ANALYSIS OF HEART RATE VARIABILITY OF INFANTS IN DIFFERENT AQUATIC ACTIVITIES

João SERRANO[1], Daniel JACINTO[2], Daniel MARINHO[3], Jorge SANTOS[1], Marco BATISTA[1], Miguel REBELO[1], SAMUEL HONÓRIO[1]*

[1] Polytechnic University of Castelo Branco. SPRINT-IPCB, Sport Physical Activity and Health Research & Innovation Center, Castelo Branco, Portugal
[2] Polytechnic University of Castelo Branco, Castelo Branco, Portugal
[3] University of Beira Interior, Investigation Centre in Sports, Health and Human Development (CIDESD), Covilhã, Portugal
*Corresponding author: samuelhonorio@ipcb.pt

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Abstract. *The focus related to Heart Rate (HR) knowledge in children in the aquatic environment already has some decades and continues to be an interest and constant research. This study intends to characterize and evaluate the level of cardiovascular responses regarding motor skills with aquatic exercises through the analysis of heart rate. The participants were 10 infants with a mean age of 17.6 months and all of them with 9 months of previous practice of water activities. Data collection was performed by a portable HR monitor with a band adjusted to the infant's chest. The highest heart rate value recorded was 194 bpm and the lowest one of 92bpm. Ventral, dorsal and vertical positions were analyzed, jumps and finally immersion. All sessions were recorded with a video camera at the same time it was made the heart rate assessments for synchronizing tasks times. For statistical analysis of the values, a comparison between infants' activities was assessed, using the T-Test to compare means of the different aquatic skills. The higher mean recorded was in jump, with a mean value of 141.3±17.65 bpm, compared with the lowest mean the ventral position task with a mean value of 119.2±22.78 bpm. There were changes on the HR associated with the tasks performed, where each motor ability showed different cardiovascular responses.*

Keywords*: aquatic exercises; motor skills; heart rate; infants.*

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Introduction

Attending formal aquatic lessons has been associated with a reduced risk of drowning in children between the ages of one and four. This autonomy provides children with a way to navigate the aquatic environment, reducing the likelihood of drowning (Fontanelli & Fontanelli, 1985). Teaching infants to enjoy the water should be the primary goal of aquatic programs. Therefore, lessons should empower babies to develop autonomy in the aquatic environment through early adaptation (McKay & McKay, 2005). They note that teaching babies to swim fosters confidence, the sharing of joyful moments, communication through

touch and words, and the creation of strong bonds between children and parents as they experience new and varied stimuli.

The practice of water activities for babies seeks to match the expectations of the physiological and psychological development (Martins, 2010). This study focuses on the analysis of heart rate (HR) during the practice of water activities and has as its main objective the understanding of HR variability in the aquatic environment through several motor skills over a period of adaptation to the aquatic environment. It is intended to identify physiological responses of the infant through the analysis of the HR values in activities in water in order to obtain averages on the ventral position (VP), dorsal position (DP), vertical position (VEP), jumping (J) and immersion (I). Water promotes specific stimulation through the action of hydrostatic pressure and buoyant force in the sensory-epicritical system that promotes different sensations related to body awareness (Catela, 2004). Water is a learning environment to new achievements, allowing to strengthen muscles and improve control of breathing by babies. To motivate the teaching of aquatic activities for infants should follow a firm and supported learning to support the physical and cognitive development. The water activities of educational character strengthen the personality and independence (Petersen et al., 2020). Research focusing on HR in children in the aquatic environment already has spanned several decades and continues to be an interest and constant research. It is intended to add data to existing studies and analyze the responses to the different aquatic motor skills in terms of cardiovascular responses. HR is used in several physical activities, to estimate the individual effort intensity. HR was used to measure the demand for each of the water activities, a method that is also commonly used to measure HR in land exercises. The use of HR allows to characterize and estimate the intensity of babies in aquatic motor activities, allowing us to determine the reaction to different types of stimuli in this environment (Vanderlei et al., 2009).

