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The relationship between fin stiffness and fin swimming speed in snorkeling

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博士学位論文内容要旨
Abstract

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論文題目 Title	The relationship between fin stiffness and fin swimming speed in snorkeling		

Marine sports and recreational activities that use fins include snorkeling, skin diving, scuba diving, and fin swimming. Snorkeling is an activity that uses a mask, snorkel, fins, and a jacket (buoyancy device). The snorkeler moves along the surface of the water with buoyancy maintained as if drifting, watching the undersea world without ever sinking below the surface. The snorkeler breathes continuously through a snorkel, which is held in the mouth. Ability to swim at higher speeds allows the snorkeler greater scope for action, and is thus likely to improve the safety of the activity.

In studies focusing on differences in fin material and stiffness in fin swimming, a study of male university swimmers swimming crawl for 60 m with fins and a study of male lifeguards swimming 25 m with fins while pulling along a rescue mannequin reported faster swimming speeds when using fins made of harder material. Also, a study of ordinary female divers reported higher swimming speed in 20 m underwater fin swimming with more flexible fins. In addition, a study in children that measured swimming speed of 50 m and 100 m crawl using fins found faster swimming speed using flexible fins for 50 m and using stiff fins for 100 m.

The above prior studies may be taken to show that fin stiffness for obtaining faster swimming speed is related to factors including gender, skill level, swimming style, and swimming distance. However, textbooks and instructional books on sports that use fins only explain that fins of flexible material are suitable and that the degree of stiffness should be selected on the basis of stamina and leg strength, with no specific expression in numerical form and without showing any precise grounds for this. In addition, no studies can be found that examine the relationship between fin swimming speed and leg strength, which is essential for the fin kick movement.

The present study therefore investigated the relationship between fin stiffness and fin swimming speed during snorkeling in snorkelers of differing skill levels, using knee extensor muscle strength as an index of leg strength, in order to collect basic data on fin stiffness that would be criteria for fin selection.

In Section 2, data were collected from 224 beginner level snorkelers who swam 25 m and 100 m flutter kick (FK) and 25 m under-arm push (UAP). Fin swimming speed was analyzed by means of a multivariate analysis of variance (ANOVA) with gender, knee extensor muscle strength group (high group [HG], medium group [MG], and low group [LG]), swimming style (FK25 and UAP25, FK25 and FK100), and rubber hardness (A75 [soft], A80 [medium], and A85 [hard], based on Japan Industrial Standard K6253A) as main factors. The results suggested that regardless of gender, knee extensor muscle strength, swimming style, or distance, selection of flexible A75 fins was advisable for the purpose of swimming fast.

In section 3, data were collected from 75 instructor level snorkelers who swam 25 m, 100 m, and 200 m FK. Fin swimming speed was analyzed by means of a multivariate ANOVA with gender, knee extensor muscle strength group (HG, MG, LG), swimming style (FK25, FK100, FK200), and rubber hardness (A75, A80, A85) as main factors, and the results suggested that regardless of gender, knee extensor muscle strength, or distance, selection of A75 and A80 fins was advisable.

In section 4, data were collected from 27 competition level snorkelers (fin swimming athletes) who swam 25 m FK. Fin swimming speed in FK 25 was analyzed by means of a multivariate ANOVA with gender, knee

extensor muscle strength group (HG, MG, LG), and rubber hardness (A75, A80, A85) as main factors, and the results suggested that regardless of knee extensor muscle strength, selection of stiff A85 fins was advisable in male athletes.

In Section 5, data from a total of 292 snorkelers (173 male, 119 female) comprising 224 beginners (139 male, 85 female), 41 instructors (23 male, 18 female), 27 competitive athletes (11 male, 16 female) were examined as an overall analysis by means of a multivariate ANOVA of fin swimming speed during FK25, the swimming style that was measured in all the above analyses, with skill level (beginner, instructor, competitor), gender, knee extensor muscle strength group (HG, MG, LG), and rubber hardness (A75, A80, A85) as main factors. The results suggested that selection of A75 fins for beginners, A75 and A80 fins for instructors, and A75 fins for women was advisable.

This study investigated the stiffness of fins that should be selected by considering the factors gender, skill level, leg strength, and swimming style/distance that were demonstrated to be related to fin selection, using fin swimming speed as an index. The results suggested that at beginner level, selection of flexible A75 fins is advisable, regardless of gender, knee extensor muscle strength, swimming style, or swimming distance. For instructor level snorkelers, the results suggested that selection of flexible A75 fins or medium A80 fins is advisable regardless of gender, knee extensor muscle strength, or swimming distance. For male competitors, the results suggested that selection of stiff A85 fins is advisable regardless of knee extensor muscle strength. For women, it was shown that fast fin swimming can be achieved with selection of flexible A75 fins, regardless of skill level or knee extensor muscle strength.

The foregoing results therefore suggest that selection of fins for snorkeling is affected by skill level and gender. The optimal fin stiffness clarified by this study is the same as that of the material used for commercially available fins, so that more specific criteria for fin selection can be shown.