Concurrent Validity of Front-Crawl Swimming Competence through Measurement of Basic Swimming Abilities for Beginners

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Received April 23, 2021; Revised June 15, 2021; Accepted July 19, 2021

Cite This Paper in the following Citation Styles

(a): [1] Badruzaman, Yudha M. Sapetra, Agus Rusdiana, Jajat, Tono Haryono, "Concurrent Validity of Front-Crawl Swimming Competence through Measurement of Basic Swimming Abilities for Beginners," *International Journal of Human Movement and Sports Sciences*, Vol. 9, No. 4A, pp. 8 - 14, 2021. DOI: 10.13189/saj.2021.091302.

(b): Badruzaman, Yudha M. Sapetra, Agus Rusdiana, Jajat, Tono Haryono (2021). Concurrent Validity of Front-Crawl Swimming Competence through Measurement of Basic Swimming Abilities for Beginners. *International Journal of Human Movement and Sports Sciences*, 9(4A), 8 - 14. DOI: 10.13189/saj.2021.091302.

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Abstract The study aimed to examine the concurrent validity of front-crawl swimming competence as a criterion by measuring the basic swimming ability for estimated swimming distance. The research samples were 35 students (15 people from the Sports Science program and 20 from the Physics program) aged 19-21. The seven components of basic swimming ability, including submerging, floating, gliding (Gd), leg propulsion, hand propulsion, leg coordination, and breath control, were the predictors, while the front-crawl swimming competence referred to the criterion. Concurrent validity analysis used PPM correlation, while factor analysis used stepwise multiple regression methods. The results indicated a significant association between basic swimming abilities and swimming competence. The moderate relationship ($r = 0.4-0.7$, $p < 0.01$), was found in gliding, leg propulsion, hand propulsion, hand and leg coordination, and breath control. While the relationship in the ability to submerge and float is weak ($r = 0.22$ and 0.16 , $p < 0.05$). Basic swimming ability as an estimator of swimming competence has a significant concurrent validity in the moderate level, except for the basic ability to dive and float, which were in the weak category. Only two factors are estimated to have the greatest influence on the beginner's front-crawl competence achievement, namely basic ability to control breathing and coordination of legs & hands.

Keywords Concurrent Validity, Swimming Competence, Basic Swimming Ability, Measurement

1. Introduction

Having swimming competence is important, especially as a preparation for possible drowning accidents [1]. There are many benefits associated with the ability to swim. Increased swimming competence is almost certain to be protective in drowning situations. Differences in swimming competence may explain why some are at a greater drowning risk than others [2]. Swimming competence has environmental characteristics that are different from activities on land. In addition to requiring a general motor ability, it must also have special abilities required in the water environment. The success of one's swimming competence can be determined by these special basic abilities, such as ability to dive, float, glide, leg motion to push (leg propulsion), arm movement to push (hand propulsion), coordination of leg & arm movements, and the ability to take a breath (breath control) [3]. This basic swimming ability is a battery that can be used as a measure to estimate the achievement of swimming competence [4]. Floating, diving, underwater swimming, and swimming for technique are basic water competency

skills. Yet, these skills are essential aspects of the concept of water competence [5]. Meanwhile, between 15-20% are unable to swim at a distance of 25 meters. Reviewing the reality of the problem's condition encourages the assessment of basic swimming skills to estimate swimming competence as a criterion through concurrent validity testing.

Measuring basic swimming skills for the beginning includes fear removing test, submerging test, floating test, gliding test, and full stroke forward movement. Findings show submerge 1.4 (W2), 4.3 (W4), 7.5 (W6), floating 3.5, 4.3, 7.5, gliding 4.6 (W4) 7.4 (W6) (6), and full stroke 6.67 [7]. Eight skill elements emerged finally as both irreducible and irreplaceable within a beginner swimming course [8]. A study on children swimming 25 m and declared as 'swimmers' shows that one quarter (26%) of them could not enter deep water by either a jump or dive. In other university students, most of them (76%) could comfortably swim more than 300 m nonstop, but only 40% who could float for 15 minutes. Such grouping facilitates diagnosis, forces a more balanced and comprehensive outline of instruction, and affords a helpful pattern for selecting practical skills [9]. Actual performance evaluation was also used to identify the respondents' swimming ability level through a rubric [10]. The obtained data show that our athletes achieved a similar distance when gliding supine or prone distance, float, and back float. This test battery included specific skills from levels 1-5 of the American Red Cross Learn to Swim Program [1].

