



## Effects of Bear Walking and Crocodile Animal Movement Training on Shoulder and Hip Joint Range of Motion in Children Aged 10–12 Years

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**Abstrac:** This study aimed to examine the effects of animal movement exercises, namely bear walking and crocodile, on shoulder and hip range of motion (ROM) in children aged 10–12 years. A quasi-experimental pretest–posttest control group design was used. Participants were selected through purposive sampling and assigned to a bear walking group (n=14), crocodile group (n=13), and control group (n=10). ROM was measured using a goniometer and analyzed with paired sample t-tests, Wilcoxon signed-rank tests, and One-Way ANOVA. The results showed significant improvements in shoulder and hip ROM in both exercise groups ( $p < 0.05$ ). Improvements in shoulder ROM were comparable between groups, while the crocodile group showed greater gains in hip ROM than the bear walking group. These findings indicate that animal movement exercises are effective for improving joint mobility in school-aged children.

**Keyword:** Children, Hip joint, Movement, Shoulder joint, Training

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## INTRODUCTION

Physical activity plays a fundamental role in supporting children's growth and development, particularly during the ages of 10–12 years. Regular physical activity contributes to the development of the musculoskeletal system, improves coordination and body balance, and enhances both fine and gross motor skills (Marzena Walasek et al., 2025; Wang & Liu, 2025; Zhao et al., 2023). However, physical activity levels tend to decline within this age range. This decline may be influenced by various factors, including increasing academic demands at school, reduced time allocated for physical education, and additional time spent studying and participating in extracurricular academic activities (E et al., 2023; Habyarimana et al., 2025). Reduced physical activity negatively affects movement function quality, including fine and gross motor coordination, muscle strength, and postural balance, which functionally contributes to a decrease in range of motion (ROM) (D'Anna et al., 2024; Engel et al., 2018).

According to Schoenfeld dan Grgic (2020), ROM refers to the degree of movement occurring at a joint during physical activity and may play an important role in muscular adaptation to exercise. One form of physical activity that has the potential to improve ROM is animal movement. Animal movement is a bodyweight training approach that incorporates movements inspired by animal locomotion patterns, including walking, transitioning, and crawling movements to enhance physical fitness (Buxton et al., 2022). This study focuses on joint mobility, particularly the shoulder and hip joints, through bear walking and crocodile movements. These two movement patterns possess different biomechanical characteristics and are therefore assumed to produce different mobility stimuli for both joints.

Previous studies have demonstrated that animal movement-based training provides benefits across various aspects of movement function and physical fitness. Matthews et al. (2016) reported that quadrupedal movement training improved joint reposition sense and cognitive function. Similarly, J. Buxton et al. (2024) found that different quadrupedal movement patterns elicited high levels of muscle activation in the upper extremities, lower extremities, and core musculature. Sidik et al. (2025) further reported that animal movement exercises enhanced muscular strength, balance, and coordination in children with Down syndrome. In addition, Savaş et al. (2025) demonstrated that a 12-week Animal Flow program significantly improved flexibility, agility, proprioceptive awareness, and core endurance among basketball athletes. Research by also indicated that motor control and core endurance training could increase hip joint range of motion (ROM). Furthermore, a literature review conducted by Eckart, (2023) concluded that quadrupedal movement training has the potential to enhance coordination, balance, proprioception, and joint mobility.

Despite these promising findings, most existing studies have been conducted among adults, athletes, or children with specific conditions and have primarily focused on physical fitness, muscle activation, stability, coordination, and overall movement performance. Research specifically comparing different forms of animal movement, particularly bear walking and crocodile exercises, in relation to changes in shoulder and hip ROM among typically developing children aged 10–12 years remains limited. This gap is noteworthy because the age of 10–12 years represents a critical stage of motor development characterized by rapid growth and the onset of peak height velocity, which is not always accompanied by proportional adaptations in muscle flexibility and soft tissue extensibility. Consequently, children may experience biomechanical imbalances and reduced neuromuscular control. Moreover, adequate shoulder and hip mobility plays an essential role in supporting physical fitness, maintaining postural alignment, preventing long-term musculoskeletal injuries, and enhancing both physical performance and cognitive function (Gasbarro et al., 2020; Ituen et al., 2025; Lloyd & Oliver, 2012).

