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Original

EFFECTS OF LOW-VOLUME, HIGH-INTENSITY TRAINING PROGRAM ON SPORT PERFORMANCE IN COMPETITIVE YOUNG SWIMMERS

EFECTOS DE UN PROGRAMA DE ENTRENAMIENTO DE ALTA INTENSIDAD Y BAJO VOLUMEN EN EL RENDIMIENTO DEPORTIVO DE JÓVENES NADADORES COMPETITIVOS

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EFFECTS OF LOW-VOLUME, HIGH-INTENSITY TRAINING PROGRAM ON SPORT PERFORMANCE IN COMPETITIVE YOUNG SWIMMERS OF VALENCIAN COMMUNITY.

EFECTOS DE UN PROGRAMA DE ENTRENAMIENTO DE ALTA INTENSIDAD Y BAJO VOLUMEN EN EL RENDIMIENTO DEPORTIVO DE JÓVENES NADADORES COMPETITIVOS DE LA COMUNIDAD VALENCIANA.

ABSTRACT

Objective: This study evaluated the effects of a 12-week low-volume, high-intensity training (HIT) program on the performance of young competitive swimmers in the Valencian Community. Methods: A total of 144 swimmers (68 males and 76 females) participated, with categories ranging from Under 8 ages to Under 16 ages. Swimming times were measured in 25m, 50m, or 100m events during pre-test and post-test evaluations using official competition timing systems. The intervention involved progressive decreases in training volume alongside intensity increases over three mesocycles. Results: The findings revealed significant improvements in swimming times across all categories ($p < 0.05$), with the most pronounced effects observed in Under 8 ages and Under 16 categories, suggesting developmental and hormonal factors may influence outcomes. Improvements were similar between sexes, although some differences in response patterns were noted. Conclusions: The results show HIT's efficacy in enhancing performance in children and adolescents, with greater gains in younger participants and no significant differences between sexes. Therefore, although more research is needed in this age group, HIT could be a potential option for improving performance in young swimmers.

Keywords: childhood; adolescence; sport; swimming; sport training program; training load.

RESUMEN

Objetivo: Este estudio evaluó los efectos de un programa de entrenamiento de alta intensidad y bajo volumen (HIT) de 12 semanas sobre el rendimiento de jóvenes nadadores competitivos en la Comunidad Valenciana. Métodos: Un total de 144 nadadores (68 hombres y 76 mujeres) participaron en el estudio, abarcando categorías desde menores de 8 años hasta menores de 16 años. Los tiempos de natación en pruebas de 25 m, 50 m o 100 m se midieron en evaluaciones pre-test y post-test utilizando sistemas de cronometraje oficial de competición. La intervención consistió en una reducción progresiva del volumen de entrenamiento junto con un aumento de la intensidad a lo largo de tres mesociclos. Resultados: Los hallazgos mostraron mejoras significativas en los tiempos de natación en todas las categorías ($p < 0.05$), con efectos más pronunciados en las categorías de menores de 8 años y menores de 16 años, lo que sugiere que factores de desarrollo y hormonales pueden influir en los resultados. Las mejoras fueron similares entre sexos, aunque se observaron algunas diferencias en los patrones de respuesta. Conclusiones: Los resultados demuestran la eficacia del HIT para mejorar el rendimiento en niños y adolescentes, con mayores ganancias en los participantes más jóvenes y sin diferencias significativas entre sexos. Por la tanto, aunque se necesita más investigación en estas edades, el HIT podría ser una opción para la mejora del rendimiento en jóvenes nadadores.

Palabras clave: infancia; adolescencia; deporte; natación; programa de entrenamiento deportivo; carga de entrenamiento.

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INTRODUCTION

Swimming is a cyclical sport characterized by a wide range of disciplines, styles, and distances, which entail unique physiological and biomechanical requirements (Nurmukhanbetova et al., 2023). Since its inclusion in the first modern Olympic Games in 1896, swimming has evolved into one of the most prominent sports in the Olympic program (Nugent et al., 2017). Swimming has seen significant advancements in recent years, with world records frequently being shattered during the Olympic cycle. The primary factors driving this evolution are improvements in biomechanics, energy systems, and training methodologies (Terzi et al., 2021). Currently, it features over 30 individual events ranging from 50 to 1500 meters. Notably, most Olympic swimming events cover distances of 200 meters or less, typically completed in under 2 minutes and 20 seconds (Nugent et al., 2017).