A powerful positive and significant relationship was observed between self-reported ability to swim and self-reported number of laps [11]. There is a weak correlation between practical skills tests and survey methods [12]. The arm propulsive motion phase was observed to generate strong vortical structures that travel along the body and toward the kicking legs. Most of the arm propulsion was generated when the hands were moving backward. The breathing actions of the non-expert swimmers amplified their asymmetric coordination on the breathing side [13]. The swimmer was modeled as if he was gliding underwater in a streamlined prone position, with hands overlapping and head between the extent [14].

Theoretically, the ability is a trait presence that underlies or contributes to success in several related skills [15]. The term abilities can also be interpreted to refer to a person's potential movement competencies instead of actual movement performances [16]. Movement behaviors are not based on a singular global ability, but also on many specific abilities, perhaps thousands [17]. The particular abilities underlying springboard diving are entirely different from those underlying tennis performance.

The ability has implications for one's performance in various activities, including swimming. An individual is said to have a high level of ability to carry out complex tasks [17]. It should be considered that swimming is

separated from the other sports mainly because of the body's prone position, the controlled respiration caused by water immersion, and the fluctuant environment in which forces are applied [18]. The ability to submerge with open eyes substantially advanced the learning process [19].

Term of water competency is a more comprehensive term than swimming ability and better describes a raft of aquatic skills and knowledge associated with aquatic activity [20]. Swimming researchers also contribute to initiating new techniques, drills, teaching, and training methods based on scientific principles [22]. A beginner was any subject who could not swim one length (25 yd.) (22.86 m) [21]. Therefore, this study aimed to test the concurrent validity to confirm the relationship between basic swimming ability as predictor factors and front-crawl swimming competence as a criterion, not as a measurement test to prepare for the prevention of drowning accidents.

2. Methods

The research subjects consisted of 35 students (age 19-20). 20 students were from the Sports Science study program and 15 students were from the Physics study program (28 males and 12 females). Subjects were beginner swimmers who have not been able to swim at a distance of 25 m [21]. A beginner was any subject who could not swim one length (25 yd.). The subject had not been given a swimming learning program in this study. The distance covered was considered the criterion. This study was limited only to the concentration on front crawl stroke to sharpen the focus of the further analysis. Interestingly, in Canada and Australia, learn-to-swim programs primarily emphasize teaching and learning the front crawl stroke. The front crawl is easy and considered as the fastest and most efficient style [24].

Instrument

To test the concurrent validity, a direct practice test and measurement of basic motor skills with a swimming competition test that refers to the concept as described were conducted. Likewise, the content of basic swimming ability referred to the validity of the construct. The basic swimming ability content being considered included diving ability test (seconds), buoyancy test (seconds), glide ability test (distance), leg motion test to push, arm motion test to push, leg and arm coordination test, and breath control, as predictors. Swimming performance is determined by generating propulsive force while reducing the resistance to forwarding motion [25].

Procedure

The first test item was head and whole-body immersion,

then the body float test, glide test, leg motion test, arm motion test, leg & arm coordination test, and breacktaking test. The last was the swimming distance competence test. The test for each item was carried out in groups of 5 people. In the diving test, students held iron and began preparations to stand facing the edge of the pool. After the signal of the whistle, all students had to put their heads in the water simultaneously. Along with the whistle sound, the stopwatch was pressed. Measurements were recorded in seconds once each subject's head comes out of the water.

Float test execution procedure included 1) the first subject was ready to stand in line with wings facing the pool wall, one meter from the wall, 2) when hearing the whistle sound, immediately the whole testee/subject floated his body to the surface of the water and maintained it as long as possible, 3) simultaneously with the sound of the whistle, the stopwatch was switched on, 4) the measurement was recorded in seconds when the teste's head had come out of the water surface or the feet had touched the floor. Glide test procedure included preparation of the testee standing against the pool wall, one leg bent, and the sole of his foot also attached to the pool wall. At the signal of the whistle, the testee slid by turning his feet against the pool wall, then slid his body as far as possible.

Analysis

Concurrent validity analysis used Pearson product-moment partial correlation. Factor analysis used multiple linear regression with the Stepwise method. The correlation value <0.4 represented poor correlation, 0.4 to 0.7 fair, 0.7 to 0.9 good, and >0.9 excellent [25]. All statistical calculations used the Statistical Package for Social Science (SPSS v.25) and the level of significance was <0.05 .