Water practice for infant's motor development

Children's aquatic education is defined as any educational action within different situations that seek to promote and enjoy the pleasure of controlling the aquatic environment in its three dimensions: motor, social, and cognitive (Wielki, 1980). According to Sarmento (2001), practicing aquatic activities improves safety, knowledge, and control of the body, favoring the infant's communication with adults and other children, thus improving the quality of life in general. McGraw (1939) describes that the movements of babies in the first weeks of life are "rowing" when they are placed in the ventral position in the water. When babies are submerged, paddling movements are even more visible. It is also reported that newborn babies after immersions reacted without any sign of coughing or stress (Kano et al., 2024). From 4 months onwards, movements tend to be disorganized due to the attempt to reach the surface. At this stage, babies swallow a lot of water during immersion, followed by coughing. The infant recovers organized movements from the second year of life to move around in the water. These stages are easy to identify when the infant is placed in a ventral position in the water (Jakobowicz & Ogonowska-Slodownik, 2024).

Within the same perspective, Moreno et al. (2003) stated that aquatic practice has an influence on the infant's development, where they cite the main proposals for teaching methodologies in the aquatic environment for babies. As Martins (2010) states, the effects produced by water sessions at earlier ages have not yet been fully substantiated (Santos et al.,

2023; Brenner et al., 2009). According to Massin & von Bernuth (1997), measuring HR is an important source of information about the child's health status, and if there are values outside the normal HR, it may be an indicator of an abnormality. Jimenez (1994) relates the cardiac aspect and the practice of aquatic activities, stating that not all cardiological pathologies are detected early. The author says that water that has a temperature between 25 degrees and 35 degrees can make the heart rate remain more stable. HR may be related to the perinatal period in which the infant is located. Millar and Weir (1998) took as their starting point the fact that children subject to medical risks during the neonatal period may process information differently than those who had a non-traumatic birth.

The authors highlight the physiological difference between children who have distinct learning processes and relate the perinatal history between children who had birth experiences without trauma. Therefore, changes in HR may be related to perinatal risks (Jeong et al., 2021; Borioni et al., 2022). Newborns have a very fluctuating HR, with resting values ranging from 120 bpm to 140 bpm. Heart rate can increase to around 170 bpm with just one cry. During sleep, the infant reaches values between 70 bpm and 90 bpm. HR decreases with a child's age (Behrman et al., 2000). Physical exercise causes an increase in HR values; this value stabilizes according to the duration of the exercise as happens with adults. Children have a lower systolic volume than adults, so exercise is compensated by increasing HR. (Bar-Or & Rowland, 2004). According to Martins (2010), of all approaches, it is worth highlighting that HR is always subject to physiological and individual variations, related to other factors such as effort and emotions (Azemar, 1974). It is necessary to be guided by normal standards, to define and measure the real intensity of the activity, and to know the effort to which the individual is subjected.

Santos et al. (2008) recorded the average of HR values in swimming classes for infants and mentioned that there was a decrease in HR. They obtained average session values of 102.8 ± 8.90 bpm, in activities inside the water the HR was 111.36 bpm and the average HR outside the water was 122.7 bpm. It also indicates an average HR value of 144.67 bpm for immersion. Martins et al. (2006) carried out a study of HR recording in different aquatic activities and obtained an average session record of 131 bpm and an average frequency of 149 bpm. Regarding immersion values, it reached an average of 130bpm, and according to the study, it was the aquatic activity that recorded the lowest value. Considering the specific focus of the study, the definition of adaptation to the aquatic environment is always associated with the concept of "knowing how to swim". It is a very broad concept, which has different interpretations, depending on the subject (Martins, 2010). Water promotes specific stimulation through the action of hydrostatic pressure and buoyancy force on the sensory-epicritical system, which promotes different sensations in body awareness (Veloso et al., 2007). Water is a means of learning new movements that strengthen muscles and improves babies' breathing control (Obeso, 2001). To motivate teaching water activities to babies, activities must follow a supported and firm learning process that promotes physical and cognitive development. Aquatic activities of a formative nature strengthen personality and independence (Moreno et al., 2003). In this way, we can integrate the way babies interact with the aquatic environment into the theme of the work, considering the effects that arise through the practice of the activity.

Methodology

The study is descriptive and observational and intends to measure cardiovascular responses (assessed by HR) in different aquatic activities, record the variation in heart rate (HR) in infants during the water sessions and compare these HR variations according to the different tasks that are performed.

Aim

This study aims to characterize and assess cardiovascular responses associated with motor skills during aquatic exercise by analyzing heart rate.