Therefore, the present study aims to examine the effects of bear walking and crocodile exercises on shoulder and hip ROM in children aged 10–12 years and to compare the effectiveness of these two forms of animal movement training. From a practical perspective, the findings are expected to provide evidence-based guidance for physical education teachers and coaches in designing age-appropriate animal movement training programs. From a theoretical perspective,

this study seeks to contribute to the growing body of literature on the development of joint mobility through functional movement-based exercise interventions.

## METHOD

### Research Design

This study employed a quantitative quasi-experimental design using a pretest–posttest control group design to analyze the effects of animal movement exercises (bear walking and crocodile) on shoulder and hip joint range of motion (ROM) and to compare the effects of both interventions. This study was categorized as quasi-experimental because random assignment was not applied in group allocation (Sugiyono, 2024).

### Participants

The study population consisted of children aged 10–12 years, with a total sample of 37 participants selected using purposive sampling based on inclusion and exclusion criteria. Purposive sampling was employed to ensure that participants met characteristics relevant to the objectives of the study (Taherdoost, 2016). The study was conducted at Training Zone Indonesia Fitness Center, Surabaya, from April to May 2026.

### Instruments and Research Procedures

Participants were then allocated into the bear walking group (n=14), crocodile group (n=13), and control group (n=10) using a matching method based on pretest scores to ensure comparable baseline characteristics among groups (Creswell, 2014). The training program, as presented in Table 1, was conducted over a period of six weeks, with a training frequency of three sessions per week, resulting in a total of 18 intervention sessions.

**Table 1.** Animal Movement Training Program: Bear Walking and Crocodile Exercises

Trainings	Components	Weeks 1-2	Weeks 3-4	Weeks 5-6
Bear Walking	Intensity	Body Weight Training	Body Weight Training	Body Weight Training
	Set × Distance	4 × 30 Meters	4 × 30 Meters	4 × 30 Meters
	Speed	Controlled	Controlled	Controlled
	Rest Period	2 minutes	1 minute 30 seconds	1 minute
Crocodile	Intensity	Body Weight Training	Body Weight Training	Body Weight Training
	Set × Distance	4 × 30 Meters	4 × 30 Meters	4 × 30 Meters
	Speed	Controlled	Controlled	Controlled
	Rest Period	2 minutes	1 minute 30 seconds	1 minute

The exercise dosage was determined based on principles of neuromuscular adaptation in growing children (Biren, 2015; Faigenbaum et al., 2009; Morawietz et al., 2024).

### Data Analysis

Data were analyzed using SPSS. Descriptive statistics were used to present mean values, standard deviations, maximum values, and minimum values. Hypothesis testing was conducted using the paired sample t-test, Wilcoxon signed-rank test, and One-Way ANOVA.

## RESULT

**Table 2.** Descriptive Statistics

Characteristics	Side	Groups	Pretest	Posttest	Pretest	Posttest
			M ± SD		Minimum-Maximum	
Shoulder Flexion	Right	Bear Walking	183.2 ± 5.1	189.6 ± 6.7	170–190	175–210
		Crocodile	183.7 ± 6.2	194.6 ± 7.1	175–200	185–230
		Control	178.1 ± 5.9	181.5 ± 3.4	170–190	175–185
	Left	Bear Walking	183.6 ± 5.3	187.1 ± 7.5	175–195	175–210
		Crocodile	184.5 ± 6.5	189.6 ± 7.4	175–200	180–200