The specific demands of training and competition in swimming vary depending on the event type, whether short-, mid-, or long-distance. Thus, depending on the characteristics of the event, the efforts require different energy systems, such as high-energy phosphagen, glycolytic and oxidative phosphorylation of carbohydrates, fats, or proteins (Domínguez et al., 2017).

Despite the short duration of many swimming competitions, traditional training practices often involve high training volumes (Nugent et al., 2017). This trend is particularly pronounced in youth categories, where training commitments range between 11 and 20 hours per week, distributed across 6 to 11 sessions (Nugent et al., 2017). This raises important questions about the relationship between training volume, athletic performance, and the long-term well-being of swimmers, especially in contexts of early specialization and overtraining risk (Nugent et al., 2017).

Numerous studies have identified physiological and biomechanical factors influencing swimming performance. For instance, stroke length, cycle frequency, stroke index and highest blood lactate concentration in post-exercise condition are essential biomechanical and energetic factors for swimming performance (Leitão et al., 2024). Barbosa et al. (2010) emphasize the intrinsic relationship between technical and biomechanical skills and physiological adaptation processes, highlighting the necessity of integrating these aspects into training (Barbosa et al., 2010). Furthermore, studies have observed that young swimmers demonstrate higher heart rate and stroke length parameters compared to highly skilled swimmers, underlining critical physiological differences to consider in training design (Sánchez & Arellano, 2002; Smith et al., 2002).

Since then, the long-standing "quality versus quantity" debate continues to engage coaches and sports scientists in swimming (Nugent et al., 2019). High-volume training (HVT), characterized by extensive distances at low intensities, has traditionally been the dominant approach in swimmer development (Nahar et al., 2025). However, its relevance has been questioned, particularly given the short duration of many swimming events, especially those under 200 meters (Nugent et al., 2017; Rushall, 2011).

In contrast, high-intensity training (HIT) has gained prominence as an effective alternative (Nugent et al., 2017; Rushall, 2011). HIT involves repeated high-intensity exercise bouts interspersed with recovery periods. In swimming, ultra-short race pace training (USRPT), proposed by Rushall (2017), has shown significant promise. USRPT focuses on high-intensity training replicating race speeds, with short distances and recovery intervals of less than 20 seconds (Nugent et al., 2019). This method allows swimmers to practice biomechanical and technical skills in conditions closely simulating competitive settings, thereby enhancing physiological and technical adaptations (Nurmukhanbetova et al., 2023).

Recent studies demonstrate that sports traditionally reliant on HVT, such as cycling, rowing, and long-distance running, may benefit from HIT interventions (Laursen, 2010). This approach can reduce total training volume without compromising performance (Buchheit & Laursen, 2013a, 2013b). Physiological adaptations to HIT include increases in plasma volume, muscle capillary density, and mitochondrial efficiency (Laursen & Jenkins, 2002). In swimming, adopting HIT could offer additional benefits, such as mitigating injury risk (Sein et al., 2010) and overtraining syndrome (Raglin et al., 2000), both associated with excessive HVT. Furthermore, high training volumes from an early age may increase the

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risk of early specialization (Myer et al., 2015, 2016), underscoring the im-portance of exploring training methods that reduce overall volume.

From a constructivist perspective, coaches should prioritize creating an optimal learning environment that integrates both social and physical aspects relevant to athletic development (Nurmukhanbetova et al., 2023). However, a disconnect between theory and practice has been noted among athletes, indicating the need for more effective pedagogical methods (Pugliese et al., 2015).

Despite advancements in training methodologies, unanswered questions remain regarding how to optimize performance in swimming, particularly at advanced stages of athletic development. Establishing pedagogical, biomechanical, and physiological foundations is essential to create an integrated framework guiding the training of swimmers. High-intensity training, combined with technical approaches tailored to individual needs, offers a promising avenue to address the limitations of traditional HVT and advance the science of swimming performance in young athletes (Karabıyık et al., 2023). Therefore, this study aims to evaluate the impact of 12 weeks low-volume, high-intensity training program on the sport performance of young competitive swimmers in the Valencian Community, analyzing the results across different age categories and sex.

MATERIAL AND METHODS

A longitudinal study was conducted to analyze the improvement in performance of young swimmers, using low-volume, high-intensity training over 12 weeks of training, with a quantitative and descriptive methodology.