Hypothesis

Infants will exhibit significantly different mean heart rate responses across aquatic motor tasks (jumps, immersion/dips, ventral, dorsal, and vertical positions), and these heart rate responses will change across the three assessment moments (Session 1 vs. Session 10 vs. Session 20), reflecting adaptation to the aquatic exercise program.

Participants and Procedure

The participants were 10 infants aged from 13 to 25 months old and they all practice the activity regularly and have previous experience in the last year. These selected infants attended classes weekly, 2 times a week for 30 minutes in each session for a period of 10 weeks (20 sessions), accompanied by a parent, taking classes always with the same parent and the same teacher, in order to guarantee the same teaching methodology, for the behaviours selected according to the variables. All infants have participated in the lessons at the same time, and performed the same number of tasks, namely, jumps (J), dives (D), dorsal positions (DP), vertical positions (VEP) and ventral positions (VP). When the infant arrived at the pool pier, an initial test was carried out to check whether the device was recording the HR correctly. All the exercises were conducted and decided by the teacher, who performed the exercise with one of the babies and then the other parents repeated this exercise with the help and supervision of the teacher, always performing the same number of pre-defined exercises with all the babies.

Among these exercises, some of the following were applied: Walking with the child in the pool and getting their feet and legs wet; Walking with the child in the pool and getting their torso, neck, and arms wet; Walking with the child in the pool and getting their head wet; Walking with the child in the pool with their feet in the water; Walking with the child in the pool with their feet and legs in the water; The instructor extends their arms, supports the child on the palm of their hand, and gently rocks them in place; Supporting the child's head with their hand, keeping the child afloat. To encourage immersion: Place objects in the water so the child opens their eyes; Dive under floating objects; Dive and retrieve objects from the bottom of the pool; Dive between the adult's arches and legs; Continually immerse yourself, jumping into the water. To stimulate breathing: Blow on the surface of the water; Blow on floating objects; Blow underwater (make bubbles); Continuous immersion with breathing (inhalation/exhalation). To stimulate buoyancy and displacement: Float on your front with

support and free movement of your legs; Float on your back with support and free movement of your legs; Float on your front without support (arms extended in front); Float on your back without support (arms extended to the sides).

The classes took place on a swimming-pool with 18x6 meters, with water heated to 31 degrees Celsius, with an 80% humidity inside this space. The infants wore waterproof diapers, specifically designed for this purpose, and the parents wore their swimsuits in accordance with the pool rules.

Data collection

After the study was approved by the institution's Ethics Committee, a questionnaire was delivered to each parent, which aimed to record important biographical data of the infants assigned. These data allowed a better characterization of the infants and the respective parent. The infants' participation in this study was allowed by their parents. The authorization was delivered in writing before the beginning of the school year. They were only given to participants who had already attended in the last year. In terms of exclusion criteria, all infants who rejected the HR device more than once or showed discomfort during the collection period did not participate. Parents were informed in advance about the procedure of all data collection, having been informed that in addition to completing the authorization, the designated representatives were filming the classes during the collection period.

Instruments

Infants' characterization was carried out through a questionnaire (Obeso, 2001), and as observed in other study by Martins et al. (2009), the characterization of the infants was conducted through a questionnaire, which allowed a better understanding of each child. The chosen method for the HR measurement was the RCX5 Polar® (Reis et al., 2017), which is considered a non-invasive method. The device records the data and is transmitted to the Polar Personal Trainer software in a graphic form. The transmitting band was placed around the infant's chest, allowing complete freedom of movement. The receiver of the data was placed in the parent's wrist. The duration of the classes for babies was about 30 minutes and the watch were placed before entering the swimming-pool pier on the respective parent. Upon the infant's arrival to the swimming-pool pier, an initial test was performed to certify if the device correctly recorded the HR measurements.

Statistical procedures

To test the normality of the data, the Shapiro-Wilk test was applied. This test is in accordance with smaller samples, which allows assumption of normality for this population levels. After the verification of all data with a normal distribution, descriptive statistics, mean values, minimum, maximum, standard deviation, and HR coefficient for each variable were selected. For the analysis of motor skills and to establish a comparison between them the T-test was conducted to compare two related samples at different time points (Xu et al., 2017). The T-test is a method to decide whether the observed difference between the two sample

means has a systematic cause that can be considered an effect due to chance fluctuations (D'Hainaut, 1990). The program used for statistical analysis was SPSS version 20.0, and the level of significance was established at $p \leq 0.05$.