Shoulder Abduction	Right	Control	177.5 ± 5.7	181.5 ± 2.6	165–185	180–185
		Bear Walking	183.1 ± 4.9	188.8 ± 6.6	170–190	175–205
		Crocodile	182.5 ± 2.9	190.0 ± 5.6	178–185	180–200
	Left	Control	177.5 ± 3.8	179.5 ± 4.1	170–180	175–185
		Bear Walking	184.2 ± 4.7	187.5 ± 6.9	175–195	175–195
		Crocodile	184.2 ± 3.4	190.8 ± 6.2	180–190	180–200
Shoulder Mid-lat	Right	Control	177.0 ± 4.1	181.0 ± 3.9	170–180	180–185
		Bear Walking	86.5 ± 5.1	93.2 ± 4.8	75–91	85–110
		Crocodile	85.2 ± 5.4	90.4 ± 5.1	80–91	80–95
	Left	Control	76.0 ± 11.3	88.0 ± 2.7	55–90	80–95
		Bear Walking	88.1 ± 6.2	92.4 ± 3.9	79–94	90–100
		Crocodile	84.3 ± 5.8	90.0 ± 5.3	80–91	80–95
Hip Internal Rotation	Right	Control	77.0 ± 10.8	88.5 ± 2.4	50–85	85–90
		Bear Walking	40.2 ± 12.1	82.1 ± 9.1	23–75	70–103
		Crocodile	44.2 ± 10.5	94.8 ± 12.1	22–59	75–120
	Left	Control	43.5 ± 24.8	51.0 ± 23.9	20–85	30–85
		Bear Walking	35.6 ± 10.8	78.4 ± 10.5	18–58	60–93
		Crocodile	38.7 ± 9.8	90.6 ± 11.3	17–54	70–112
Hip External Rotation	Right	Control	45.0 ± 24.0	55.0 ± 24.3	20–80	30–80
		Bear Walking	82.5 ± 10.4	99.6 ± 9.1	60–110	90–122
		Crocodile	102.4 ± 11.6	102.3 ± 9.4	85–128	93–117
	Left	Control	74.8 ± 22.7	73.5 ± 22.8	35–100	30–90
		Bear Walking	84.1 ± 11.2	100.3 ± 8.7	45–107	87–114
		Crocodile	99.8 ± 10.9	103.1 ± 8.7	85–122	93–112
		Control	73.5 ± 22.6	72.5 ± 22.8	30–90	30–90

**Notes.** *N* Bear Walking = 14; *N* Crocodile = 13; *N* Control = 10; shoulder ROM = flexion, abduction, and mid-lat; hip ROM = internal and external rotation; unit: degrees (°).

Based on Table 2, all groups demonstrated changes in ROM values from pre-test to post-test. Overall, greater increases in mean ROM were observed in the Bear Walking group (right shoulder flexion: 183.2° to 189.6°; right hip internal rotation: 40.2° to 82.1°) and the Crocodile group (183.7° to 194.6°; 44.2° to 94.8°) compared with the control group.

**Table 3.** Effects of Bear Walking and Crocodile Training on Shoulder and Hip Joint ROM

Characteristics	Pretest	Posttest	Test Statistics	p
	M ± SD	M ± SD		
Animal Movement Bear Walking				
Shoulder Joint ROM	149.64 ± 4.27	156.96 ± 9.25	Z = -2.386	0.017
Hip Joint ROM	47.73 ± 5.17	93.89 ± 6.67	t(13) = -18.084	< 0.001
Animal Movement Crocodile				
Shoulder Joint ROM	150,36 ± 3,82	158.40 ± 3.46	Z = -3.110	0.002
Hip Joint ROM	48.12 ± 3.95	98.35 ± 7.86	t(12) = -27.034	< 0.001
Control Group				
Shoulder Joint ROM	142.77 ± 5.00	150.92 ± 1.54	t(9) = -4.719	0.001
Hip Joint ROM	60.50 ± 16.78	61.80 ± 16.90	t(9) = -2.164	0.059

**Notes.** *N* for Bear Walking = 14, *N* for Crocodile = 13, and *N* for Control = 10. Shoulder ROM was calculated as the average of shoulder flexion, abduction, and mid-lat measurements on the right and left sides. Hip ROM was

calculated as the average of internal and external hip rotation measurements on the right and left sides.  $Z$  = Wilcoxon signed-rank test;  $t(df)$  = paired samples  $t$ -test. All measurements were expressed in degrees ( $^{\circ}$ ).

