The Reliability and Validation of the Aquatic Movement Protocol as an Instrument for Assessing Aquatic Motor Competence in Primary Aged Children

Nicole A. Pratt, Michael J. Duncan, Martyn G. Morris, and Samuel W. Oxford

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Construct Validation of the Aquatic Movement Protocol (AMP) in children aged 7- 9 years.

Nicole A Pratt
Coventry University

Michael J Duncan
Coventry University

Martyn G Morris
Coventry University

Samuel W Oxford
Coventry University

Abstract: There is a dearth of research in aquatic motor competency, a key requirement for primary physical education in order to become physically literate. This study proposes a new assessment protocol for aquatic motor competence and sets out to examine the validity of The Aquatic Movement Protocol (AMP) in children aged between 7-9 years. Test of Gross Motor Development–Second Edition (TGMD-2) was implemented to assess general motor competence including a composite of 10 m running sprint time and standing long jump distance. Aquatic motor competence was assessed by the AMP. Univariate ANCOVAs were used to examine whether assessment of general motor competence differed as opposed to aquatic motor competence. Process and product measures of dryland motor competence were analysed using 2 gender (male and female) and 3 aquatic motor competences (Low, medium and high). Cronbach alpha and exploratory factor analysis was implemented to show both construct and concurrent validity of the AMP. Children who were classified as high for aquatic motor competence had significantly higher general motor competence (P=0.001). Those who achieved a higher composite score for faster sprint speeds and longer jump distances had significantly higher aquatic motor competence (P=0.001). Cronbach's alpha of 0.908 showing internal consistency of the AMP. A factor of (Eigenvalue = 6.2; % Variance = 62.1) with loadings higher than 0.5. This data suggests that the items on the AMP measure a single construct that we would call: Aquatic motor competence. This study demonstrates that the AMP is a valid measure of aquatic motor competence in primary aged children.

Keywords: Swimming, Motor Competence, Aquatic, Dryland, Fundamental Movement Skills

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1. Introduction

Swimming is a statutory requirement in England within Physical Education and is a lifelong physical activity and motor skill. Therefore, developing competency in aquatic domains is important, but often overlooked in literature, as most studies focus on non-aquatic environments. The importance of learning how to swim has rapidly increased over the last decade due to the amount of fatality's worldwide with an estimation of 320,000 annual drowning deaths worldwide (World Health Organization, 2020). Swimming became a part of the National Curriculum for Physical Education (PE) to ensure safety around the water environment due to it being identified as a life skill (Parry, 2007). The National Curriculum PE states a child must be able to swim competently, confidently, and proficiently for 25 m by the time a child leaves primary school (Department of Education, 2013). A child also must use a range of strokes effectively and be able to perform safe self-rescue manoeuvres in a range of water-based scenarios by the end of primary school (Department of Education, 2013). It has been suggested teaching individuals to cope with the risk of drowning through the acquisition of swimming skills is an important aspect to drowning prevention interventions (Stallman et al, 2017). Recently a debate among drowning prevention experts have suggested further research to include attitudes and knowledge based around aquatic motor skills (Stallman et al, 2017).

In the last decade, there has been a rapid increase in the understanding of motor competence development being an important factor for promoting participation in physical activity and a variety of health benefits (DeMeester et al, 2020). Motor competence is defined as the degree of skilled performance in a range of motor tasks including coordination, control and movement quality (Burton and Miller, 1998). Most often motor skills are divided into two aspects; locomotor and object control skills which are combined and referred to as Fundamental movement skills (FMS) (Burton and Miller, 1998). Motor competence is found to have considerable associations with anthropometric variables (Shibli et al, 2008). Research has indicated obtaining excessive weights can cause negative alterations to a child's ability to perform fundamental movements (Bremer and Cairney, 2018). Children classified as overweight and obese causes significant alterations to their musculoskeletal system, which in later life can result in orthopaedic abnormality including considerable amount of health risks (Duncan and Stanley, 2012). Obesity and excess weight have a profound amount of risks on an individual's movement patterns indicating the importance in assessing anthropometric measurements. Previous research found there was significant links between body height and swimming performance, indicating individuals who are taller and with longer limb measurements perform better within the aquatic environment (Sekulić, Zenić and Grčić Zubčević, 2008). However, the impact of anthropometric measurements on children's swimming ability has not yet been examined in depth. A study by Erbraugh, (1986) found bodyweight to significantly influence swimming ability in children and found it to be a predictor of swimming ability. Adverse to this Gllareva et al, (2020) found that at an early stage of swimming development anthropometric measurements do not play a significant role in swimming performance.