Results

In this section, the results obtained during the study are presented, as well as their respective interpretation. The results that will be presented concern the HR values, in terms of their mean, maximum, minimum and standard deviation values.

Heart Rate Recording

The following tables present the individual data of each of the infant's water tasks. These values will be presented as mean values, according to the three moments that were analyzed in each of the activities. The data presented in all tables refers to the values recorded over the 20 lessons, however, in order to compare HR values, according to the exercise program applied, we registered mean values at specific moments, an initial assessment in the first session, an intermediate assessment in the tenth session and a final assessment in the twentieth session. All babies performed the same number of jumps (J), dips (D), dorsal position (DP), vertical position (VEP) and ventral positions (VP).

Table 1. *Presentation of the individual values obtained for the HR means for each infant and analyzed variable*

Infant	Age (months)	HR mean per / session	HR Immersion	HR Jump (Bpm)	HR Ventral (bpm)	HR Dorsal (bpm)	HR Vertical (bpm)	HR Max (bpm)
8	14	142	128	142	128	147	162	170
6	17	115	119	133	105	103	116	136
4	16	126	136	143	130	105	133	145
2	20	119	114	136	107	120	116	140
10	13	165	153	175	169	138	188	194
3	14	107	121	106	94	96	121	132
7	15	125	141	140	105	124	117	154
9	24	137	144	137	128	125	151	157
1	18	127	126	139	109	129	134	143
5	25	149	137	162	148	151	147	159

Regarding Table 1, mean values range from the lowest value of 94bpm to the highest value of 188bpm being the highest value obtained by the infant 3 in the ventral position (VP) and the infant number 10 respectively in the vertical position (VEP). In general, the values of aquatic motor skills in relation to its mean values are within the values that are indicated in the literature. However, we must point out that one of the babies reached a value of 194bpm HR as the maximum value and had the highest mean for all other tasks, so we believe it is necessary to carry out a more direct monitoring of the infant establish the facts. Beyond these means, in

relation to aquatic tasks, we consider it important to measure each one of the three distinct moments. According to this, it is presented in the next table (Table 2) the mean and standard deviation of each of the three aquatic skills moments of registration.

Table 2. *HR mean frequencies of ventral positions (VP), dorsal (DP), vertical (VEP) and immersions (I)*

	N	Minimum	Maximum	Mean	SD
HR mean of the 1st VP	10	92	159	119.2	22.78
HR mean of the 2nd VP	10	94	160	121.4	19.83
HR mean of the 3rd VP	10	96	190	123.8	27.74
HR mean of VP	10	94	169	121.4	22.93
HR mean of the 1st DP	10	111	182	139.2	25.10
HR mean of the 2nd DP	10	115	190	137.4	22.99
HR mean of the 3rd DP	10	112	194	139.6	24.98
HR mean of DP	10	112	188	138.6	23.54
HR mean of 1st VEP	10	94	150	121.2	18.61
HR mean of 2nd VEP	10	97	149	126.4	20.26
HR mean of 3rd VEP	10	112	194	125.4	18.42
HR mean of VEP	10	95	151	124.3	18.58
HR mean of 1st J	10	107	179	139.3	20.55
HR mean of 2nd J	10	108	176	141.3	17.65
HR mean of the 3rd J	10	105	172	140.8	18.46
HR mean of J	10	95	151	140.4	18.28
HR mean of 1st I	10	111	160	135.3	15.56
HR mean of the 2nd I	10	114	148	131.5	12.78
HR mean of the 3rd I	10	114	152	131.4	12.68
HR mean of I	10	113	153	132.8	13.40