Participants

All members of all the swimming clubs from Marina Alta in the Valencian Community were invited to participate in the study. Finally, a total of 144 youth swimmers (68 males and 76 females) who competed in official competitions (with a federation license) participated in this study. The categories were divided according to the guidelines of the Royal Spanish Swimming Federation (RFEN): Prebenjamín or U8 (born between 2014-2015; n=23); Benjamín or U10 (born between 2012-2013; n=28); Alevín or U12 (born between 2010-2011; n=34); Infantil or U14 (born between 2008-2009; n=36); Cadete or U16 (born between 2006-2007; n=23). The participants belonged to 7 swimming clubs from Marina Alta in the Valencian Community (Club-Benissa, Club-Benitatchell, Club-Lady, Club-Pégo, Club-Tonus, Club-Aqualia, Club-Dénia). Table 1 shows the characteristics of all subjects and the different categories into which the sample was divided.

----------------------- Table 1 --------------------------

To ensure sample homogeneity, specific inclusion, exclusion, and elimination criteria were established. The study included underage swimmers born between 2006 and 2015 who participated in official competitions and had a minimum of three years of competitive experience, except for those in the Prebenjamín and Benjamín categories. Swimmers who did not complete at least 80% of training sessions, did not participate in competitions during the study period, or had injuries or illnesses limiting their athletic performance were excluded. Additionally, swimmers who failed to complete all four scheduled measurements were removed from the final analysis.

Instruments

To assess the swimmers' athletic performance, times for a 25, 50, or 100-meter event were recorded based on the category during two different evaluations. These times were obtained directly from the official timing of competitions held at the beginning and end of the intervention. This time was measured using a digital stopwatch (Finis Pace Clock 3X-100M; 0.01 second precision). Smartwatches (Amazfit GTR 3) were used as a heart rate monitor to control the planned intensity through heart rate (HR). All collected data were recorded in a digital database hosted on Google Drive.

Procedure

The clubs were contacted to invite them to participate in the study. The study design and the 12-week training program were explained, which was structured into three mesocycles, each consisting of four microcycles with three weekly sessions. Each session lasted approximately 90 minutes.

The program began with a weekly volume of 5,700 meters. The training intensity was monitored using the recorded time from the first freestyle trial, setting an intensity of 85-95% of that time (Karabıyık et al., 2023), and with Maximum Heart Rate (MHR) for the other strokes, maintaining an intensity between 85-95% of MHR throughout the 12 weeks. Following the recommendations of Cicone et al. (2019) for children and adolescents, MHR was calculated using the formula by Tanaka et al. (2001) (Tanaka et al., 2001). The volume progressively decreased by 5% each month, while the intensity rate increased by 5%.

To properly conduct the study, a detailed 12-week training plan was established. Each session began with a dry-land warm-up focused on joint mobilization, followed by a water-based warm-up adapted to the age category: 250 m combining strokes for U8 and U10, and 500 m for U12 and older. The main part of each session primarily focused on freestyle, although sets of other strokes were incorporated depending on the day and category. The cool-down phase consisted of light swimming and dry-land stretching.

All questions regarding the HIT training plan and time recording were addressed, and both aspects were continuously supervised to ensure proper development. Legal guardians of the participants, as the study involved minors, received a detailed description of the study and signed informed consent forms. This study complies with the Declaration of Helsinki and was approved by the ethics committee of Pablo de Olavide University (code 23/4-3).

Statistical Analysis

For the statistical analysis of the data, IBM SPSS Statistics version 26 (SPSS Inc., Chicago, IL, USA) was utilized. Descriptive statistics included the mean and standard deviation. The reliability of the measurements was assessed by a 95% confidence interval for the mean. The next inferential analyses were conducted. Intra-category comparisons: Pretest vs. posttest differences (paired data) were analyzed for each category of swimmers. This analysis was performed separately for the entire sample, men and women. Since the samples did not meet the normality assumption (Shapiro-Wilk test), the non-parametric Wilcoxon test was applied. Inter-category and between-sex comparisons: The dependent variable was the percentage of change between the pretest and posttest. Because the data did not meet the assumptions of normality (Shapiro-Wilk test) and homoscedasticity (Levene's test), a Generalized Linear Model (GLM) was applied, with "Pretest" as a covariate and "Category" and "Sex" as factors. Effect size calculation: Effect sizes were calculated by Cohen's d. The following thresholds were used for interpretation: trivial (<0.2), small (0.2–0.8), large (0.8–1.2), and very large (>1.2). Statistical significance was set at a p-value ≤ 0.05.