Based on Table 3, bear walking and crocodile training resulted in significant improvements in shoulder and hip joint ROM ( $p < .05$ ). In the control group, a significant improvement was observed only in shoulder ROM ( $p = .001$ ), whereas hip ROM did not show a statistically significant change ( $p = .059$ ).

**Table 4.** One-Way ANOVA Results for Improvements in Shoulder and Hip Joint ROM

Measures	Walking Bear	Crocodile	Kontrol	F(2, 34)	$\eta^2$
	M $\pm$ SD	M $\pm$ SD	M $\pm$ SD		
Shoulder ROM Gain	7.32 $\pm$ 8.67	8.04 $\pm$ 5.00	8.20 $\pm$ 5.50	0.057	0
Hip ROM Gain	46.16 $\pm$ 9.55	50.20 $\pm$ 6.70	1.30 $\pm$ 1.90	155.87***	0.9

**Notes.**  $M$  = mean;  $SD$  = standard deviation;  $F$  = ANOVA test statistic;  $\eta^2$  = eta squared (effect size);  $p < .001$ .

Based on Table 4, there was no significant difference in shoulder ROM improvement among the groups ( $F(2,34) = 0.057, p > .05, \eta^2 = 0.003$ ), indicating that bear walking and crocodile training produced relatively similar improvements in shoulder ROM. In contrast, a highly significant difference was found in hip ROM improvement ( $F(2,34) = 155.87, p < .001, \eta^2 = 0.90$ ), with the crocodile group ( $M = 50.20$ ) demonstrating greater improvement compared to the bear walking ( $M = 46.16$ ) and control groups ( $M = 1.30$ ).

## DISCUSSION

Descriptive analysis in Table 2 showed changes in ROM values from pre-test to post-test. In the crocodile group, right-side external rotation showed minimal change ( $102.4^{\circ}$  to  $102.3^{\circ}$ ), whereas the left side increased from  $99.8^{\circ}$  to  $103.1^{\circ}$ . This difference may be associated with functional biomechanical asymmetry, including variations in femoral torsion, acetabular version, pelvic tilt, limb dominance, and neuromuscular control affecting bilateral movement distribution (Chadayammuri et al., 2016; Donati et al., 2024; Kiapour et al., 2024; Kiba et al., 2024; Promsri et al., 2018, 2020). Meanwhile, the improvement in internal rotation may be influenced by the dominant restriction of the iliofemoral ligament on external rotation, as in vitro studies have demonstrated that reducing this restriction can significantly increase external rotation (Myers et al., 2011). These findings suggest that internal rotation is more strongly influenced by neuromuscular control and posterior soft tissues, making it more responsive to dynamic animal movement-based training (Baba et al., 2022).

The analysis presented in Table 3 demonstrated that bear walking and crocodile training significantly improved shoulder and hip joint ROM, consistent with previous findings (J. D. Buxton et al., 2023; Sidik et al., 2025). Animal movement involves bodyweight and multi-joint movement patterns that combine dynamic stretching, eccentric activation, and light resistance, thereby enhancing ROM. This training approach is categorized as bodyweight resistance training based on a closed kinetic chain, which contributes to greater muscle activation, stability, and postural control. Alizadeh et al. (2023) reported that resistance training contributes to ROM improvement through neuromuscular adaptations. At the age of 10–12 years, neuromuscular responsiveness remains high, making children more adaptive to dynamic exercise. This is consistent with Abdulazeez et al. (2025) who stated that ROM development in children is influenced by age and anthropometric factors, highlighting the relevance of exercise interventions for this age group. Although the control group demonstrated variation in several variables, the changes were inconsistent, particularly in hip ROM. These variations may be explained by daily physical activity, differences in neuromuscular adaptation, and repeated measurement effects.