Due to the positive relationship between motor competences, physical activity and sport as a whole, links between swimming and general motor competence become necessary. It has become apparent an enhancement in aquatic movements will result in an improvement in dryland motor skills, with children who participate in swimming lessons within an educational setting (school swimming lessons) have more defined motor development on a range of gross motor tests and especially with respect to object control skills (Martins et al, 2015). Previous research has shown prior participation in swimming programmes have resulted in optimized motor competence (Rocha et al, 2016). Several authors have studied children's motor development and the connections it has with the water (Erbaugh, 1979; Langendorfer and Bruya, 1995; McGraw, 1939). They described children aged between 3 and 5 years as being capable of performing aquatic movements similarly, as to how they develop motor competence on dryland (Murcia and Pérez, 2008). Previous studies have failed to identify a direct link between motor competence and movements within the aquatic environment (Murcia and Pérez, 2008; Rocha et al, 2016).

A study by Rocha et al, (2016) Investigated the impact swimming experience had on object control skills including; bounce, catch, over arm throw, under arm throw and strike and found children who engage in swimming and have swimming lessons demonstrated more efficient fundamental movement and motor skills compared to those who have not been swimming before. Rocha et al, (2016) failed to implement a method of assessment for aquatic motor competence therefore, made no attempt to quantify the association between general motor competence and aquatic motor competence. As a consequence of this, there were no consolidated evidence on whether aquatic motor competence have links with general motor competence and if fundamental movement skills were affected by swimming.

Swimming is compulsory for children in England at a primary school aged between 4-11 years (Swim England, 2020). School swimming lessons have been shown to optimise performance in a range of global motor skills (Martins et al, 2008). However, to date there are no protocols for assessing aquatic motor competence. Due to results and the profound amount of links between fundamental movement skills and swimming shown in previous research it has become an important factor for physical educators to implement assessments of swimming. These assessments can be implemented to employ new strategies to improve dryland weaknesses considering the impact swimming has on a child's fundamental movements (Martins et al, 2008; Langendorfer and Bruya, 1995). Aquatic motor competence assessment is poorly understood even though swimming being a critical part of the national curriculum it's important that further research is carried out to provide a deeper understanding of motor competency in swimming with respect to primary age children.

Currently, there is no evidence showing the associations between dryland and aquatic motor competences. It has been previously hypothesized that swimming can have a positive impact on general motor competence (Rocha et al, 2016). Developing this evidence base will demonstrate the importance of swimming in the national curriculum and its importance to a child's early development. Currently swimming curriculum standards are not being achieved with only half of children aged between 7 to 11 years old meeting the required swimming standard (Swim England, 2017). It is important to evaluate the impact swimming has on a child's motor development due to the considerable number of associations it has towards dryland performances. This study has identified the importance to employing a direct investigation between general motor competence and aquatic motor competence to prove the importance to swimming. Thus, the need is apparent for our first aim of this study (i) developing a valid and reliable assessment method for analysing aquatic motor competence "The Aquatic Movement Protocol (AMP)" which leads us onto our second aim (ii) allowing us to further investigate the associations between dryland and aquatic movements to see whether swimming has a positive impact on dryland motor competence.

2. Materials and Methods

2.1 Participants

Primary schools (n= 5) from central England were contacted and invited to participate in the study, all of these schools accepted. Following ethics approval (P61595) and informed parental consent, 201 children (n=96 males, n=105 females) in school Years 3,4 and 5 (7.8 ± 0.63 years of age) within the Coventry area were recruited to take part in the study. Verbal assent was provided from each participant to take part. The schools were selected using convenience sampling: all of which were a-part of a sporting programme at CVLife, (2019) a charitable trust company providing a wide range of sporting, recreational, social and educational activities to underrepresented groups and individuals within Coventry

2.2 Anthropometry

Anthropometric data was recorded, which including Height (cm), sitting height (cm), leg length (cm), arm length (cm) hand width and lengths (cm), foot width and lengths (cm) and arm span (cm) were recorded to the nearest cm using a stadiometer (SECA Instruments, Ltd, Germany) and anthropometric measuring tape. Mass (kg) and body fat (%) were recorded using electronic scales (TANITA scales C-300, Germany). Children were dressed in physical education uniform without shoes, measurements were taken from the right-hand side of the body to ensure consistency throughout.