RESULTS

Table 2 shows the times recorded in Pretest, Posttest and the Post — Pre differences obtained in each category after the HIT intervention. Statistically significant improvements in swimming tests (time) can be observed in all categories. The effect size corresponding to these improvements has been small in all categories.

----------------------- Table 2 --------------------------

Table 3 shows the times recorded in Pretest, Posttest and the Post - Pre differences obtained in male categories during the intervention. Statistically significant improvements in swimming tests (time) can be observed in all categories. All categories improved their swimming test times by more than two seconds, except for the U10 category, which reduced the time by 1.53 seconds. The effect size corresponding to these improvements has been small in all categories, except for U14 was trivial (0.15).

----------------------- Table 3 --------------------------

Table 4 shows the times recorded in Pretest, Posttest and the Post - Pre differences obtained in the female categories during the intervention. The results report improvements in performance in all categories, however these improvements are statistically significant in 3 of the 5 categories. The reduction in the records is not significant in the U10 and U12 categories. The effect size in the three categories with significant improvements has been small.

----------------------- Table 4 --------------------------

The Pre-Post percentage of change is the variable used to compare categories and sexes since, in addition to the differences in physical condition

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across sexes and categories, the distance of the swimming tests changes depending on the category. Table 5 presents the Pre-Post Percentage Changes in swimming times following the HIT training intervention across the five categories and shows also the comparison of performance improvements between men and women within each category. The data indicate that in the lower categories, women achieved greater time reductions, whereas in the two higher categories, men demonstrated better results. However, no statistically significant differences in swimming performance improvements were observed between men and women in any of the analyzed categories.

------------------------ Table 5 ---------------------------

Finally, Figure 1 illustrates the comparisons of pre-post percentage changes across the different categories, with separate analyses for the total sample and for each sex. The results indicate that the time improvements in the U8 category were significantly greater than those in the other categories.

--------------------- Figure 1 ---------------------------

DISCUSSION

The purpose of this research is to analyze sports performance following the implementation of a low-volume, high-intensity training program in young competitive swimmers. The dependent variable for performance parameters related to swimming was the time recorded in a swimming test (25 m, 50 m or 100 m) based on the category. Our findings revealed a significant improvement in times after applying a 12-week low-volume, high-intensity training program.

The results obtained demonstrate significant improvements ($p < 0.05$) in swimming times across all categories following the implementation of a HIT program (Table 2). These results align with current studies where the implementation of a HIT program in young swimmers over 8–12 weeks led to improved sport performance (Karabıyık et al., 2023; Nurmukhanbetova et al., 2023). In contrast, Faude et al. (2008) and Nugent et al. (2018) found no improvements in performance after implementing a 4 and 7-week HIT program respectively (Faude et al., 2008; Nugent et al., 2018). However, compared to the traditional high-volume training group, HIT maintained performance with a significantly reduced weekly training load highlighting its potential as a time- and effort efficient approach (Faude et al., 2008; Nugent et al., 2018).

These improvements were most pronounced in the U8 category with the greatest effect size, although moderate (0.39, 0.38 and 0.39 to All, Men and Women respectively, Tables 2, 3 y 4). It is important to note that performance improvement is greater when athletes are beginners, which may explain why this improvement in U8 compared to other categories could be attributed to this factor (Figure 1) (Thomas, 1994). In the rest of the categories significant improvements were also observed with effect sizes lower (0.22 to 0.29). This may be attributed to swimmers in these age groups being in a transitional phase of physiological and technical development, which could potentially limit the adaptations achievable through high-intensity training. (Born et al., 2022).

Although the results report improvements from HIT in both sexes, sex-specific analyses revealed distinct response patterns. Among males (Table 3), the U8 (ES = 0.38) and U12 (ES = 0.46) categories exhibited the largest effect sizes, suggesting, likewise an overall sample, that younger boys and preadolescent males responded more effectively to HIT. In the U14 and U16 categories, although the results were statistically significant ($p < 0.05$), the effect sizes were smaller (0.15 to 0.26), indicating less pronounced improvements in older adolescent males. For females (Table 4), the U8 (ES = 0.39) and U16 (ES = 0.37) categories showed the largest effect sizes, indicating that younger girls and older adolescent females particularly benefited from the HIT program. In the U10 and U12 categories, improvements were not statistically significant ($p > 0.05$), with low effect sizes (0.09 to 0.26). This could reflect hormonal differences or less advanced physical development in these age groups.