The analysis in Table 4 indicated no significant difference between bear walking and crocodile training in improving shoulder ROM. Although these exercises differ in movement amplitude, both are classified as closed kinetic chain exercises. According to Luedeka et al. (2026), during closed kinetic chain training, the upper extremities support body weight, causing the

shoulder joint to experience compressive and shear forces that must be stabilized by the deltoid, serratus anterior, trapezius, and rotator cuff muscles. Therefore, despite differences in movement patterns, the functional stimulus applied to the shoulder joint was likely similar, resulting in relatively equivalent improvements in shoulder ROM. In contrast, a highly significant difference was found in hip ROM improvement, with crocodile training producing superior outcomes compared with bear walking. Biomechanically, Wiseman et al. (2021), explained that crocodile movement is performed in a lower body posture (sprawl), which requires greater hip mobility and multiplanar lower-extremity movement during locomotion. Furthermore, repeated active-passive stretching may improve ROM through increased stretch tolerance and neuromechanical tissue adaptation, although muscle-tendon stiffness may remain unchanged (Ikeda et al., 2024). Conversely, bear walking involves relatively moderate hip and knee ROM and does not reach extreme movement ranges according to functional kinematic studies (Hindle et al., 2020). Therefore, crocodile training likely provided greater stimulus, leading to greater improvements in hip ROM.

The findings of this study indicate that animal movement training may serve as an alternative functional exercise to improve shoulder and hip joint ROM in children aged 10–12 years. The main findings showed that both bear walking and crocodile training improved shoulder ROM to a relatively similar extent, whereas crocodile training produced greater improvements in hip ROM than bear walking. These findings may provide an evidence-based foundation for developing training programs aimed at improving movement quality and physical readiness in children.

This study has several limitations that should be acknowledged. First, the relatively small sample size may limit the generalizability of the findings. Second, participants' daily physical activity levels were not controlled, which may have influenced the observed changes in ROM. Third, more comprehensive biomechanical assessments, such as electromyography (EMG) and kinematic analysis, were not conducted. Consequently, the neuromuscular and biomechanical mechanisms underlying the observed improvements in ROM could not be fully elucidated. In light of these limitations, several directions for future research are recommended. Future studies should involve larger and more representative samples to enhance the external validity of the findings. Furthermore, the integration of biomechanical and neuromuscular measurements, including EMG, motion analysis, and force analysis, would provide a more comprehensive understanding of the adaptive mechanisms associated with animal movement training. Longitudinal research is also warranted to evaluate the long-term sustainability of training-induced improvements in ROM. Additionally, comparative studies involving other mobility training approaches or functional exercise methods may help determine the relative effectiveness of animal movement training across different age groups and athletic populations.

Nevertheless, this study contributes novelty by comparing two variations of animal movement on shoulder and hip ROM using quantitative ROM measurements expressed in degrees with standardized measurement instruments in a school-aged population.

## CONCLUSION

This study demonstrated that animal movement training, specifically bear walking and crocodile exercises, was effective in improving shoulder and hip joint ROM in children aged 10–12 years. Both exercises resulted in relatively similar improvements in shoulder ROM, whereas crocodile training produced greater improvements in hip ROM compared with bear walking. These findings indicate that the movement characteristics of each animal movement variation may produce different responses in joint mobility. Therefore, animal movement has the potential to be used as an alternative functional exercise to support movement quality improvement in school-aged children. Future studies are recommended to involve larger sample sizes, control participants' physical activity levels, and incorporate additional biomechanical measurements to obtain a more comprehensive understanding of the mechanisms underlying ROM improvement.

