

THE Evidence-Based Dancer

MADE TO move
MADE TO move
MADE TO move

Demands at the Knee Joint During Jumps in Classically Trained Ballet Dancers

T. S. Lemes¹, G. A. G. De Villa¹, A. P. Rodrigues¹, J. M. A. Galvão¹, R. M. Magnani^{1,2}, R. S. Gomide¹, M. B. Millan¹, E. M. Mesquita¹, L. C. C. Borges¹ and M. F. Vieira¹

¹ Bioengineering and Biomechanics Laboratory, Federal University of Goiás, Goiânia, Brazil
² State University of Goiás, Goiânia, Brazil

Abstract— The aim of this study was to analyze the differences in ground reaction strength and knee mechanics joint in four jumps usually trained in ballet: *Changement*, *Echappé Sauté 1* (fifth position for second position), *Echappé Sauté 2* (second position for fifth position) and *Sauté*. Fifteen professional dancers participated in this study, exceeding a weekly 15 hours of classes. The participants performed three trials of each jump in a randomized order on a force platform. The *Sauté* jump produced the greatest peak knee moment in both propulsion (<0.001) and landing phases (<0.001), but the lowest rate of force development in propulsion phase (0.023). These results indicate that *Sauté* is performed with a deeper plié in both propulsion and landing phases, with smaller ground reaction force peak and knee peak force. This pattern of jumping may be less harmful and should be adopted in the other jumps by classical dancers who perform such exercises daily several times.

Keywords— Demand, jumps, knee

Professional classical dancers perform more than 200 jumping and/or landing actions in daily training sessions. Vertical jumps have been used in studies [9–11] as tests to evaluate the performance and other characteristics of the lower limbs. Some of the daily jumps of classical ballet have characteristics like those of vertical jumps, as they are jumps that do not have anterior-posterior displacement and have phases of propulsion, flight, and landing. Thus, variables and calculations similar to those of studies involving vertical jumps can be used to evaluate these ballet jumps [12].

Therefore, the aim of this study was to analyze the differences in knee demand in four jumps usually trained in ballet: *Changement*, *Echappé Sauté 1* (fifth position for second position), *Echappé Sauté 2* (second position for fifth position) and *Sauté*, to verify which jump has the greatest potential for injuries. We hypothesize that landing phase produces results more deleterious than propulsion phase, and the jumps performed in fifth position would be of greater risk.

I. INTRODUCTION

The specificities of classical ballet require a lot of dexterity and training to perform the only form of dance that encompasses a high level of athletics and unique visual aesthetics [1]. The practice of dance, including classical ballet at high levels of preparation, can be considered a sport, due to the amount of intense rehearsals and classes performed by its practitioners [2]. Around 73% of the severe injuries were traumatically caused when performing jumps and lifts [3]. One of the aspects that most demand ballet practice is the jumping movements [4] which require a high mechanical demand for rapid muscular effort in the lower extremity and are associated with joint injuries. There are an alarming number of injuries caused by the frequent practice of ballet, and some studies [5,6] report that injuries to the feet, ankles, knees and spine occur constantly, so that these segments are susceptible of chronic and acute illnesses. The most frequently knee injuries in dancers are related to patellar alignment, inflamed plica, or torn meniscus or cruciate ligaments [7].

The ground reaction force (GRF) is a variable of interest due to its potential correlation with high injury rates. Greater ground reaction force can have harmful effects on the body and can result from an inadequate ground surface, poor technique, or footwear used [8].

II. MATERIAL AND METHODS

A. Subjects

Fifteen individuals (6 males and 9 females; age: 21.4 ± 3.1 years; body mass: 57.2 ± 8.6 kg; height: 1.66 ± 0.08 m) participated in the study with ballet experience of 10.6 ± 5.9 years, and exceeding a weekly 15 hours of classes. All participants were tested in individual sessions. The subjects performed three trials of each jump in a randomized order on a force platform. The execution of all trials was validated by a dance specialist, who also applied a question form to learn about demographic characteristics and possible injuries.

B. Protocol

The volunteers were instructed to perform the jumps keeping their hands on their waist to exclude the contribution of the upper limbs. They were also instructed to perform the jumps as they do during classes.

A force platform (AMTI, model OR6-7) positioned on a flat and stable surface was used to collect GRF. Both kinetic and kinematic data were captured using full body plug-in-gait at sampling frequency of 100 Hz by the Vicon system, which

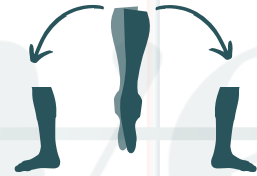
THE Article

- a randomized trial looking at the knee demands during four classical ballet jumps

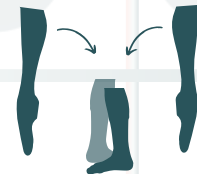
- sauté,



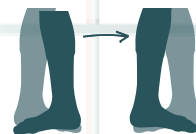
- échapé (1st to 2nd),



- échapé (2nd to 5th)



- and changement





- published in 2022 by the Brazilian Congress on Biomedical Engineering

THE Takeaways

- Looked at Ground Reaction Force (GRF) because of its correlation with high injury rates
- Increased GRF can be due to
 - inadequate ground surface,
 - poor technique,
 - or footwear



THE Takeaways

- Propulsion phase  = deepest part of plié to loss of contact w/ floor
- Landing phase  = first contact w/ floor to deepest part of plié
- Landing phase more demanding on knee joint than propulsion phase



THE Takeaways



- Plié (prep & landing) for a **sauté** was deeper than other 3 jumps
- GRF and the maximum force going through the knee joint was the least for **sauté**
- Therefore **sauté** is performed in the safest way
- This safer way of jumping should be adopted in other jumps

Like this post?

Follow [@madetomove.ca](https://www.instagram.com/madetomove.ca) for more!

Questions?

Email hello@madetomove.ca!

Dance friends?

Share this link!