Related to this point, it is important to note that biological and morphological maturation does not progress linearly or at the same rate within the same age group and/or sex from pre-puberty onwards (earlier in girls). This means that chronological and biological age can significantly diverge (Malina, 1994; McNarry et al., 2020; Nevill et al., 1998; Viru et al., 1999). Consequently, this can lead to considerable differences in maturation among

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swimmers within the same chronological age group (Geladas et al., 2005; Vaeyens et al., 2008). This aspect reinforces the idea that training is an individualized process, where training loads (volume, intensity, density) should be adapted to the morphological characteristics and maturation status of the athletes (Lloyd & Oliver, 2012; Sellés et al., 2016).

Regarding the pre-post percentage changes in swimming times at the end of the intervention and the comparison between men and women, it is important to consider that, in addition to the differences in physical condition between sexes and categories, the distance of the swimming tests varies according to the category. The percentage change analysis revealed overall improvements across all categories (-2.75% to -8.41%), with the most pronounced improvement observed in U8 (-8.41%), reinforcing the effectiveness of HIT at younger ages. When analyzed by sex, the U8 group also exhibited the greatest improvement (Male: -8.48%, Female: -8.36%). In males, besides the U8 group, the U12 swimmers also showed a notable improvement (-5.26%). Additionally, the U16 female group demonstrated a greater percentage change (-4.13%) compared to their male counterparts (-2.95%), though this difference was not statistically significant ($p = 0.406$). This finding contrasts with those reported by Casanova and Gamardo (2017), who observed a higher fatigue index in girls compared to boys, noting a decrease in performance in the female category (Casanova Machek & Gamardo Hernández, 2017). Concerning this issue, a current review highlights key sex and age differences in swimming performance. Thus, after the age of 10 and up to 17, boys tend to be faster than girls. However, women tend to reduce existing sex differences in specific age groups (i.e., under 10 years and over 75-80 years) (Knechtle et al., 2020).

In any case, coaches and athletic trainers should adopt an integrated approach to evaluate children and adolescent readiness for sports, considering individual differences in somatic, neurologic, cognitive, and psychosocial development, as well as the impact of gender differences on sports participation (Brown et al., 2017; Pradas-Valverde et al., 2022).

Pairwise comparisons between categories revealed that, for the total sample, only the U8 category demonstrated significant differences compared to other groups. Among females, these differences were observed exclusively between U8 and U10, and U8 and U12. For males, U8 once again emerged as the category showing significant pairwise differences, specifically with U10, U14, and U16. The physiological and functional adaptations resulting from the use of this method are comparable to those achieved with medium and high volumes of low-intensity training. However, the authors state that when using the LHT method, physiological changes occur more rapidly, especially in athletes who have not previously employed this method in their training (Seiler, 2010).

These findings are alienated by the results presented in our first data showed in this study. In fact, it confirms that HIT program was more effective in the younger category. Although the U8 or beginner category had already trained and were physically active before starting their training with HIT programs, they had not previously been trained with this type of planning. Therefore, it is more likely that they responded to HIT through the principle of overload. Maybe, it is possible that these subjects behaved similarly to sedentary individuals regarding the effect of high-intensity training (Adami et al., 2020). The general hypothesis about adaptation to overload in this type of program is related to improvements in muscle buffering capacity, muscle quality, and glycogen content (Gibala et al., 2006, 2012), but it is necessary more research in this direction.

Childhood and adolescence are periods of significant physical growth and development, which can influence swimming performance. Factors such as variations in body composition, muscle development, and bone growth are key considerations when evaluating and training young swimmers. Implementing appropriate training during this phase of adolescence is crucial for achieving performance improvements and overall health benefits (Hibberd et al., 2016). Additionally, it is important to note that young female athletes often report a sense of overtraining, whether due to volume or intensity (Ferreira et al., 2021). Therefore, proper management of training loads is essential to ensure athletic

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longevity and maintain good health in athletes, as poorly calibrated training loads in young athletes can lead to early burnout, school dropout, and the onset of physiological and psychological conditions (Almási et al., 2021).

The findings of this study highlight the potential of HIT as an effective strategy for enhancing performance in competitive youth swimmers. The implementation of a 12-week HIT program demonstrated significant improvements across various age and sex categories, reinforcing its utility as a time-efficient training modality. Importantly, tailoring training programs to account for sex-specific and developmental differences could further optimize individual performance outcomes. Moreover, incorporating technical analyses—such as stroke rate, stroke length, and biomechanical efficiency—alongside HIT may enhance training precision and promote a more holistic approach to swimmer development.