3. Results

Table 1 shows basic swimming ability and swimming competence, including submerging, floating, gliding, leg

propulsion, hand propulsion, coordination of leg & hand propulsion, breath control, and swimming competence. The measurement of mean, minimum score, maximum score, range, standard deviation, and standard error of all variables are shown in Table 1.

According to Table 2, there were two components of basic swimming ability that have no significant concurrent validity with swimming competence, namely the ability to dive and float with a correlation coefficient value below $r = 0.30$. Meanwhile, there were five components of basic swimming ability which have a significant correlation coefficient in a moderate category, namely gliding with SC ($p < 0.01$), leg propulsion with swimming competence ($p < 0.01$), HP with SC value $r = 0.604$, CL & HP propulsion with SC ($p < 0.01$), and BC with SC ($p < 0.01$). The highest concurrent validity score was obtained between breathing ability and swimming competence with $r = 0.675$ in the moderate relationship category.

Only two variables were selected into the regression model that met the Probability of F to enter criteria ≤ 0.05 or ≥ 0.10 , namely the breath factor (see Table 3), breath control, and coordination of leg & arm movements. Model 1, R^2 value for breath factor, was 0.456 (45.6%). Basic ability to breath in swimming (BC) had a contribution of 45.6% to front crawl swimming competence. The basic ability to breath simultaneously with the legs and arms coordination contributes 58.7% to front crawl swimming competence. Other factors contributed to the remaining 40.3%.

In Table 4, the ability to breath had a significant impact on swimming distance competence ($p < 0.00$). This means that model 1 breath control can be used to predict swimming competence. Model c, the ability to breath and the coordination movement of the legs & arms as a predictor, had a value of $F = 22.75$, $p < 0.00$. The two essential swimming ability factors, including ability to take breath and leg and arm coordination, significantly affected the student front crawl swimming competence.

Table 5 shows that the breath factor had a significant effect on swimming competence. Likewise, the leg & arm coordination factor had a significant impact on swimming competence ($p < 0.05$). Thus, it was selected into the stepwise regression model.

Table 1. Descriptive data of basic swimming ability and swimming competence

No	Dependent and Independent Variable	Measure	Mean	Minimal	Maximal	Range	Sd.	SEE
1	Submerge (Sm)	second	17	1.60	27.59	25.99	5.26	0.88
2	Floating (Ft)	second	16	1.00	52.95	51.94	9.60	1.62
3	Glide (Gd)	meter	3.51	0.00	7.00	7.00	1.40	0.23
4	Leg Propulsion (LP)	meter	5.51	3.00	9.00	6.00	1.77	0.29
5	Hand Propulsion (HP)	meter	7.90	5.00	11.00	6.00	1.62	0.27
6	Coordination of Leg & Hand Propulsion (CL & HP)	meter	9.14	4.00	14.00	10.00	2.26	0.38
7	Breath Control (BC)	frequency	1.80	0.00	4.00	4.00	1.05	0.17
8	Swimming Competence (SC)	meter	10.94	7.00	15.00	8.00	2.01	0.34

Table 2. Concurrent validity correlation matrix between swimming basic ability and swimming competence

S.B.A.	S.C.	Submerge	Floating	Glide	LP	HP	CL & HP	BC
Submerge	0.223	1	-0.052	0.072	0.112	0.115	0.089	0.217
Floating	0.161		1	0.474**	-0.147	-0.088	0.027	0.126
Glide	0.438**			1	0.423*	0.223	-0.024	0.411*
L.P	0.602**				1	0.758**	0.201	0.641**
H.P	0.604**					1	0.570**	0.490**
CL & HP	0.466**						1	0.161
BC	0.675**							1

Table 3. Results analysis of stepwise multiple regression linear methods

Model	Predictors Variable	R	R Square	Adjusted R Square	Std. Error of Estimate	Durbin-Watson
1	Breath Control	0.675a	0.456	0.439	1.50824	
2	Breath Control, CL & HP	0.766b	0.587	0.561	1.33390	1.529

Table 4. Results of ANOVA test

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	62.818	1	62.818	27.615	0.000b
	Residual	75.068	33	2.275		
	Total	137.886	34			
2	Regression	80.948	2	40.474	22.747	0.000c
	Residual	56.938	32	1.779		
	Total	137.886	34			

