Analele Universităţii din Oradea
Facicula Educaţie Fizică şi Sport
ISSN **2286-2870**, E-ISSN **1224-5100**

XXXVI / 2026, pp. 23-30
DOI 10.30892/AUOFEFS.2026.03

DEVELOPING FLEXIBILITY THROUGH STATIC STRETCHING IN 8–10 YEAR OLD HANDBALL PLAYERS

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Citation: Cristea D.I., Mariș V., Cristea A.A., Buhaș S.D., Pop A.C., Grosu V.T. (2026). Developing flexibility through static stretching in 8–10 year old handball players, *Analele Universității din Oradea, Fascicula Educație Fizică și Sport*, 36, 23–30. https://doi.org/10.30892/AUOFEFS.2026.03

Abstract: The development of flexibility during childhood plays an important role in physical performance and injury prevention, particularly in organized sports such as handball. This study investigated the effects of a 15-week static stretching program on mobility in 15 female handball players aged 8–10 years. A quasi-experimental pre–post design without a control group was employed. Mobility of the ankle, coxo-femoral joint, trunk, and shoulders was assessed at baseline and post-intervention. Paired samples t-tests and Cohen's d effect sizes were calculated. Statistically significant improvements were observed in all assessed variables ($p < 0.05$). Effect sizes were predominantly moderate, with moderate to large effects for trunk right mobility ($d = 0.65$) and ankle mobility ($d = 0.67$ left; $d = 0.58$ right). Significant correlations were identified between coxo-femoral and trunk mobility, as well as between trunk and shoulder mobility. The findings suggest that integrating static stretching into regular training sessions may contribute to improved mobility in young female handball players. Results should be interpreted cautiously due to the limited sample size and absence of a control group.

Key words: static stretching; flexibility; youth athletes; handball; mobility; pre-post intervention.

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INTRODUCTION

Flexibility is a central component of general physical fitness, defining an individual's ability to perform wide-ranging movements around a joint, with increased biomechanical efficiency and reduced risk of injury. This motor quality fundamentally influences performance in daily and sports activities, facilitating the correct execution of complex movements and reducing excessive strain on musculoskeletal structures (Zvetkova et al., 2023). In this context, stretching is a category of exercises that involve the application of external or internal forces on muscles and joints, being recognized as an effective method of increasing flexibility and is widely used in sports training (Màhler, 1995; Peck et al., 2014).

Stretching is often integrated into the warm-up phase of exercise, contributing to increasing muscle and tendon flexibility, stimulating peripheral circulation, increasing body temperature, and optimizing neuromuscular coordination (Smith, 1994). A standard protocol includes light aerobic activities followed by static or dynamic stretching exercises and ends with sport-specific movements, as some specialists state (Popelka & Pivovarniček, 2022).

In children, developing flexibility through stretching requires an adapted approach, taking into account age-specific physiological and biomechanical characteristics. During the period 8–10 years, the musculoskeletal system is in an active growth phase, and connective tissue properties, such as viscoelasticity and plasticity, differ significantly from those of adults (Bothorel et al., 2015; Gleim & McHugh, 1997).

Stretching exercises for this age group must be chosen carefully, because excessive or incorrectly performed stretches can negatively affect bone growth processes, especially sensitive areas of the developing skeleton and the integrity of forming ligaments (Fu, 2018; Kalkman et al., 2020).

The choice of working technique, whether static, dynamic or based on proprioceptive neuromuscular facilitation (PNF), should be made according to the child's level of physical and neurophysiological maturity, in order to maximize mobility gains without compromising bone or joint development (Konrad et al., 2016). Studies indicate that regular stretching, applied correctly, contributes not only to improving flexibility, but also to reducing the incidence of injuries among young athletes (Bouguezzi et al., 2023; Koźlenia & Domaradzki, 2021; Sabău et al., 2023).