The practical implications of this study are particularly significant for coaches working with early developmental categories, especially the U8 group. The findings revealed the most pronounced performance improvements in this youngest cohort, underscoring the receptiveness of novice swimmers to high-intensity stimuli. Coaches can incorporate HIT principles by designing age-appropriate, race-specific sessions that maintain a balance between technical development and physiological overload. For U8 swimmers, this might involve short-distance intervals (e.g., 6–10 × 15–20 m) performed at 85–95% of race pace with brief rest periods (15–20 seconds), ensuring adequate supervision and technical feedback. Dry-land activities focusing on mobility and motor coordination should precede water-based sessions. Additionally, integrating HIT in microcycles of 2–3 sessions per week—aligned with developmental and motivational capacities—can optimize training efficiency without imposing excessive physical or psychological strain. This approach aligns with the principle of training individualization and supports long-term athletic development by fostering neuromuscular adaptations and motor learning in sensitive periods of growth.

Despite its contributions, several limitations must be acknowledged to contextualize the results. The relatively short intervention period, while sufficient to detect acute performance gains, may not adequately capture long-term adaptations in areas such as growth trajectories, technical skill acquisition, or injury risk—particularly in older age groups. Although the overall sample size was robust, the uneven distribution across sex and age categories may have constrained the statistical power for subgroup comparisons. Additionally, the absence of biomechanical or technical performance variables limits the ability to discern whether improvements were predominantly metabolic, neuromuscular, or technical in nature. The study’s exclusive focus on freestyle events may also restrict generalizability to other strokes or combined disciplines. Finally, biological maturation was not directly assessed, a notable omission given the divergence that often exists between chronological and biological age in youth athletes. These limitations underscore the need for longitudinal, multidisciplinary research that integrates physiological, biomechanical, and developmental factors to better elucidate the role of HIT in youth athletic development.

Future research should focus on longitudinal studies to evaluate the long-term effects of HIT on youth swimmers' performance, physiological development, and injury prevention. Investigating technical parameters, such as stroke rate, stroke length, and biomechanical efficiency, in conjunction with physiological variables like VO_2max, could provide a more comprehensive understanding of HIT's impact. Additionally, exploring how sex-specific and developmental differences influence adaptations to HIT will help optimize training protocols. Comparative studies that assess HIT against traditional high-volume training methods across various age groups and competitive levels could further elucidate its role in swimmer development and performance enhancement.

CONCLUSIONS

According to the findings of the present study, a 12-week low-volume, high-intensity training program during the season demonstrated positive effects on the performance of children and adolescents competing in swimming, with more pronounced improvements observed in younger ages. While improvements were noted in both sexes, no significant differences were found between them. Proper load management that adheres to the principles of individualization and progression is essential at these ages.

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Table 1. Characteristics of the sample by categories.

	U8 (n=23)	U10 (n=27)	U12 (n=34)	U14 (n=36)	U16 (n=23)	Total (n=144)
Born between	2014-2015	2012-2013	2010-2011	2008-2009	2006-2007	2006-2015
Body mass (kg)	124.1 ± 0.8	135.8 ± 6.95	155.6 ± 7.5	166.1 ± 6.3	172.5 ± 7.0	150.8 ± 7.6
Height (cm)	40.4 ± 9.5	41.5 ± 4.73	45.3 ± 5.4	54.9 ± 5.7	63.3 ± 9.7	49.1 ± 5.4

Data expressed as mean ± standard deviation (SD).

Table 2. Swimming test times (seconds) to entire sample. Intra-category comparisons pretest vs. posttest

Category (meters)	**n**	**Pretest**		**Postest**		**Difference Post—Pre**		**p value**[¥]	**Effect Size***
		Mean ±SD	**CI (95%)**	**Mean ±SD**	**CI (95%)**	**Mean ±SD**	**CI (95%)**		
U8 (25m)	23	30.76 ± 7.11	27.69-33.84	28.09 ± 6.56	25.25-30.92	2.68 ± 2.48	-3.75-(-1.60)	0.001	0.39
U10 (50m)	28	51.56 ± 5.80	49.31-53.81	50.06 ± 5.47	47.94-52.18	1.50 ± 2.69	-2.54-(-0.46)	0.012	0.27
U12 (50m)	34	44.64 ± 6.83	42.26-47.02	43.23 ± 5.85	41.19-45.27	1.41 ± 2.45	-2.26-(-0.55)	0.001	0.22
U14 (100m)	36	89.83 ± 12.09	85.74-93.92	86.98 ± 12.22	82.85-91.11	2.85 ± 5.60	-4.74-(0.96)	0.001	0.23
U16 (100m)	23	82.02 ± 9.94	77.72-86.32	79.18 ± 9.47	75.08-83.27	2.84 ± 2.07	-3.74-(-1.95)	0.001	0.29

[¥] Comparison of paired data (Wilcoxon test).