2.3 General motor competence

Process measures of motor competence were assessed using eight motor skills (3 locomotor and 5 object control) from the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000). The eight motor skills selected were outlined by Swim England, (2020) to have associations to aquatic movement patterns. The following motor skills were assessed run, jump, hop, catch, overhand throw, bounce, strike and kick. Each skill was broken down into 3-4 components. TGMD-2 assesses whether the components of the skill are present or absent in each participant. Each skill was video recorded (Nikon B500, Japan) and analysed using Quintic biomechanics analysis software V26 (Quintic Consultancy Ltd., Coventry, UK). Videos clips of each individual skill were uploaded to

Quintic and analysed in slow motion to caption all efficiency's and deficiencies. Three trials of each skill were recorded with the first as a practice the second and third were scored. Subjects' scores were calculated for locomotor competence (0-26) and object control motor competence (0-48). An experienced researcher assessed the children's movement through analysis of the videos as according to recommended guidelines for scoring of the TGMD-2 (Ulrich, 2000). Inter and intra-rater reliability ICC'S for analysing the videos was performed for all skills in comparison to an expert ensuring trials differ no more than (≥ 80 % agreement) per skill using 10 % of the videos recorded in accordance with Duncan et al, (2018). This current study followed guidelines with all ICC's (>80 % agreement) for both AMP and TGMD-2 video analysis.

Product measures of motor competence were as follows; standing start 10 m sprint time and standing long jump distance. Each 10 m sprint were timed using smart speed gates (Fusion Sport, Coopers Plains, Australia). Standing long jump were recorded by a floor tape measure recording distance from the take off point to the back of the closest heel on landing. For both measures the best trial out of three trials was selected. A Z-score was calculated for each product measure of motor competence to create a composite product measure of motor competence. Composite scores consisted of a sum of both z scores.

2.4 Aquatic motor competence

This current study derived the Aquatic Movement Protocol (AMP) as a method for assessing aquatic motor competence. The AMP assesses eleven aquatic motor skills (3 strokes and 8 aquatic skills). The following aquatic motor skills were assessed; front crawl, back crawl, breaststroke, push and glides, log rolls, sculling feet first and head first, treading water, entering water via a jump, submersion, floating and tuck position due to these being the main skills concentrated on the national curriculum and Swim England's strategy (Swim England, 2020). Each aquatic movement was broken down into 3-6 components, the AMP assesses whether the components of the skill were present or absent in each participant. Each movement was video recorded (Nikon B500, Japan) and each component was analysed using Quintic biomechanics analysis software V26 (Quintic Consultancy Ltd., Coventry, UK). Videos clips of each individual skill were uploaded to Quintic and analysed in slow motion to caption all efficiency's and deficiencies. Three trials are completed by each participant in which two were used to create a total score (0-138). Participant scores were calculated for Aquatic strokes (0-66) and Aquatic skills (0-72). An experienced researcher assessed the children's movement through analysis of the videos as according to recommended guidelines for scoring of the AMP.

2.5 Statistical Analysis

Pearson product moment correlations were used to examine the relations between general motor competence (TGMD-2) and aquatic motor competence (AMP). The Aquatic movement protocol (Aquatic motor competence) scores were recoded into three equal tertiles of low, medium and high competence. Tertile analysis was employed by subgrouping children of a young age.

Concurrent validity was assessed by Analysis of univariate (ANCOVA) models to see whether general motor competence differed as appose to aquatic motor competence, where any significant differences were found, post hoc pairwise comparison (Bonferroni adjusted) to investigate where differences lay. Examining whether actual motor competence differed by sex and perceived competence using 2 (sex) and 3 (high, medium and low perceived competence) analysis of covariance (ANCOVA) (Duncan et al, 2018).

Construct validity was used to test the relationship between AMP and an unrelated measure TGMD-2. ANCOVA was used to show the key differences between aquatic motor competence and general motor competence. Construct validity was assessed by both Cronbach Alpha and exploratory factor analysis. Cronbach alpha was used to assess the internal consistency and reliability of the AMP to provide confirmation of the validity on its ability to assess aquatic motor competence. Providing unidimensional validity and to explore inter-correlation between items contained within the AMP. All items within the AMP were analysed by Cronbach's alpha to see if all items total up to a valid and reliable measurement of aquatic motor competence (Cronbach, 1951).