Table 5. T-test and multicollinearity test

Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	8.616	0.511		16.865	0.000		
	Breath C	1.293	0.246	0.675	5.255	0.000	1.000	1.000
2	(Constant)	5.832	0.928		5.937	0.000		
	Breath C	1.180	0.220	0.616	5.352	0.000	0.974	1.026
	CL & HP	0.327	0.102	0.367	3.192	0.003	0.974	1.026

4. Discussions

Based on the results, there was a relationship between basic swimming ability factors and front crawl swimming distance competence. Five basic swimming ability factors significantly correlated in the moderate category with front crawl swimming competence. The five factors were gliding capability, leg propulsion, hand propulsion, leg and arm coordination, and breath control. Two factors had a weak correlation. They were the ability to dive and float. It could be understood because these two basic swimming abilities do not generate distances. However, the ability to dive in swimming has a vital role. It is the first foundation that must be implanted to facilitate float and move forward [19].

The ability to immerse the body and float in the water are the basic abilities to support the next ability. People who have difficulty engaging their bodies in the water will

have problems floating their bodies to the water's surface. Likewise, the essential ability to float serves to make it easier for the body to move above the water surface. Thus, the ability to float has a vital role in the sufficient swimming competence to cover a certain distance compared to those without buoyancy [26]. A body's ability to float is important in most aquatic sports. The basics are that your body is lighter than water and floats [27]. Staying afloat is a major contributor to survival in an aquatic emergency. It is suggested that learning and mastering floating skills under unsteady, wavy water conditions may comprise an essential aquatic skill competence for the novice swimmer [5]. The results of previous studies explain that the ability to dive, float, and glide has a contribution to swimming distance abilities [28].

The ability to swim more dominantly results from the encouragement of leg and arm movements and the ability

to breath. Most of the arm propulsion is generated when the hands are moving backward [12]. The ability to move arms has a similar contribution to leg movement, which is 33.4% for swimming distance competence. This happens, based on observations, because their arm movements still do not have the correct technique, so they have not yet produced a maximum propulsion power. In contrast to trained swimmers/athletes, front-crawl stroke arm movement contributes 70 - 80% greater than leg movements' contribution [29]. It is not surprising that the hand and forearm are seen as the major propelling surfaces responsible for > 85% of the total propulsion in able-bodied front-crawl swimming [30]. The motion makes the propulsive force of the hand in front-crawl and backstroke, except for the breaststroke.

The ability to swim can take a breath [13] in non-expert swimmers, leading to suggestions that breathing may affect arm coordination. Swimmers roll further when taking a breath. A person who cannot take a breath will produce a limited swimming distance because of running out of oxygen. Conversely, if he can take a breath, he will continuously increase his physical strength to increase his swimming distance.

The stepwise multilinear regression test results were more convincing that two entered models were selected from seven basic swimming abilities, namely the ability to breath (breath control) and the coordination of leg and arm movements. It means that in front-crawl swimming competence for beginner swimmers, the strength of the carrying capacity lies in the collaboration between taking a breath and the coordination of leg & arm movements. It is consistent with the concept highlighting two essential aspects of swimming, named floating to permit breathing and propulsion to provide mobility. Understanding the interactions of arm coordination, leg kicks, and the body roll during arm strokes and breathing is essential [13]. In the whole stroke, coordination of arm and leg superposition coordination appears as the main solution over a critical speed of 1.8 m.s [31].

The concurrent validity test results between basic swimming ability and front-crawl swimming distance competence for beginners are in the moderate category on average. This fact is acceptable because all of the basic movement abilities performed have not been shown in the quality of movement techniques. Following the other findings, the swimming technique was given a low score [19]. Unskilled swimmers frequently have inadequate body roll [32]. Any two tests that had correlations of 0.70 or less were said to be specific [3]. Previous findings show that interval training has been related to freestyle swimming skills adolescent athletes [33]. In other words, measuring skills in sports is essential and must have good validity and reliability [34].

5. Conclusions

It concludes that the seven basic swimming abilities presented as content and predictors of swimming competence as a criterion had positive and significant concurrent validity in the weak to moderate category. Two basic swimming abilities had concurrent validity in weak categories, namely the ability to dive and float. The five basic swimming skills had moderate concurrent validity. In the seven basic skills stepwise method, only two were selected to be the variable involved into two models. The concurrent validity between basic swimming ability as an estimator and the front-crawl swimming distance competence as a criterion for beginners had concurrent validity in the weak to moderate category.

Acknowledgement

The authors would like to thank all the students who participated in the study and the Universitas Pendidikan Indonesia for allowing us to use swimming pool facilities during data collection.

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