*Cohen's d: trivial (<0.2), small (0.2–0.8), large (0.8–1.2), and very large (>1.2).

Table 3. Swimming test times (seconds) to men. Intra-category comparisons pretest vs. posttest

Category (meters)	**n**	**Pretest**		**Postest**		**Difference Post—Pre**		**p value**[¥]	**Effect Size***
		Mean ±SD	**CI (95%)**	**Mean ±SD**	**CI (95%)**	**Mean ±SD**	**CI (95%)**		
U8 (25m)	10	31.49 ± 8.31	25.54-37.44	28.54 ± 7.03	23.51-33.57	-2.95 ± 3.13	-5.19-(-0.71)	0.017	0.38
U10 (50m)	14	51.27 ± 5.65	48.01-54.53	49.74 ± 5.90	46.33-53.15	-1.53 ± 1.92	-2.64(-0.42)	0.016	0.27
U12 (50m)	14	47.48 ± 6.26	43.86-51.09	44.83 ± 5.20	41.83-47.84	-2.64 ± 2.24	-3.93-(-1.35)	0.003	0.46
U14 (100m)	17	88.18 ± 13.37	81.30-95.05	86.12 ± 13.24	79.31-92.93	-2.06 ± 4.70	-4.47-0.36	0.039	0.15
U16 (100m)	14	79.33 ± 9.60	73.78-84.97	76.93 ± 9.06	71.70-82.16	-2.40 ± 1.99	-3.55-(-1.25)	0.003	0.26

[¥] Comparison of paired data (Wilcoxon test).

*Cohen's d: trivial (<0.2), small (0.2–0.8), large (0.8–1.2), and very large (>1.2).

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Table 4. Swimming test times (seconds) to women. Intra-category comparisons pretest vs. posttest

Category (meters)	n	Pretest		Postest		Difference Post—Pre		p value¥	Effect Size*
		Mean ±SD	CI (95%)	Mean ±SD	CI (95%)	Mean ±SD	CI (95%)		
U8 (25m)	13	30.21 ± 6.33	26.38-34.03	27.74 ± 6.44	23.85-31.63	-2.47 ± 1.96	-3.66- (-1.29)	0.003	0.39
U10 (50m)	14	51.85 ± 6.16	48.3-55.41	50.39 ± 5.20	47.38-53.39	-1.47 ± 3.36	-3.41- (0.47)	0.272	0.26
U12 (50m)	20	42.65 ± 6.63	39.55-45.76	42.11 ± 6.14	39.23-44.98	-0.54 ± 2.25	-1.60-0.51	0.073	0.09
U14 (100m)	19	91.31 ± 10.96	86.03-96.59	87.75 ± 11.55	82.18-93.31	-3.56 ± 6.34	-6.61- (-0.51)	0.004	0.32
U16 (100m)	9	86.21 ± 9.46	78.94-93.48	82.67 ± 9.52	75.35-89.99	-3.53 ± 2.10	-5.15- (-1.92)	0.011	0.37

¥ Comparison of paired data (Wilcoxon test).

*Cohen's d: trivial (<0.2), small (0.2–0.8), large (0.8–1.2), and very large (>1.2).

Table 5. Pre-Post Percentage Changes in swimming times at the end of the intervention. Comparison between men and women.