Exploratory factor analysis (EFA) was conducted to examine the dimensional validity of the internal structure of the AMP and its ability to assess aquatic motor competence. EFA was implemented to investigate the number of factors influencing the ability to assess aquatic motor competence (DeCoster,1998). EFA analysis was used to identify constructs of the AMP and used to reduce variables into a valid reliable data set to assess aquatic motor competence (Cook and Campbell, 1979).

3. Results

Those who were in the medium aquatic motor competence category had significantly smaller statures (126.99 ± 0.9 cm) compared to those who were in the high aquatic motor competence group (130.5 ± 0.9 cm) (P = 0.017) table 1. Insignificant results were found between body mass in males and females and aquatic motor competence. Similar results shown for body fat (%) with no significant relationship between males and females in aquatic motor competence.

Table 1: Mean ± SD and 95 % confidence intervals for anthropometric, motor competence according to aquatic motor competence**.**

	Low Aquatic Motor Competence			Medium Aquatic Motor Competence			High Aquatic Motor Competence		
	Mean	SD	95 % CI	Mean	SD	95 % CI	Mean	SD	95 % CI
Height (cm)	128.6	0.9	126.8-130.4	127.9	0.92	126-129.7	130	0.95	128.1-131.8
Mass (kg)	30.6	1.1	28.5-32.7	28.9	1.1	26.8-31.1	30	1.1	27.7-32.2
Body fat (%)	24.9	1.2	22.2-26.9	22.5	1.2	20.2-24.9	22.3	1.3	19.8-24.8
AMP (0-138)	4.2	1.4	1.5-6.9	18.6	1.4	15.9-21.4	42.8	1.4	40-45.7
TGMD-2 (0-66)	21.2	1	19.3-23	29.3	1	27.4-31.3	32.8	1	30.8-34.8
Locomotor (0-26)	12.2	0.4	11.3-13	14.9	0.4	14-15.8	16.4	0.5	15.5-17.2
Object (0-40)	9.97	0.7	8.7-11.3	15.1	0.7	13.7-16.4	16.5	0.7	17.8
Sprint 10m (Seconds)	2.8	0.5	2.7-2.9	2.8	0.5	2.7-2.9	2.8	0.5	2.7-2.8
Standing Long Jump (m)	1.2	0.03	1.1-1.3	1.3	0.03	1.2-1.4	1.5	0.03	1.4-1.5

This study found males to perform significantly better at object control skills (14.5 ± 0.6) compared to females (13.6 ± 0.6) (P=0.222). Females obtained greater locomotor scores (14.9 ± 0.4) and general motor competence scores (28.2 ± 0.9) compared to males (14.2 ± 0.4) and (27.7 ± 0.97) (P<0.05). Females perform better at aquatic skills (13.8 ± 1.2) compared to males (11.2 ± 1.3) (P=0.001). Females performed better at aquatic strokes (15.5 ± 15.6) compared to males (12.4 ± 12.9) (P<0.05). Females were shown to have better overall aquatic motor competence (27.97 ± 27.9) compared to males (21.1 ± 22.7).

Cronbach's statistic, alpha, was used as a measure of the internal consistency of the skills on the AMP. Individual skills correlated positively with the total AMP score with correlations ranging from 0.235 and 0.965. Reliability analysis show 11 aquatic movements (8 aquatic skills and 3 strokes) combined reflect aquatic motor competence through the AMP with total scores adding up to Cronbach's alpha of 0.908. The skill submerge was identified and if removed from data set would provide an increase to the value of alpha by α=0.02.

After conducting exploratory factor analysis one main component was extracted from the analysis (Eigenvalue = 6.2; % Variance = 62.1) and a second component was extracted from this analysis (Eigenvalue = 1.4; % Variance = 14.2). All factor loadings for the first factor were higher than 0.5. This data suggests that the items on the AMP measure a single construct that we would call: Aquatic motor competence (Table 2). The higher loadings of the majority of the items on the second factor were lower than 0.3, and when these loadings were higher, they were still far away from the factor loadings of the first factor. The higher factors in the second factor were item 7 (submerge) and item 8 (floating) both with positive loadings. Item 5 (sculling), item 6 (tuck in water) and item 9 (treading water) had negative loadings.