Regarding the VP mean it's observed that the value is 121.4±22.93, with a minimum value of 94 bpm and the maximum value was 169 bpm. Comparing the three distinct moments when babies were assessed in VP, it can be highlighted the HR mean of the 3rd VP slightly higher than the previous two times with a value of 123±27.74, for the first time with a value of 119.2±22.78. In general, the mean values of VP are within the normal values. The DP compared to the VP reaches higher values in their minimum values as in their maximum values. Regarding means, the values are all very similar in the three times, and the highest DP occurred at the 3rd moment with a value of 139.6±24.98, and the lowest value with respect to the DP mean of the 2nd time with a value of 137.4±22.99. The mean of three times has a value of 138.6±23.54. The VEP is the one with the lowest values compared to those previous skills. However, it performs at its maximum index value a record of 194 bpm, however, also presents minimum values relatively low of 94 bpm and 97 bpm. Regarding the mean of the three moments the lowest value is presented in the first VEP with a value of 121.2±18.61, and 126.4±20.26 the highest value for the 2nd VEP. Regarding the jump, the values are heterogeneous in its minimum and maximum extension. The mean of the three times also have very similar values, with the lowest value of 139.3±20.55 and the highest one of 141.3±17.65.

Compared to the previous aquatic motor skills the jump is undoubtedly the task where the values are more approximate, representing a physiological impact of the task with an identical response in these three moments. Regarding the mean values, the highest value is 135.3±15.66 and it represents the first immersion, and the lowest value relates to the 3rd immersion with the value of 131.4±12.40. With a global analysis of these aquatic motor skills, it seems that the means of the activities are all of them very approximate. It can be highlighted the lowest value for 121.4±22.93 in VP and the highest value for Jumping at a mean of 140.4±18.28. The data obtained from means of aquatic motor activities, allows to understand what degree of physiological responses were given by the babies considering the HR values. According to the data obtained regarding the immersion, the values are all of them very heterogeneous. The level of statistical significance was set in $p \leq 0,05$ and were found significant results with the highest value of the ratio between the 1st and 3rd immersion. This is the largest difference between the minimum and maximum values of immersion. All infants performed the same number of jumps and by comparing with the immersions, the minimum values were lower, but the maximum values were relatively higher. Both the minimum values as the maximum values are very approximate. The highest mean between HR happened between the first and second jump (177,5 bpm). Statistically significant differences were found between the three jump moments (Table 3).

Table 3. *Comparison of the means between Ventral Position, Vertical, Immersion and Jump and between the means of Dorsal Position, Immersion and Jump*

	N	Minimum	Maximum	Mean	SD	Sig.
HR mean of 1st and 2nd VP	10	94	159.5	120.03	20.82	0.000
HR mean of the 1st and 3rd VP	10	94	174.5	121.5	24.82	0.001
HR mean of the 2nd and 3rd VP	10	95	175	122.06	23.50	0.000
HR mean of VP	10	94	169.6	121.06	22.93	
HR mean 1st and 2nd VEP	10	95.5	149.5	123.65	19:10	0.000
HR mean of the 1st and 3rd VEP	10	94	149.5	123.3	17.75	0.002
HR mean of the 2nd and 3rd VEP	10	95.5	151.5	125.76	18.85	0.001
HR mean of VEP	10	94	169.6	124.23	18:58	
HR mean of 1st and 2nd DP	10	113	186.5	138.35	23.45	0.000
HR mean of the 1st and 3rd DP	10	111.5	188.5	123.3	24.37	0.000
HR mean of the 2nd and 3rd DP	10	113.5	192	138.05	23.39	0.000
HR mean of DP	10	112.6	188.6	138.76	23.54	
HR mean of the 1st and 2nd I	10	112	154	133.50	14.01	0.005
HR mean of the 1st and 3rd I	10	112	156	133.45	13.97	0.009
HR mean of the 2nd and 3rd I	10	114	150	131.45	12.39	0.001
HR mean of Immersion	10	113	153	132.08	12.68	
HR mean of 1st and 2nd Jump	10	107.5	177.5	140.03	18.67	0.000
HR mean of the 1st and 3rd Jump	10	106	175.5	140.05	19.03	0.000
HR of the 2nd and 3rd Jump	10	106.5	174.5	141.05	17.58	0.000
HR mean of Jump	10	106.6	175.6	140.06	18:28	
HR mean of 1st VP and 1st DP	10	102	170.5	129.25	17.81	0.006
HR mean of 1st VP and 2nd DP	10	103.5	174.5	128.3	14:28	0.003