Category (meters)	n	All		Female		Male		p value¥	Effect Size*
		Mean ±SD	CI (95%)	Mean ±SD	CI (95%)	Mean ±SD	CI (95%)		
U8 (25m)	23	-8.41 ± 7.37	-11.60- (-5.22)	-8.36 ± 6.43	-12.24-(-4.472)	-8.48 ± 8.82	-14.79-(-2.18)	0.763	0.01
U10 (50m)	28	-2.75 ± 5.04	-4.70-(-0.79)	-2.49 ± 6.13	-6.03-1.0497	-3.00 ± 3.87	-5.24-(-0.77)	0.870	0.05
U12 (50m)	34	-2.81 ± 4.99	-4.55-(-1.07)	-1.10 ± 4.66	-3.28-1.0816	-5.26 ± 4.52	-7.87-(-2.65)	0.081	0.36
U14 (100m)	36	-3.04 ± 6.15	-5.13-(-0.96)	-3.78 ± 6.76	-7.04-(-0.52)	-2.22 ± 5.48	-5.03-0.60	0.516	0.11
U16 (100m)	23	-3.41 ± 2.53	-4.50-(-2.32)	-4.13 ± 2.62	-6.15-(-2.12)	-2.95 ± 2.45	-4.36-(-1.53)	0.406	0.28

¥ Generalized Linear Model. (Factor: Sex; Covariate: Pretest). Post hoc pairwise comparisons (men vs. women; Bonferroni).

* Men vs. Women Cohen's d: trivial (<0.2), small (0.2–0.8), large (0.8–1.2), and very large (>1.2).

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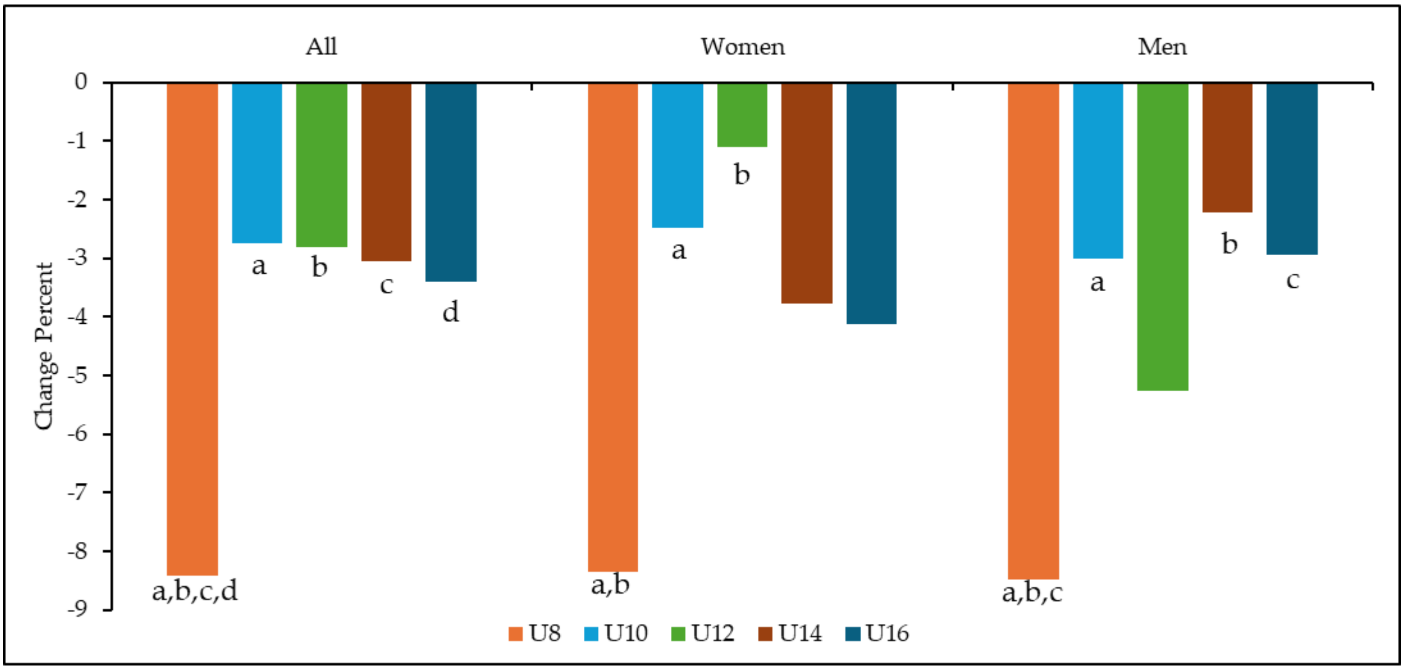
Figure 1. Pre-Post percentage changes in swimming times at the end of the intervention. Comparison between categories.



Generalized Linear Model. (Factor: category; Covariate: Pretest). Post hoc pairwise comparisons between categories; Bonferroni (same letter denotes significant statistically differences between pairs of categories).