Apuntes Universitarios, 2022: 12 (4),octubre-diciem bre
ISSN: 2304-0335 DOI: https://doi.org/10.17162/au.v12i4.1255

Efectos de diez semanas de entrenamiento funcional en niños de 8-10 años sobre parámetros respiratorios y motores

Effects of ten weeks functional training on 8-10 age children on respiratory and motor parameters

Alper Cenk Gürkan[1a], Mehmet Söyler [2], Erdem Subak [3]

Gazi University, High School of Physical Education and Sports, Ankara, Turkey[1]
Cankiri Karatekin University, Vocational School of Social Sciences, Çankırı, Turkey[2]
Igdır University, Sports Sciences Faculty, Turkey[3]

ORCID ID: https://orcid.org/0000-0002-3977-0091[1]
ORCID ID: https://orcid.org/0000-0002-6912-4218[2]
ORCID ID: https://orcid.org/0000-0003-1696-2620X[3]

Recibido: 18 de marzo de 2022 **Aceptado:** 12 de Agosto de 2022

Resumen
Dentro del número de efectos positivos del entrenamiento funcional en el rendimiento de los atletas, los parámetros físicos está aumentando. Por tanto, el presente estudio, describe la preparacion en diez semanas de entrenamiento funcional para niños y la medicion de parámetros físicos y respiratorios antes y después del período de entrenamiento. Veinticinco jugadores de escuela de fútbol infantil, de 8 a 10 años, participaron en este estudio. Los participantes recibieron entrenamiento funcional durante 45 minutos al día, 3 días a la semana durante 10 semanas. La composición corporal de los participantes, los parámetros respiratorios y los parámetros de aptitud física se midieron antes y después de 10 semanas de ejercicio. Los resultados mostraron disminuciones significativas después de diez semanas de entrenamiento funcional en peso corporal, índice de masa corporal y presión arterial sistólica y aumentos significativos en capacidad vital, capacidad vital forzada, volumen espiratorio forzado, salto en cuclillas, salto con contramovimiento, abdominales de 1 min, flexibilidad y VO2máx. Las diferencias en la frecuencia cardíaca en reposo y las medidas de agarre no tenían sentido. En conclusión, el entrenamiento funcional podría mejorar las habilidades motoras y las funciones respiratorias de los niños de 8 a 10 años y ser beneficioso para controlar el peso corporal.

Palabras clave: Entrenamiento funcional, actividad física, entrenamiento de larga duración, funciones respiratorias, deportistas de larga evolución.

[a]Correspondencia al autor:
E-mail: alpercenkgurkan@gmail.com

Abstract

Among the number of positive effects of functional training on the performance of athletes, physical parameters is increasing. Therefore, the present study describes the preparation in ten weeks of functional training for children and the measurement of physical and respiratory parameters before and after the training period. Twenty-five male 8-10 age children soccer school players participated in this study. Participants were given functional training for 45 minutes a day, 3 days a week for 10 weeks. Participants' body composition, respiratory parameters and physical fitness parameters were measured before and after 10 weeks of exercise. The results showed significant decrease after ten weeks of functional training in bodyweight, body mass index, and systolic blood pressure and significant increases in vital capacity, forced vital capacity, forced expiratory volume, squat jump, countermovement jump, 1 min crunch, flexibility and VO_{2max} ($p <$ 0,05). The differences in resting heart rate and handgrip measures were meaningless. In conclusion, functional training could improve 8-10 age children's motor skills and respiratory functions and beneficial to controlling body weight.

Keywords: Functional training, physical activity, long training, respiratory functions, long development athletes.

Introduction

Increased inactive life to technology addiction affects children as humanity and health issues emerge dependent on physical inactivity (Nilsson et al., 2009). Along with factors that caused physical inactivity, the Covid-19 pandemic quarantine increased the inactive lifetime of children (Stavridou et al., 2021). The lack of physical activity causes obesity with gaining weight (Fogelholm, 2010). If this deficiency doesn't eliminate at an early age, the risk of metabolic diseases such as cardiovascular diseases and diabetes will improve in the upcoming years (Nilsson et al., 2009). Watts et al. (2005) reviewed exercise workouts and results of varied ages children. The review showed the eight weeks to 1 year of aerobic, resistance, or both aerobic and resistance training applied to the children in general. Among these training types, long-distance walking, long slow distance running (60-70% HR-max), dance, and resistance training (55-70% of 1 RM) are the most frequent training types.