HR mean of the 1st and 3rd DP	10	102	176.5	129.04	14:18	0.001
HR mean of 2nd VP and 1 DP	10	102.5	171	130.35	13:59	0.002
HR mean of 2nd VP and 2nd DP	10	104.5	175	129.04	10:58	0.001
HR mean of the 2nd and 3rd DP	10	103	177	130.5	10.65	0.000
HR mean of 3rd VP and 1 DP	10	103.5	186	131.55	14.24	0.007
HR mean of DP and 2nd 3rd VP	10	105.5	190	130.6	9:45	0.001
HR mean of the 3rd and 3rd DP	10	104.5	192	131.7	7.46	0.000
HR mean of 1st J and 1st I	10	110	169.5	137.05	18.88	0.540
HR mean of 2nd I and 2nd J	10	110.5	163.5	135.4	15.09	0.137
HR mean of the 3rd I and 1st J	10	110.5	165.5	135.35	16.33	0.161
HR mean of 2nd J and the 1st I	10	109.5	168	138.45	17.77	0.329
HR mean of the 2nd I and 2nd J	10	104.5	162	134.5	13.48	0.047
HR mean of the 2nd I and 3rd J	10	111	164	136.35	14:00	0.052
HR mean of 3rd J and 1st I	10	108.5	166	138.15	19.38	0.409
HR mean of 2nd I and 3rd J	10	109	160	136.15	15.83	0.096
HR mean of the 3rd I and 3rd J	10	109.5	162	136.1	15.67	0.090

Analyzing the values for VP, the minimum values are all very similar in relation to the maximum, there is a greater diversity between the lowest value of 159,5 bpm and the highest value of 175 bpm. The maximum values are relatively high compared to the values of immersion and jumping. Statistically we have found no significance. The VEP and VP assumed minimum lower values compared to other aquatic motor skills. The maximum values are all rather approximate, which suggests that the physiological response regarding HR was similar in the three times when babies conducted the VEP. Regarding the significance $p \leq 0,05$ significant values were obtained. Finally, values of DP were analyzed. Regarding the maximum values DP task, it has reached quite high values, where the highest value was 192 bpm. The three mean values are related to the previous values, however slightly higher compared with the values of VP and VEP, in which there are similar tasks. The level of HR values in DP seems to be one that have increased physiological stress for the infant. Like the previous times, significance values were found, $p \leq 0.005$. In the following table values of VP, DP, I, and J are compared. In general terms, the values between VP and DP are identical in their minimum values and no considerable differences between these were found. The maximum values reach an increased dispersion, the lowest value is 171 bpm and the highest value reaches to 192 bpm. Again, the main attention is that the DP appears to increase values in their maximum rate even compared to other activity. Statistically, differences were found among all moments ($p \leq 0.005$). Finally, by comparing the mean of J and I, the minimum and maximum values are equivalent in relation to DP and VP and the minimum values are relatively higher, but the maximum values are indeed lower. The means are within the previous activity's values, the lowest value is 134.5 bpm and the highest value is 138.15 bpm. Statistically there are significant differences only between the mean in HR of the 2nd jump and the 2nd immersion, these two moments have the lowest minimum value of 104.5 bpm and the lowest maximum of 162 bpm.

Discussion and Conclusions

The main objective of this study focused on identifying a methodology to understand the physiological responses of infants' HR levels while they are in the aquatic tasks. It was found that HR is a factor which can establish a reliable relationship between physiological parameters and being a non-invasive method, it seemed the most appropriate for the study. According to the literature (Bar-Or & Rowland, 2004), heart rate ranges between 120 bpm and 160 bpm which is within the limits of physical demand for these ages. The maximum heart rate in this study was 194 bpm, achieved in a DP moment in one of the babies, however the overall mean of the activities was 132.6 bpm that is within the recommended values. Thus, water activities for babies seem to present a proper and safe intensity to this practice in a comprehensive manner.

The objective of the activity is the intention for prevention and safety of drowning (Martins, 2010; Brenner et al., 2009), and motor development, but water can also assume another dimension, related to the physical abilities and physiological characteristics (Langendorfer & Bruya, 1995).

The higher values were found in the DP at its maximum extension, but the higher mean was observed in jumps. Jumps appear to require greater physiological demand than other aquatic motor skills. The same interpretation was found in Goksor et al. (2002) and Langendorfer & Bruya (1995). The VP, DP, VEP seem to assume lower values for the other aquatic skills, may be because they are more pleasant for children, most children seem more familiar with these activities. Although the DP assume a relatively low mean reaching values at its maximum rate much higher than the other activity, this may be because some babies show rejection in relation to this activity, sometimes when forced can lead to tears and creating a situation of stress which can significantly increase the HR, also found on Kano et al. (2024) and Jakobowicz & Ogonowska-Slodownik (2024). A jump or dive cannot be performed in the same way by an infant of eight months if you compare it to the actions of an older one. We also need to understand which or what previous experiences the infant had with the aquatic environment, to determine whether to have an impact on HR values.