Given the increasing number of children participating in organized sports and the need for a safe and effective physical training environment, systematic investigation of the effects of stretching on flexibility in this age group is warranted. The development of an appropriate protocol should consider frequency, intensity, duration, and type of training, as well as the integration of stretching into the broader framework of physical literacy, which involves motivation, confidence, competence, and knowledge about movement (Carl et al., 2022; Longmuir et al., 2015). Children's cognitive and emotional engagement is essential for maintaining long-term adherence to such training (Scantlebury et al., 2020).

In the context of handball, motor demands include explosive movements, repeated throws, rapid changes of direction, and large amplitudes at the level of the scapulohumeral girdle and lower kinetic chain. Therefore, the level of joint mobility can be an important factor in both optimizing performance and preventing injuries in this age group.

Considering the particularities of musculoskeletal system development at the age of 8–10 and the specific demands of the handball game, it is necessary to analyze the effects of a systematic stretching program on joint mobility in this age category.

The aim of the study was to evaluate the influence of applying a static stretching protocol, carried out over a period of 15 weeks, on the development of flexibility in 8–10-year-old female handball players.

The working hypothesis was that systematic implementation of stretching exercises would be associated with significant increases in mobility at the tested joints between baseline and final assessment.

METHODOLOGY

The present study used a quasi-experimental pre–post design without a control group, with the objective of evaluating changes in joint mobility following the application of a static stretching protocol in female athletes aged between 8 and 10 years.

The research sample consisted of 15 athletes registered with the CSU Oradea-KIDS women's handball team, minihandball category, aged between 8 and 10 years and with a body mass index (BMI) between 14.7 and 24.7. All participants began organized sports training in February 2024 and carried out regular training specific to the discipline practiced. The inclusion criteria included constant participation in training, the absence of musculoskeletal injuries in the last six months and the informed consent of parents or legal guardians for participation in the study.

The analysis of the BMI distribution revealed that 12 of the participants (80%) were in the normal weight category, one athlete (6.7%) was classified as overweight, and two participants (13.3%) had values corresponding to the severely overweight category. No cases of underweight were identified. This distribution indicates a predominance of the normal weight category within the investigated sample.

The study was conducted over a period of 15 weeks, with two evaluation moments: initial testing (IT) and final testing (TF). Between the two evaluations, an integrated static stretching protocol was implemented at the end of handball training. The exercises were applied twice a week, each exercise being maintained for 15 seconds, with a break of approximately 20 seconds between repetitions. The intensity of the exercises was moderate, the stretches being performed until a sensation of mild muscle tension appeared, without exceeding the pain threshold. In total, 13 stretching exercises and their variants were used, adapted to the age characteristics of the participants.

The following segments and planes of movement were analyzed during the assessments: ankle mobility, hip-femoral mobility (by testing forward trunk bending), trunk mobility in the frontal plane (left and right lateral bending), hip mobility in the frontal plane (lateral twine) and shoulder mobility. The measurements were performed under standardized conditions, using the same procedures and instruments at both testing times.

Data processing was performed using SPSS, version 26. The distribution of variables was verified by the Shapiro–Wilk test ($n = 15$), with most variables showing normal distribution. Consequently, the paired-samples t-test was used to compare the values between the initial and final testing, at a statistical significance threshold of $p < 0.05$. The Pearson correlation coefficient was used to analyze the relationships between the studied variables. The effect size (Cohen's d) was also calculated to assess the magnitude of the observed differences.

The study was conducted in accordance with the principles of the Declaration of Helsinki, and all participants and legal guardians were informed about the purpose and procedure of the research, and informed consent was obtained.

RESULTS

Descriptive analysis revealed increases in mean values for all variables investigated between baseline and post-intervention testing (Table 1). Right ankle mobility increased from 8.60 cm to 9.47 cm, and hip mobility from sitting from 6.80 cm to 9.07 cm. Also, mean values for trunk and shoulder mobility showed increases between the two evaluation times (Table 1).