Table 2. Loadings for unrotated orthogonal factors for the Aquatic Movement Protocol (AMP).

Item	*Description*	*Factor 1*	*Factor 2*
Item 2	Front Crawl	0.876	0.170
Item 3	Back Crawl	0.857	0.199
Item 4	Breaststroke	0.907	-0.134
Item 5	Push and Glide	0.813	0.291
Item 6	Sculling	0.829	-0.508
Item 7	Tuck in water	0.854	-0.406
Item 8	Submerging	0.549	0.574
Item 9	Floating	0.576	0.401
Item 10	Treading Water	0.822	-0.503
Item 11	Aquatic Jump	0.705	0.284

Eigenvalue	6.206	1.418
%Variance	62.064	14.176
%Cumulative Variance	62.064	76.241

Regarding general motor competence there was a significant difference in TGMD2 scores between children who were high or low for aquatic motor competence (P=0.001), achieving higher scores on the TGMD-2 in the high aquatic competence group. Univariate general linear models show AMP scores to have significant relationship with TGMD-2 (P=0.01) scores indicating those who can swim efficiently will be able to perform better on dryland motor competence. Aquatic strokes have significant relations with both locomotor (P=0.01) and object control skills (0.01). Similarly, aquatic skills have a significant relationship with both locomotor (P=0.01) and object control skills (0.01).

Those who achieved faster sprint speeds and longer jump distance had significantly higher aquatic motor competence (P=0.001) in comparison with those categorised within the low aquatic motor competence group *(Table 1)*. There were no significant differences in sprint speed in comparison to high medium and low aquatic motor competence (P=1.000). Low to high (P=0.001) and medium to high (P=0.03) aquatic motor competence had significant differences in comparison to standing long jump showing those who achieve better aquatic motor competence were able to jump further than those with low aquatic motor competence. No significant differences were found with those who obtained low to medium aquatic motor competence (P=0.069).

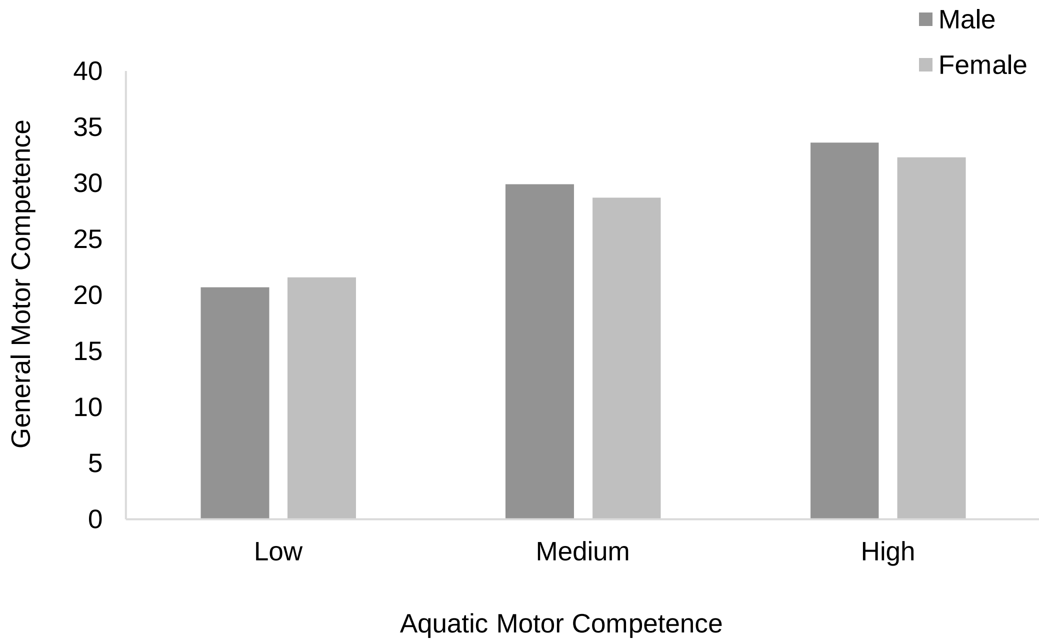

Figure 1. Mean ± SD of general motor competence of male and female in subgroups of low, medium, and high aquatic motor competence.