Infants who demonstrate greater aquatic autonomy may present higher values compared to other children, since the effort is superior and because they have acquired a greater number of motor tasks allowing them to have greater autonomy (Santos et al., 2023; Brenner et al., 2009). In short, we can conclude that, the means of aquatic motor skills are in general within the values that are recommended. Regarding higher values we found in our study, some cases deserve in the future our focus of attention to be able to reverse this situation. The variability of the values found in this work reinforces the idea that each case is different. The individuality is an uncontrollable factor in this way there is a great dispersion among the values obtained from the HR. It is also important to state that the infant's companion can have an influence on the physiological response of the infant, at certain times in class aquatic education. The infant behavioral factor is crucial in the response for aquatic tasks, so is important to realize the emotional state of the child during class (Jeong et al., 2021; Borioni et al., 2022). This behavior may be a reason for a significant change in HR when performing a task. Given the example of the infant number 10 that reached a highest HR value during the moment on DP. Analyzing the video, the infant cries whenever it is placed in the DP, however each time it performs a dip

he lows the HR, we suspect that crying has a significant influence on increasing the maximum HR at certain times in class (Veloso et al., 2007).

The variability of values that we found in this work reinforces the idea that each case is a unique. Individuality is an uncontrollable factor, so there is a huge dispersion between the values obtained in the HR. It is also important to state that the infant's companion can have an influence on the infant's physiological response, at certain times in the aquatic education class. The infant's behavioral factor is decisive in the response to aquatic tasks. Therefore, it is important to understand the child's emotional state during class. This behavior may be justification for a change. significant change in HR when performing a task. As an example, the infant no. 10 reached a very high HR value during the PD, analyzing the video the infant cries every time he is placed in the PD, but, in turn, every time he performs an immersion when his HR decreases, we can suspect that crying has significant influence in increasing up to maximum HR.

In short certain behaviours that are manifested during realization of some tasks may have direct influence on changing in babies' HR. Thus, it is important that professionals may be able to interpret correctly the infant's responses. HR values indicate the physiological response of the infant at any given time, being aware of the intensity of cardiovascular level is necessary to adopt the methodologies according to the child's response. In specific relation to our study, we can conclude that there are changes in HR associated with the tasks performed. By analyzing the values there was HR variability in children's aquatic sessions. Thus, we see constant changes between aquatic tasks compared individually. Each motor ability showed different cardiovascular responses, so it is necessary to consider what will be the infant's response, and if it is adequate.

In terms of study limitations, despite the full support of parents in carrying out this study, the placement of the chest band, even though it is non-invasive, is always a strange device to the infant, and sometimes its rejection happens. In some situations, the infant removed the chest band, for no apparent reason, and when this happened it was necessary to repeat the process again until the infant completely accepted or rejected the band transmitter. In short, the number of babies could have been much more extensive, but many of them showed rejection to the device and were therefore not included in the study, this was undoubtedly one of the greatest, if not the greatest, limitation of this work.

Water activities for infants offer opportunities that increase and improve their motor coordination, cognitive, emotional, and social skills, and contribute to their growth and development. Making children more participatory, intelligent, and independent is favorable to their education. These sessions can promote emotional balance, as relationships with other infants and adults foster socialization and self-esteem. These lessons are also important for improvement in the circulatory, cardiac, and respiratory systems, posture, motor coordination, and rhythm of each infant. Water activities with babies are extremely specific and require a unique set of skills from the teacher, enabling them to adapt, plan, implement, and evaluate their own activities. These classes provide adequate adaptation to the aquatic environment, focusing on the child's transition to the next levels of learning and fostering the relationship between parents and their children, promoting safety in the aquatic environment.

Future research should compare the results obtained in aquatic and land environment against different activities. It should also compare activities in aquatic and land environment such as

jumping, walking, and running, among others. Develop an investigation for parental influence related to infant's behaviours in the aquatic context.

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