Table 1. Descriptive statistics of mobility variables (Mean ± SD)

Variable	TI (Mean ± SD)	TF (Mean ± SD)
Right ankle (cm)	8.60 ± 1.64	9.47 ± 1.46
Coxofemoral (cm)	6.80 ± 5.16	9.07 ± 4.86
Trunk left (cm)	19.07 ± 2.71	20.47 ± 2.61
Trunk right (cm)	18.53 ± 3.02	20.40 ± 2.75
Shoulders (cm)	18.47 ± 4.37	20.40 ± 3.70
Left ankle (cm)	8.40 ± 1.35	9.27 ± 1.39

To analyze the differences between the initial and final testing, the paired samples t-test was applied, at a significance level of $p < 0.05$. The results indicated statistically significant differences for all investigated variables (Table 2). The effect size values (Cohen's d) revealed moderate effects for the shoulders ($d = 0.47$), coxo-femoral ($d = 0.45$) and left trunk ($d = 0.53$), respectively moderate to large effects for the right trunk ($d = 0.65$) and ankles ($d = 0.67$ for the left and $d = 0.58$ for the right).

Table 2. Results of paired samples t-test and effect sizes

Variable	Mean difference	t	df	p	Cohen's
Right ankle	-0.87	-4.03	14	.001	0.58
Coxofemoral	-2.27	-6.11	14	< .001	0.45
Trunk left	-1.40	-3.40	14	.004	0.53
Trunk right	-1.87	-3.69	14	.002	0.65
Shoulders	-1.93	-5.04	14	< .001	0.47
Left ankle	-0.87	-4.52	14	< .001	0.67

Correlational analysis did not reveal significant associations between age and the mobility variables analyzed ($p>0.05$). A significant positive correlation was observed between coxofemoral mobility and left-sided trunk mobility ($r = 0.624$, $p = 0.013$), as well as between left-sided trunk mobility and shoulder mobility ($r = 0.738$, $p = 0.002$) (Table 3).

Table 3. Significant Pearson correlations between mobility variables (initial testing)

Variables	R	p
Coxofemoral – Trunk left	.624	.013
Trunk left – Shoulders	.738	.002

Effect size values (Cohen's d) indicated moderate effects for shoulder mobility ($d = 0.47$), hip mobility ($d = 0.45$) and left trunk mobility ($d = 0.53$), respectively moderate to large effects for right trunk mobility ($d = 0.65$) and ankle mobility ($d = 0.67$ for left and $d = 0.58$ for right).

DISCUSSIONS

The results of the study revealed significant increases in mobility in all segments analyzed after applying the static stretching protocol over a period of 15 weeks. The effect size values indicated moderate effects in most cases, and for some segments (trunk mobility to the right and ankle mobility) moderate to large effects, suggesting a practically relevant improvement in the amplitude of movements.

These findings are consistent with the literature, which emphasizes the role of static stretching in increasing flexibility in children and adolescents, when applied systematically and adapted to age-specific characteristics. Although the physiological mechanisms differ from adults, the increased properties of tissue plasticity in the period 8–10 years may favor adaptations at the level of musculotendinous chains.

The higher effect size values at the right trunk and ankle levels may be associated with the particularities of the demands in the handball game, which involve rapid changes of direction, impulses and repeated rotational and stabilizing movements. The significant correlation identified between hip and trunk mobility, as well as between trunk and shoulder mobility, may indicate a functional interdependence between the segments involved in the kinetic chain.

These data are consistent with the most extensive evidence in the literature: the meta-analysis by Donti et al., conducted on 73 studies and a total sample of 6,851 participants aged 3 to 18 years, demonstrated that static stretching produces significant increases in range of motion in both children (SMD = 1.09; 95% CI: 0.77–1.41), as well as in adolescents (MDS = 0.90; 95% CI: 0.70–1.10), with no significant differences between the two age categories ($p = 0.32$) (Donti et al., 2022). The same author suggests the hypothesis of a possible "window of opportunity" for the development of flexibility in the 8–11 age range, in which high-volume stimuli produce additional effects on the myotendinous chains, possibly due to the higher tissue plasticity specific to prepubertal ages (Behm, 2023; Donti et al., 2022). However, it should be noted that the "sensitive windows" hypothesis has recently undergone a critical evaluation by Van Hooren and De Ste Croix, who concluded that empirical evidence for the existence of specific sensitive periods is limited, and motor adaptations can also be obtained outside these ranges (Hooren & Croix, 2020). Therefore, the results of the present study should be interpreted as dosable effects in the 8–10 year age category, without being considered unique or impossible to replicate at other ages.