Children who were classified as high for aquatic motor competence had significantly higher general motor competence (P=0.001) compared to those with low aquatic motor competence (*Table 1)*. Children in the high aquatic motor competence group demonstrated significantly higher locomotor scores (P=0.001) compared to their low aquatic motor competence peers. This was the same for object control scores (P=0.001) where children who were in the high aquatic motor competence group scored considerably higher on the object control subtest compared to those who were in the low aquatic motor competence grouping *(figure 1*).

Individuals with lower general motor competence had significantly (P=0.001) lower aquatic motor competence and were categorised in the low aquatic motor competence category compared to those who were categorised in the high aquatic motor competence category. Those who were in the medium aquatic motor competence group had a medium range of general motor competence compared to those who were high aquatic motor competence (P=0.047) and low aquatic motor competence (P=0.01).

4. Discussion

The focus of this study was to provide both construct and concurrent validation of the measurement of primary aged children's aquatic motor competence through the Aquatic Movement Protocol (AMP). Investigating internal consistency of the AMP and whether children who scored high medium or low on the AMP had similar scores for general motor competence on dryland. This is the first study to the author's knowledge that has proposed an assessment method for aquatic motor competence in young children. Providing a valid tool which can be executed by education teachers, specialist coaches and exercise scientists to be used in future research. This study examined the underpinning link between motor competence on dryland and within the aquatic environment.

This study has shown both construct and concurrent validity of the AMP, those who scored higher on the AMP had higher gross motor competence on the TGMD-2. Pinpointing children with defined aquatic motor competence in turn had defined movements on dryland. Construct validity is defined as the extent to which an operationalization measures a concept in which it is supposed to measure (Yong and Pearce, 2013). Construct validity tests the relationships between the construct and an unrelated measure the findings of the current study show those who display more developed aquatic skills and strokes to have optimized gross motor competence and generally scoring higher on TGMD-2. The AMP was significantly related to dryland movements with children in the high aquatic motor competence category performing better on general motor competences. Concurrent validity is made up of both predictive and criterion validity (Lin and Yao, 2014). This current study implemented criterion validity to see how effectively a test examines an individual's performance with a specific measurement outcome (Lin and Yao, 2014). Concurrent validity was used to examine the effectiveness of the AMP in assessing aquatic motor competence.

Exploratory factor analysis and Cronbach analysis provided evidence of the AMP being a reliable and valid protocol for assessing aquatic motor competence within primary aged children. Individual strokes and aquatic skills having strong positive correlations with one another showing a commonality in assessing one component (aquatic motor competence). Cronbach analysis indicated high reliability and internal consistency of the AMP with a high alpha scoring throughout all skills. When the submerge skill was removed it marginally increased the alpha score. With correlations between submerging and other skills shown to be positive removing the submerging skill was found to be inappropriate. Factor analysis shown the AMP to display 62 % of aquatic motor competence scorings. Showing the one factor (AMP total score) to have high loadings on all skills suggesting AMP to be an accurate and valid method of assessment of aquatic motor competence. All skills had positive loadings on the AMP and ranged between 0.5 and 0.91. A second factor explained 14 % of aquatic motor competence scores however, due to the low percentage of this factor indicating low loadings on each skill therefore, this current study seen fit to disregard this second factor. The AMP displaying positive and high factor loadings demonstrate validity for assessing aquatic motor competence with correlations which add to the validity and reliability of the AMP.

Children in this current study with taller statures and lower body fat percentages were more likely to be categorised in the high aquatic motor competence groups compared to those who were smaller and with higher body fat percentages. Morais, et al, (2013) found both anthropometrics, kinematics, and energetics to have a significant effect on performance. Those who were taller achieved better aquatic motor competence scores compared to those who were shorter in stature. Research indicates those who are taller had a positive relationship with speed, stroke length and final time (Landers, Blanksby and Ackland, 2011). Therefore, it is evident individuals who perform better within the aquatic environment are significantly taller due to them being able to achieve longer stroke lengths and faster finish times (Kennedy et al, 1990). Similar results were shown from Jürimäe et al, (2017) reporting anthropometric data such as height are related to better performance in young swimmers.