Another training method that all children (including overweight and obese) can participate in is functional training. The popularity of functional training increases day by day (Santana, 2015) with the aim of functional training improving body functionality. Functional training improves the capability of daily movements such as climbing upstairs and lifting objects (Cress et al., 1996). Regular functional training ensures physical and functional fitness by improving strength, flexibility, mobilization, coordination, and cardiorespiratory functions (Corazza et al., 2016).

Functional training activates many muscle groups. Crossfit training includes high intensity of functional training (Sperlich et al., 2011).

Besides the increasing abilities of both athletes and daily activity performance of functional training, it can be used on children to their physical improvement and become elite athletes in further years. In addition, Fisher et al. (2016) showed that the functional training participants enjoyed more functional training methods than traditional training methods. It is also substantial that the children want to enjoy their physical training program to maintain a regular physical activity program. The improving motivation feature of functional training shows it can ingratiate regular exercise to the children. In this study, the effects of 10 weeks of functional training on 8-10 age children to body weight, body mass index (BMI), resting heart rate (Rest-HR), systolic blood pressure, respirational functions, jump, sprint, crunch, flexibility, handgrip, and VO2max capacity. 8-10 age range is the age of puberty does not start yet, especially sprint and flexibility progress peak.

By its part, Balyi et al. (2013) revealed the best training terms for fundamental motor skills as windows. The table in that research showed that the 8-10 age range particularly windows of flexibility and sprint training terms. Researchers suggested that these motor abilities would not improve with the high yield if the children miss these training windows. Researchers showed the strength and endurance windows with bilateral arrows and stated that these abilities could improve these any time. In light of this information, this study aims to analyze the effects of functional training on respiratory and motor parameters in 8-10 age children. This research hypothesizes that functional training will contribute to the 8-10 age children's motor development windows. This study adds to the literature on the respiratory and motor benefits of ten weeks of functional training in 8-10 age children.

Methods

Participants

The participants of this research are 25 male volunteer soccer club players of the U10 summer soccer school team in Ankara, Turkey. The average age of participants is 9.20 ± 0.76 years, and the height is 144.04 ± 4.28 cm. Before measurements, all participants were informed about the study design and tests. Before measurements, all participants filled out the health forms about no health issues to contribute to the study.

Study design

The pretest-posttest design was used for this study (Buhi, 2006). The physical and physiological measurements were implied before soccer school and after (10 weeks). The children participated in the tests at the same hours (08:30-12:00 / 14.00- 16.00) on different days. The professional and fully equipped camp facility and fitness center of the soccer club were used for controls and performance tests in Ankara, Turkey. The sequence of performance tests was applied properly to the American College of Sports Medicine guidelines (Ratamess, 2012).

Tests and Training Protocol

Children participated in performance tests at the beginning of summer soccer school. The age, height, weight, BMI, Rest-HR, systolic blood pressure, respiratory functions, vertical jump, sprint speed, flexibility, YoYo-IR1 VO_{2max} in the (first week), and the maximal resistance (1-min crunch and handgrip) (second week) were measured, respectively. The test program and functional training schedule are shown in Table 1 and Table 2 (Table 1, Table 2).

Table 1
Test and training program of 10-weeks

Week-1	Week-2	Week 2-10	Week 10
Performance Tests	Maximum Resistance Tests	Functional Training Prog.	**Day1:** Performance Tests **Day 2:** Max. Resistance Tests

Table 2
Functional Training Program

	Monday	Wednesday	Friday
Week 1-5 (%70)	Back Squat 3x5	Power Clean 5x3	Back Squat 3x5
	Shoulder Press 3x5	Pull ups 3x max	Bench Press 3x5
Week 5-10 (%75)	Back Squat 3x5	Deadlift 3x5	Back Squat 3x5
	Shoulder Press 3x5	Pullups 3xmax	Bench Press 3x5

Composition measure

The height of participants and body composition were measured, respectively. For the body weight (kg) and BMI (kg/m2), the bioelectrical electric impedance analysis (BIA, Inbody 270 Body Composition Analyzer, model Plus 270) was used. In this case, BIA is an analysis method dependent on lean tissue mass and permeability of adipose tissue (Lukaski, 2003). Children participated in the body composition analysis at 8.30 – 12.00 A.M., without any food and fluid consumption and after toilet needs. Participants were taken off the metal wear and accessories, and they wore light clothes for the measure. Participants stepped on the device with bare feet and stood upright, and held the hand electrodes. Data was saved by a computer program connected to the device.