From a dosage point of view, the magnitude of the effect observed in our study is in line with the data in the literature on the duration–effect relationship. Mayorga-Vega and Redondo-Martín demonstrated that medium-term programs (16–17 weeks) produce moderate to large effect sizes ($g = 0.85–0.88$), compared to short-term programs (8–10 weeks, $g = 0.35–0.67$), and those of a full school year (31–32 weeks) achieve very large effects ($g = 0.85–2.06$) (Mayorga-Vega & Redondo-Martín, 2017). With the 15 weeks of intervention, our data falls within the moderate-to-high response associated window. Regarding the volume per session, the data indicate that the total accumulated volume is more decisive than the individual duration of each session: Ballesta-García did not identify differences between sessions of 60 s and 20 s with total equivalent volume (10 weeks) in high school students (Ballesta-García & Durán-Rodríguez, 2025), and Mayorga-Vega et al. demonstrated that, in 7–10-year-old schoolchildren, a program of only 4 minutes × 2 sessions/week produced significant increases in hamstring extensibility ($p < 0.001$), a maintenance program of 1 minute per session being sufficient to preserve these increases (Mayorga-Vega et al., 2016). These results highlight the feasibility of integrating stretching in practical contexts with time constraints, such as the end of the mini-handball training session. The choice to apply static stretching at the end of training is also supported by evidence of acute effects on explosive performance. Faigenbaum et al. showed that, in children (11.3 years), 5 minutes of static stretching in warm-up significantly reduced vertical jump height and shuttle run time compared to dynamic exercises ($p < 0.05$) (Faigenbaum et al., 2005); The higher values of the effect, recorded at the level of the torso (right rotation) and ankle, can be interpreted in terms of the biomechanical requirements of the game of handball. Throwing is the central technical element — throwing speed is a predictor of marking (Bauer et al., 2022). The significant correlations we have identified between hip, trunk and shoulder mobility are fully compatible with this model: Bauer et al. demonstrated in young sub-elite handball players (9–19 years) that upper area mobility (shoulder, thoracic trunk) is functionally correlated with lower area mobility (hip, ankle) in passes, throws and sprints (Bauer et al., 2021). For the ankle in particular, data from the literature highlight that rapid changes of direction, impulses and repeated rotations — all components of the game of handball — exert specific demands on the tibiotarsal joint, which can generate a higher "functional demand" for range of motion at this level (Fernández-Fernández et al., 2022).

These data align with the Youth Physical Development Model, which places the range 6–11 years as the optimal period for the development of flexibility and general mobility, through exercises, coordination, agility, balance and muscular endurance with own body weight (Granacher et al., 2016; Lloyd and Oliver, 2012).

The results obtained indicate that the systematic integration of static stretching at the end of training can contribute to optimizing joint mobility in this age group, but these findings should be interpreted with caution in the absence of a control group.

CONCLUSIONS

The findings support the hypothesis that the systematic implementation of a static stretching protocol can be associated with improvements in mobility in female athletes aged 8 to 10. The increases observed in all segments analyzed, as well as the moderate to large effect sizes, suggest a practical relevance of the intervention in the context of sports training in this age group.

Controlled integration of stretching exercises into handball training may contribute to optimizing joint mobility, with potential implications for harmonious physical development. However, the results must be interpreted in the context of the methodological limitations of the study.

Aknowlegments

The study included a relatively small sample size, which limits the generalizability of the findings. We plan to expand the study and associate methods for developing flexibility with injury prevention strategies in extracurricular sports activities.

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Submitted:	Revised:	Accepted and published online
April 20, 2026	June 30, 2026	July 22, 2026