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## REFERENCES

- Abdulazeez, M. U., Alhefeiti, M., Alhammadi, S., Alnuaimi, H., Abdullahi, A. S., Shaikhoun, L., Aminian, K., Stylianides, G. A., & Abdullah, K. A. (2025). Normative Knee Range of Motion for Children. *Life*, *15*(7). <https://doi.org/10.3390/life15071000>
- Alizadeh, S., Daneshjoo, A., Zahiri, A., Anvar, S. H., Goudini, R., Hicks, J. P., Konrad, A., & Behm, D. G. (2023). Resistance Training Induces Improvements in Range of Motion: A Systematic Review and Meta-Analysis. In *Sports Medicine* (Vol. 53, Number 3, pp. 707–722). Springer Science and Business Media Deutschland GmbH. <https://doi.org/10.1007/s40279-022-01804-x>
- Baba, K., Chiba, D., Mori, Y., Kuwahara, Y., Kogure, A., Sugaya, T., Kamata, K., Oizumi, I., Suzuki, T., Kurishima, H., Hamada, S., Itoi, E., & Aizawa, T. (2022). Impacts of external rotators and the ischiofemoral ligament on preventing excessive internal hip rotation: a cadaveric study. *Journal of Orthopaedic Surgery and Research*, *17*(1). <https://doi.org/10.1186/s13018-021-02873-w>
- Biren, G. B. (2015). Youth Resistance Training: An Alternative Means to Physical Activity. In *American College of Sports Medicine (ACSM)*. American College of Sports Medicine (ACSM)
- Buxton, J. D., Prins, P. J., Miller, M. G., Moreno, A., Welton, G. L., Atwell, A. D., Talampas, T. R., & Elsey, G. E. (2022). The Effects of a Novel Quadrupedal Movement Training Program on Functional Movement, Range of Motion, Muscular Strength, and Endurance. *Journal of Strength and Conditioning Research*, *36*(8), 2186–2193. <https://doi.org/10.1519/JSC.0000000000003818>
- Buxton, J. D., Prins, P. J., Miller, M. G., Moreno, A., Welton, G. L., Atwell, A. D., Talampas, T. R., & Elsey, G. E. (2023). The Effects of a Novel Quadrupedal Movement Training Program on Functional Movement, Range of Motion, Muscular Strength, and Endurance. *Original Research*. [www.nsc.com](http://www.nsc.com)
- Buxton, J., Daugherty, M., Grubbs, R., Isles, M., Mulligan, S., Plank, E., Taylor, E., & Prins, P. (2024). Comparison of muscle activation during quadrupedal movement training and traditional bodyweight exercises. *Journal of Bodywork and Movement Therapies*, *40*, 2173–2178. <https://doi.org/10.1016/j.jbmt.2024.11.002>
- Chadayammuri, V., Garabekyan, T., Bedi, A., Pascual-Garrido, C., Rhodes, J., O'Hara, J., & Mei-Dan, O. (2016). Passive hip range of motion predicts femoral torsion and acetabular version. *Journal of Bone and Joint Surgery - American Volume*, *98*(2), 127–134. <https://doi.org/10.2106/JBJS.O.00334>
- Creswell, J. W. (2014). *Research Design Qualitative, Quantitative, and Mixed Method Approaches by John W. Creswell (z-lib.org)* (V. Knight, J. Young, K. Kosolelek, B. Bauhaus, & M. Markanich, Eds.; 4th ed.). SAGE Publications.
- D'Anna, C., Forte, P., & Pugliese, E. (2024). Trends in Physical Activity and Motor Development in Young People—Decline or Improvement? A Review. In *Children* (Vol. 11, Number 3). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children11030298>
- Donati, D., Giorgi, F., Fari, G., Tarallo, L., Catani, F., & Tedeschi, R. (2024). The Influence of Pelvic Tilt and Femoral Torsion on Hip Biomechanics: Implications for Clinical Assessment and Treatment. In *Applied Sciences (Switzerland)* (Vol. 14, Number 20). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/app14209564>
- E, Y., Yang, J., Shen, Y., & Quan, X. (2023). Physical Activity, Screen Time, and Academic Burden: A Cross-Sectional Analysis of Health among Chinese Adolescents. *International Journal of Environmental Research and Public Health*, *20*(6). <https://doi.org/10.3390/ijerph20064917>
- Eckart, A. C. (2023). *Quadrupedal Movement Training A Brief Review and Practical Guide Apply It!* [www.acsm-healthfitness.org](http://www.acsm-healthfitness.org)