Heart Rate Measure

The Rest-HR was measured with a Polar RS800cx watch. The data was transferred to a computer with an infrared connection and saved it. The watch is made in Finland and has two parts. One of the parts is a watch and wear on the wrist. The other part is a rubber band and wears to the heart line to surround the chest. It has options to save HR to a computer at 5, 10, or 15 seconds intervals (Tamer, 2000).

Blood Pressure Measure

The blood pressure of participants was measured in resting position with an aneroid sphygmomanometer and stethoscope as mmHg (Tamer, 2000). The measure was repeated three times for all participants and saved the minimum value.

Respiratory Function Test

For respiratory function analysis, a Spirolab III (Medical International Research) spirometer device was used. During spirometer measures, the participant's noses were congested with a latch. In sitting position, after a maximal inspiration, the forced expiration volume of children was saved by reading from the spirometer's digital screen (Alpay et al., 2007). Vital capacity (VC*), forced vital capacity (FVC), and forced expiratory volume (FEV)* were measured.

Flexibility Test

The sit-and-reach table (35x45x32 cm) was used to test flexibility. All children participated in the test three times, and the best flexibility score was saved in cm (Tamer, 2000).

Vertical Jump

The participants were stepped on the jump-meter mat and do a vertical jump. Participants were free to get speed from the knees for jumping, squatting, and using time. Participants tried to fall into a rectangular plastic area (mat) connected to the jump-meter. All children participated in the test two times, and the best score was saved as cm. Fusion Sport Smart Speed (Australia) was used and the device has a digital atmospheric system and has a 0,01-second precision (Reilly et al., 2000).

30 m Sprint Test

Fusion Sport Smart Speed (Australia) system used for sprint measures. Participants was started 1 meter behind the start line. All children were participated in the test two times at 3 minutes intervals and the best score was saved (Koley et al., 2011).

Yo-yo IR 1 Test

Starting from the starting line, the athletes were made their runs according to the given speed by making 20 m going and coming. A signal tone rang at every 20 m and the starting point. After completing every 40 m distance, all participants were rested 10 seconds by walking for active recovery. If a participant could not achieve the finish line two times successive, the test finished, and the distance was saved. After the results, the VO_{2max} values were calculated of participants by the given formula (Bangsbo & Krustrup, 2008):

$$VO_{2max}\ (ml/min/kg) = (YoYo\ IR1\ Distance\ (m) \times 0{,}0084) + 36{,}4$$

Handgrip

Takei T.K.K. 510 (Takei Scientific Instruments Co. Ltd.) was used for handgrip measures. The grip gap of the dynamometer was adjusted if required for the participant. While the participant was standing, three measurements were taken for the right arm without bending the measuring arm and without contacting the body (approximately 30-45 degrees angle) (Koley et al., 2011). The best score (kg) was saved. The handgrip test was processed the second week (after the participant's anatomical adaptation) (Baechle & Earle, 2008).

Functional Training Protocol

In this study, after pre-tests, the participants did ten weeks (three days for a week: Monday, Wednesday, and Friday) of functional training dependent on condition and resistance training. This study aims different adaptations based on the same training by focusing on Crossfit training programs designed for summer school athletes in the functional training content and applied in various sports branches. The duration of the pieces of training was 45 mins. The load and intensity (1-1.25 kg dependent on children's maximal capacity) of exercises was increased dependent on the activity type week by week. The athletes maintained their soccer training prepared by the coaches of the team. After ten weeks of training, the children were tested with the same tests (post-test).

Statistical analysis

Skewness and Kurtosis statistics analyses were used to control the distribution of participants' height. Paired samples t-test was used for pre, and post-test compare and the confidence level was settled at 95% ($p < 0.05$). IBM SPSS Statistics 26.0 was used for statistical analysis.

Ethical approval

This study was approved by the Ethics Committee of Igdır University (Decision No: 2022/4). After all the volunteers were verbally informed prior to the study, their written informed consents were obtained. Written informed consent outlining the purpose, procedures, and protocol risks were obtained from all participants; the study procedures followed the principles outlined in the Declaration of Helsinki.