This current study found children with greater body mass's achieved lower AMP scores. Individuals who were classified as overweight had lower motor competency levels in dryland fundamental movement skills. Similarly, body fat percentage indicated those with lower body fat percentages achieved better aquatic motor competence compared to those who were in the low aquatic motor competence grouping. Lower body fat percentages allow a larger range of movement resulting in individuals being able to perform aquatic skills and aquatic strokes proficiently (National Strength and Conditioning Association, 2017). Children who have a lower body mass and lower body fat percentages perform better in the aquatic environment. Siret, Pancorbo and Lozano, (1985) found similar results showing a positive correlation with lower body mass's and swimming performance. Demonstrating individuals with a healthy weight are more likely to perform better at aquatic motor competences compared to those who have a greater body mass.

This study found children who were classified high for aquatic motor competence demonstrated significantly (P=0.03) greater standing long jump distance however did not demonstrate faster sprint speed times compared to those who were classified as low for AMP scores. Standing long jump distance is a similar movement pattern as a push and glide both being a 2 footed push using congruent mechanisms. Building strength in the water with push and glides has a comparable link to a standing long jump. Similar movements including a grab start, defined as a two-legged take off like a two-legged countermovement jump (Benjanuvatra, Edmunds and Blanksby, 2007). The knees and hips flex with arms working as stabilisers to support and maintain balance, hips, knees and ankles extend forcefully to maximise velocity (Benjanuvatra, Edmunds and Blanksby, 2007). Positive correlations between leg-extension power, vertical jump and starting performances have been previously reported (Miyashita et al, 1992; Pearson et al, 1998). Therefore, it is considered an improvement in jumping abilities could enable swimmers to generate greater horizontal velocities (Benjanuvatra, Edmunds and Blanksby, 2007). Equivalently, developing two footed skills in the water (push and glides, jumping into water etc.) will improve dryland jumping skills.

Children who performed well within the aquatic environment were seen to be more comfortable and confident in the water which could of be developed through prior participation in swimming programs additional to the primary physical education in place (Martins et al, 2008). Results indicate that individuals who demonstrate more efficient movements in the water, (scoring higher on the AMP were able to demonstrate more efficient object control and locomotor skills. These findings are supported by Rocha, et al, (2016) who reported children who were exposed to swimming or participated in swimming lessons demonstrated more efficient fundamental movement and motor skills compared to those who were not. The study's findings indicate those achieving lower fundamental movements, achieving lower scores on locomotor and object control tests were able to perform inferiorly within the aquatic environment. Similarly, those with superior fundamental movement skills performed better within the aquatic environment and achieved greater scores on the AMP. There is a clear link between TGMD-2 and AMP scores which, indicates the importance of children's exposure to swimming on a regular basis. In turn this would equate to better performance on general motor competences as well as aquatic motor competences. Martins et al, (2008) found that children who participate in swimming lessons during the educational setting (school swimming lessons) have more defined motor development on a range of gross motor tests especially on object control skills the main weakness of the study is the failure to address aquatic motor competence as appose to just swimming lessons. This current study took this into account and found individuals with more experiences in the aquatic domain to perform better on dryland.

All participants took part in regular swimming lessons during a primary school setting. Therefore, there were no congruent evidence on whether results would have been the same for those who have never been around the aquatic environment. We acknowledge the sample was collected within the same regional area and city thus, does not include geographical differences. Tertile analysis has only been based on this group of participants and not based upon normative data set hence, this data is only representative on this current study population. Tertile's only reflect the span of score since the population had overall low scores this study split them into low, medium and high of a low proficient group therefore, tertile cut points used here should be applied to other groups with caution.

5. Conclusions

To summarise this present study set out to provide construct validation of the aquatic movement protocol (AMP) a new assessment protocol to assess aquatic motor competence. This current study provides evidence that the Aquatic movement protocol (AMP) is a valid and reliable protocol in assessing aquatic motor competence and to date is the only form of assessment for aquatic motor competence. This study also indicates swimming practice during childhood seems to contribute to a higher motor development with those who can achieve greater results in aquatic motor competency in turn achieve greater general motor competence on dryland. Providing strong positive associations between aquatic movements and those performed on dryland. The has become a vitality for children to achieve minimum requirements of 25m distance using a range of different strokes. Considering the impact swimming has on a child's movement on dryland, the importance to having swimming in the national curriculum is evident. With children who are competent in the water are seen to perform superior on dryland compared to children who have no experience within the aquatic environment.

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