with a non-parametric procedure (Mann-Whitney, level of significance was set at \( p<0.05 \)).

RESULTS AND DISCUSSION

Characteristics of the participants results related to flexibility tests are outlined in Table 1.

Table 1: Participants’ characteristics and clinical tests results

<table>
<thead>
<tr>
<th>Participants' characteristics</th>
<th>Runners (n=12)</th>
<th>Non runners (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>43.8 (5.5)</td>
<td>43.3 (10.1)</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>73.9 (12.4)</td>
<td>74.3 (13.8)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>173.6 (8.5)*</td>
<td>164.8 (8.5)</td>
</tr>
<tr>
<td>Body mass index (Kg/cm²)</td>
<td>24.5 (3.7)</td>
<td>23.3 (3.5)</td>
</tr>
</tbody>
</table>

From these results, one can observe that the group samples were similar in terms of age, weight and body mass index and muscle flexibility.

No difference was observed between the groups for cadence (51.2 ± 4.1 steps/min for runners vs. 52.5 ± 2.4 steps/min for non-runners) and gait speed (0.72 ± 0.8 m/sec for runners vs. 0.79 ± 1.0 m/sec for non-runners).

For flexion-extension movements, runners demonstrated greater knee flexion angles at initial contact, during loading response and during the swing phase than non-runners (IC: 18.1 ± 6.1° for runners vs. 12.5 ± 4.4° for non runners; LR: 21 ± 6.5° for runners vs. 15.3 ± 4.9° for non runners; S: 62. ± 5.2° for runners vs. 52.7 ± 6.4° for non runners). With regard to abduction/adduction movements, no difference was observed between the groups. Finally, internal/external rotation movements show that the runners had smaller knee external rotation angle at initial contact, greater knee internal rotation in terminal stance (IC: 5.2 ± 1.9° for runners vs. 1.9 ± 2.2° for non runners; TS: 5.5 ± 3.5° for runners vs. 1.3 ± 1.5° for non runners).

These data suggest that since cadence and gait velocity are similar in both groups, these variables might not be responsible for the differences observed for the kinematic parameters. The reason why runners from our sample walked with this kinematic pattern cannot be explained by the results of this pilot study. A possible explanation for the observed difference might be related to gait strategy adaptation inherited from the specificity of their sport. Nevertheless, we do know that a knee flexion gait pattern raises a red flag in a clinician’s mind. This greater knee flexion can increase the compressive forces between the patella and the femoral condyles, making those walking with this pattern vulnerable to patella-femoral knee OA over the long term. Moreover, internal rotation of the tibia may relocate the joint contact force on a cartilage not adapted to receive this load. Gait strategies aimed at decreasing knee flexion and/or internal rotation should be considered.

The secondary objective of this study was to comment on the feasibility of using knee gait kinematics as an evaluation tool in a real clinical setting. Our main comment is that the instrumentation and protocol used to record knee kinematics was designed to overcome many issues highlighted with the use of gait analysis in a clinical environment. The time required to perform both the clinical and gait kinematic evaluations was approximately an hour and a half, which is a little longer than the time it usually takes an experienced physical therapist to complete an initial evaluation for a patient consulting for a knee problem. Data processing and analysis were fast; the data output was readily available in a convivial format within 5 minutes so it could be used by a clinician to determine the next plan of action for a patient.

CONCLUSIONS

The results of this study support the concept that runners exhibit knee kinematics that are different from that of non-runners. We do believe in the clinical potential of using gait analysis for determining kinematic factors that may predispose runners or other athletes to knee OA development or progression. Some of these factors could be modifiable with specific strengthening exercises or gait training programs.

ACKNOWLEDGEMENTS

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REFERENCES