Results

The distribution analysis for height showed the population had a normal distribution (Skewness: 0.789 ± 0.464; Kurtosis: 0.004 ± 0.902). Results of the Paired Samples T-Test analysis of each parameter mean pre and post-10-weeks of the functional training period are shown in Table 3 (Table 3). Apart from Rest-HR and handgrip results, all measures showed statistically significant differences. Bodyweight (-2.30%), BMI (-2.91%), SBP (-1.07%) means were decreased after ten weeks. VC (+31.6%), FVC (+10.82%), FEV (+4.86%), squat jump (+4.71%), CMJ (+7.52%), 1 min crunch (+26.27%), flexibility (+6.77%), and VO2max (+11.37%) means increased. The participants' 30-meter sprint time mean was decreased (-10.77%). Insignificant changes were recorded on Rest-HR (-0.91%) means and handgrip (+1.98%) means.

Table 3
Paired samples t-test analysis of each parameter mean pre and post 10-weeks of the functional training period

		Mean (n = 25)	Sd	CV (%)	t	df	ES	*p*
Body Weight (kg)	Pre	41.22	4.00	9.7	2.63	24	0.53	0.015 *
	Post	40.27	3.13	7.8				
BMI (kg/m^2)	Pre	18.56	0.68	3.7	3.53	24	0.71	0.002 **
	Post	18.02	0.84	4.6				
Rest-HR (bpm)	Pre	94.38	2.89	3.1	1.60	24	0.32	0.123
	Post	93.52	3.17	3.4				
SBP (mmHG)	Pre	119.75	1.42	1.2	6.87	24	1.37	0.000 ***
	Post	118.47	0.95	0.8				
VC (Lit.)	Pre	2.15	0.14	6.7	-10.82	24	0.21	0.000 ***
	Post	2.82	0.29	10.1				
FVC (Lit.)	Pre	1.94	0.25	12.9	-4.10	24	0.82	0.000 ***
	Post	2.15	0.39	18.1				
FEV (Lit.)	Pre	1.85	0.12	6.7	-5.34	24	1.07	0.000 ***
	Post	1.94	0.13	6.8				
Squat Jump (cm)	Pre	19.54	1.40	7.2	-5.26	24	1.05	0.000 ***
	Post	20.46	1.65	8.1				
CMJ (cm)	Pre	22.46	2.05	9.1	-4.90	24	0.98	0.000 ***
	Post	24.15	2.19	9.1				
30 m Sprint (sec)	Pre	6.50	0.29	4.4	11.12	24	2.22	0.000 ***
	Post	5.80	0.14	2.4				
1 min Crunch (repeat)	Pre	31.52	4.04	12.8	-14.67	24	2.93	0.000 ***
	Post	39.80	4.35	10.9				
Flexibility (cm)	Pre	27.17	2.02	7.4	-5.31	24	1.06	0.000 ***
	Post	29.01	2.02	7.0				

Handgrip (Lb)	Pre	23.78	1.10	4.6	-2.00	24	0.40	0.057
	Post	24.25	1.07	4.4				
VO_{2max} (ml/min/kg)	Pre	28.67	1.25	4.4	-8.07	24	1.61	0.000 ***
	Post	31.93	1.34	4.2				

BMI: Body Mass Index; Rest-HR: Resting Heart Rate; SBP: Systolic Blood Pressure; VC: Vital Capacity; FVC: Forced Vital Capacity; FEV: Forced Expiratory Volume; CMJ: Countermovement Jump; Sd: Standard deviation; CV: Coefficient of Variation; t: Paired Samples t-test Score; df: Degrees of freedom; ES: Effect Size; $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Discussion

Results showed that functional training affects various parameters in children significantly (Table 3). The significant decreases in body weight and BMI values exhibited that children could use regular functional training to lose weight and balance their bodies.

Obesity researches showed that the risk of type 2 diabetes and cardiovascular diseases would increase with a BMI increase (Fogelholm, 2010).

In this study, it was shown a decrease in BMI values of children after ten weeks of the functional training period. This result indicates that functional training could prevent diseases dependent on body weight increase and BMI increase. Gutin et al. (1995) parallelly showed ten weeks of aerobic training decreased BMI values in obese children. In our study, we calculated the VO_{2max} by YoYo IR1 test before and after ten weeks of functional training. And the results showed a significant increase in aerobic capacity. Besides, our results showed ten weeks of functional training improved blood pressure, respiratory functions, power, and flexibility parameters of children. These results indicated that functional training provides multiple developments by improving both health and athlete performance in children.