- Engel, A. C., Broderick, C. R., van Doorn, N., Hardy, L. L., & Parmenter, B. J. (2018). Exploring the Relationship Between Fundamental Motor Skill Interventions and Physical Activity Levels in Children: A Systematic Review and Meta-analysis. In *Sports Medicine* (Vol. 48, Number 8, pp. 1845–1857). Springer International Publishing. <https://doi.org/10.1007/s40279-018-0923-3>
- Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J. R., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth Resistance Training: Updated Position Statement Paper From The National Strength and Conditioning Association. *Journal of Strength and Conditioning Research*, 23(5), 60–79. <https://doi.org/10.1519/JSC.0b013e31819df407>
- Gasbarro, L., Padua, E., Tancredi, V., Annino, G., Montorsi, M., Maugeri, G., & D'Amico, A. G. (2020). Joint mobility protection during the developmental age among free climbing practitioners: A pilot study. *Journal of Functional Morphology and Kinesiology*, 5(1). <https://doi.org/10.3390/jfmk5010014>
- Habyarimana, J. de D., Tugirumukiza, E., Sun, H., Pathirana, A., & Zhou, K. (2025). From active play to sedentary lifestyles: understanding the decline in physical activity from childhood through adolescence—a systematic review. In *Frontiers in Public Health* (Vol. 13). Frontiers Media SA. <https://doi.org/10.3389/fpubh.2025.1636891>
- Hindle, B. R., Keogh, J. W. L., & Lorimer, A. V. (2020). Validation of spatiotemporal and kinematic measures in functional exercises using a minimal modeling inertial sensor methodology. *Sensors (Switzerland)*, 20(16), 1–21. <https://doi.org/10.3390/s20164586>
- Ikeda, N., Hiratsuka, K., & Isaka, T. (2024). Effect of 6-Week Instrument-Assisted Soft Tissue Mobilization on Joint Flexibility and Musculotendinous Properties. *Sports*, 12(6). <https://doi.org/10.3390/sports12060150>
- Ituen, O. A., Akwaowo, C. D., Ferguson, G., Duysens, J., & Smits-Engelsman, B. (2025). Impact of generalized joint hypermobility on quality of life and physical activity in school-aged children: a longitudinal study. *BMC Musculoskeletal Disorders*, 26(1). <https://doi.org/10.1186/s12891-024-08259-3>
- Kiapour, A. M., Mitchell, C., Hosseinzadeh, S., Emami, A., Lewis, C. L., Warfield, S. K., Bixby, S., Stracciolini, A., Novais, E. N., & Kim, Y. J. (2024). Association Between Hip Translation and Hip Rotation and Anatomy: A Pilot Quasi-static MRI Study. *Orthopaedic Journal of Sports Medicine*, 12(10). <https://doi.org/10.1177/23259671241275662>
- Kiba, H., Miaki, H., Yokogawa, M., & Asai, H. (2024). Lower-limb asymmetry in healthy male athletes. *Journal of Physical Therapy Science*, 37, 118–5. <https://doi.org/10.1589/jpts.37.118>
- Lloyd, R. S., & Oliver, J. L. (2012). The Youth Physical Development Model: A New Approach to Long-Term Athletic Development. *Strength and Conditioning Journal*, 34(3), 61–62. <https://doi.org/10.1519/SSC.0b013e31825760ea>
- Luedeka, D., Strick, K., Roche, N., & Williams, C. (2026). Shoulder Complex Dysfunction Through an Evolutionary Lens: The Need for Closed Kinetic Chain Loading in Upper Extremity Program Design. *Journal of Functional Morphology and Kinesiology*, 11(2), 131. <https://doi.org/10.3390/jfmk11020131>
- Marzena Walasek, Michał Ziemba, Katarzyna Giedzicz, Rafał Kulgawczuk, & Jan Smusz. (2025). Effects of Physical Activity on Children's Development - A Review. *International Journal of Innovative Technologies in Social Science*, 2(4(48)). [https://doi.org/10.31435/ijitss.4\(48\).2025.4321](https://doi.org/10.31435/ijitss.4(48).2025.4321)
- Matthews, M. J., Yusuf, M., Doyle, C., & Thompson, C. (2016). Quadrupedal movement training improves markers of cognition and joint repositioning. *Human Movement Science*, 47, 70–80. <https://doi.org/10.1016/j.humov.2016.02.002>
- Morawietz, C., Wissmann, A. M., & Muehlbauer, T. (2024). A 6-week coordinative motor training program improves spatial ability performances in healthy children. *Frontiers in Cognition*, 3. <https://doi.org/10.3389/fcogn.2024.1396399>
- Moreside, J. M., & McGill, S. M. (2012). Hip Joint Range of Motion Improvements Using Three Different Interventions. *Journal of Strength and Conditioning Research*, 26(5), 1265–1273. <https://doi.org/10.1519/JSC.0b013e31824f2351>

