

## THE STUDY OF KNEE JOINT FORCE AND TORQUE DURING STEPPING EXERCISE ON THE GROUND AND UNDERWATER

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**KEY WORDS:** stepping exercise, impact force, inverse dynamics.

**INTRODUCTION:** Step aerobic is a popular exercise in a fitness center. Unfortunately, stepping activities will bring lower-extremity stress and pain especially for stepping dancer in aerobic exercise (Hains et al., 1997). This study characterized the lower-extremity joint biomechanics associated with stepping activities in different environment. The impact forces on knee joint are important for walking, running and stepping in the lower-extremity, because it may cause knee joint injuries such as OA. Loading is also believed to play a role in the onset of OA (William et al., 2004). He found that the forces at the knee are considerably larger during stair climbing than during walking: the average resultant peak force during stair climbing is 5.4 times body weight (BW). Because of the decrease of the BW loading, former researchers agree that exercises underwater are better than those on the ground. Therefore, the purpose of this study is to identify the knee joint loading difference between ground and underwater stepping exercise. My hypotheses are 1) the knee force underwater is larger than on the ground during the up stepping position; 2) the knee force underwater is smaller than on the ground during the down stepping position.

**METHOD:** All participants chosen are healthy and without lower-extremity disease. Moreover, they participate in both step testing on the ground and underwater respectively. The experimental stair is 35 cm in height and all subjects have to finish the stepping exercise within three minutes continually at 96 rpm. The reason for using the two measurements above is because they are the standard of testing generally used in Taiwan during the public sports enhancement test. The kinematics data will be collected by SONY digital camera (30Hz) from the ground and Dae Han digital camera (30Hz) from underwater. The motion analyses will use SIMI motion analysis system; calibration parameters obtained from the image of a calibration frame recorded previously to the stepping cycles. The filtering method chosen is band pass filter. The kinetic data will be collected from an AMTI force plate, the sampling at 500Hz. To standardize the data of on the ground and underwater measurements, the data will be transformed into the rates of body weight. The knee joint force will be obtained from the inverse dynamics theory. The body segment parameters are derived from the previous research data (2005) of Wei-Hua Ho et al., whom has already established a system of body segmental parameters for Taiwanese. The statistics used is a paired sample *t*-test to make knee joint force comparisons between on the ground and underwater.

**RESULTS:** Frequent stepping exercise is an influential factor in knee joint injuries. But, we still haven't got a clear solution as to an expert advocating underwater exercise. We would like to find out from this study the difference between knee joint impact force and torques during stepping activities on the ground and underwater. Therefore, this study will be able to determine the measuring of the knee stress force especially for elder people and people with obesity. And, not only can it be used as biomechanics analyses but it also allows us to understand the physical condition of stepping activity.

**DISCUSSION & CONCLUSION:** As indicated by previous studies, knee pains will result from stepping activities when excessive force is exerted on knee joints over time (William et al. 2004). Because of this we could assume that ground stepping exercise could cause chronic injury. A number of coaches are under the impression that stepping exercises underwater are better than those on the ground. From this study you will understand the difference of knee joint impact force and torques between stepping activities on the ground and underwater. In the future, we will be applied in measuring for different age, gender and physical condition analyses.

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