This study showed that the ten weeks of functional training decreased systolic blood pressure in children. Literature showed increased systolic blood pressure related to weight gain and obesity (Muntner et al., 2004). Markus et al. (1998) indicated a relation with increased systolic blood pressure, hypertension, and sleep apnea in children. Farpour-Lambert et al. (2009) specified that three weeks of exercise could decrease systolic blood pressure in children. Son et al. (2017) applied a training program that included a combined aerobic and resistance training by 12 weeks and showed a significant decrease in systolic blood pressure in children. Correspondingly with these results, our study showed a periodical functional training could prevent systolic blood pressure increase and obesity in children. After ten weeks of functional training, increases in VC, FVC, and FEV showed the functional training could improve respiratory functions in children. Ribeiro et al. (2005) indicated obesity affects FVC responses negatively.

These results revealed that increased body weight affects respiratory capacity negatively. Our study showed ten weeks of functional training increased FVC by 10.82% in children (Table 3). Similarly, Fatima et al. (2013) showed regular physical activity improves FEV values in adolescents. In the meantime, our results showed ten weeks of functional training improved VC and FEV values. These results demonstrated that functional training could improve respiratory functions while preventing obesity in children.

This study showed that ten weeks of functional training significantly improved the squat jump and CMJ abilities of participants. In a similar study, Diallo et al. (2001) revealed plyometric training improved squat jump and CMJ scores. Researchers and instructors frequently used the squat jump and CMJ to measure lower extremity power and determine the neuromuscular abilities of children (Acero et al., 2011). Our results showed significant increases in squat jump and CMJ values, and by this, functional training could improve the explosive power and neuromuscular abilities of children.

Explosive power is also substantial in short distance running speed (Buchheit et al., 2010). 30 m sprint time of participants improved after ten weeks of functional training. This progress showed functional training improved the explosive power and sprint speed of children. Short-distance sprint speed and explosiveness are also related to agility ability (Muniroglu & Subak, 2018). Besides, our results showed 1 min crunch scores and flexibility values of children improved after ten weeks of functional training (Table 3). Sprint speed, explosiveness, general power, agility, and flexibility are motor skills substantial in almost all sports.

Our results showed functional training could improve all these abilities in children. So, the functional training method could be beneficial to all children competing in various sports. In this case, YoYo IR1 test results showed VO_{2max} values increased after ten weeks of functional training. These results indicated that functional training affects aerobic endurance positively besides strength parameters. Multiple studies showed aerobic training improves the VO_{2max} level of children (Lemura et al., 1999).

On the other hand, it is stated the VO_{2max} levels of children increase without any exercise to a certain age. However, if supported with training, the rising would be high (Balyi et al., 2013).

Our results revealed the functional training could improve both anaerobic (explosiveness, short-distance sprint speed, etc.) and aerobic capacity in children. These results exhibited functional training could be beneficial to children for general physical development. Balyi et al. (2013) remarked pre-puberty ages are a substantial term for improving sprint and flexibility abilities in the progress of long-term athlete development.

The participant group was 8-10 age children and in pre-puberty age according to the table in Balyi's article. In this perspective, ten weeks of functional training improved sprint and flexibility abilities of 8-10 age children significantly. In addition to these findings, after ten weeks of functional training, BMI, respiratory, general power, and aerobic endurance values improved in children. Our results showed that ten weeks of functional training improved motor abilities in the developmental window and the other motor skills in pre-puberty children.

One of the limitations of this study was absence of a control group. One of the reasons for the absence of the control group in this study was that our study group consisted of very young children, and they were training together. Grouping the team and applying different training could cause an imbalance within the team. At the same time, grouping children into different groups could affect their psychology. In further studies, an advanced experimental model can be designed to examine the differences between functional training and other training types in children.

Conclusion

The popularity of functional training increases day by day, and functional training methods could adjust for children to contribute to children's physical development. Our results showed functional training ensured significant improvements in motor skills and respiratory functions in pre-puberty children. Children would enjoy functional training by its enjoyable and attractive content, and so children could maintain exercise for a lifetime. Due to the contents being similar to daily movements, functional training could contribute to general children's physical development, prevent posture deformities, and prevent metabolical problems like diabetes, cardiovascular diseases, and obesity (Santana, 2015).

Apart from the 8-10 age group, it could be examined whether functional training can be used as a method in the development of elite athletes with studies to be carried out with other age groups and with long-term follow-up studies from an early age to advanced ages. On the other hand, we have observed that the children in the football school period had the opportunity to get to know their bodies thanks to functional training. The children' self-confidence level has increased with functional training, and their desire for training has increased. In addition, according to our ten-week observations, accompanied by physical results, the social motivation of children increased related to improvements in their bodies.

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