- Myers, C. A., Register, B. C., Lertwanich, P., Ejnisman, L., Pennington, W. W., Giphart, J. E., Laprade, R. F., & Philippon, M. J. (2011). Role of the Acetabular Labrum and the Iliofemoral Ligament in Hip Stability: An in Vitro Biplane Fluoroscopy Study. *American Journal of Sports Medicine*, 39(1\_suppl), 85S-91S. <https://doi.org/10.1177/0363546511412161>
- Promsri, A., Haid, T., & Federolf, P. (2018). How does lower limb dominance influence postural control movements during single leg stance? *Human Movement Science*, 58, 165-174. <https://doi.org/10.1016/j.humov.2018.02.003>
- Promsri, A., Haid, T., Werner, I., & Federolf, P. (2020). Leg Dominance Effects on Postural Control When Performing Challenging Balance Exercises. *Brain Sciences*, 10(3), 128. <https://doi.org/10.3390/brainsci10030128>
- Savaş, B. Ç., Ulupınar, S., Özbay, S., Gençoğlu, C., Turan, M., Asan, S., Mavibaş, M., Namlı, S., Karababa, B., & Yılmaz, E. (2025). Animal Flow as a Supplementary Training Tool for Basketball: A 12-Week Randomized Controlled Trial. *Pamukkale Journal of Sport Sciences*, 16(3), 798-817. <https://doi.org/10.54141/psbd.1672553>
- Schoenfeld, B. J., & Grgic, J. (2020). Effects of range of motion on muscle development during resistance training interventions: A systematic review. In *SAGE Open Medicine* (Vol. 8). SAGE Publications Ltd. <https://doi.org/10.1177/2050312120901559>
- Sidik, M. A., Pranoto, A., Wijaya, F. J. M., Mahardika, I. M. S. U., Suyoko, A., Pramono, B. A., Wahyudi, A. R., Faruk, M., Wulandari, N. S., & Orhan, B. E. (2025). The effect of animal movement exercises on improving upper and lower body muscles in children with down syndrome. *Pedagogy of Physical Culture and Sports*, 29(3), 204-210. <https://doi.org/10.15561/26649837.2025.0306>
- Sugiyono. (2024). *Metode Penelitian Eksperimen (Pendekatan Kuantitatif, Kombinasi dan R&D)* (1st ed.). Alfabeta.
- Taherdoost, H. (2016). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. In *International Journal of Academic Research in Management (IJARM)* (Vol. 5, Number 2). <https://ssrn.com/abstract=3205035>
- Wang, S., & Liu, J. (2025). Comparing the effects of physical activity and cognitive training on cognitive performance, physical fitness, and mental health in 9- to 10-year-old children: a randomized clinical trial. *Frontiers in Psychology*, 16. <https://doi.org/10.3389/fpsyg.2025.1555451>
- Wiseman, A. L. A., Bishop, P. J., Demuth, O. E., Cuff, A. R., Michel, K. B., & Hutchinson, J. R. (2021). Musculoskeletal modelling of the Nile crocodile (*Crocodylus niloticus*) hindlimb: Effects of limb posture on leverage during terrestrial locomotion. *Journal of Anatomy*, 239(2), 424-444. <https://doi.org/10.1111/joa.13431>
- Zhao, Q., Wang, Y., Niu, Y., & Liu, S. (2023). Jumping Rope Improves the Physical Fitness of Preadolescents Aged 10-12 Years: A Meta-Analysis. *Journal of Sports Science and Medicine*, 22(2), 367-380. <https://doi.org/10.52082/jssm.2023.367>