



## The effect of Stickygym games on motor development of children during Covid-19 lockdown

Amin Gholami\*, Malihe Naeimikia

Motor Behavior Department, Sport Sciences Research Institute of Iran, Tehran, Iran (\*Corresponding author, Email: Amingholami91@gmail.com)

Article Info	Abstract
<p>Original Article</p> <p><b>Article history:</b></p> <p>Received: 18 August 2020</p> <p>Revised: 28 August 2020</p> <p>Accepted: 10 September 2020</p> <p>Published online: 1 January 2021</p> <p><b>Keywords:</b></p> <p>Covid-19, motor development, preschoolers, Stickygym games.</p>	<p><b>Background:</b> Children's motor skills are inversely related to sedentary screen time. COVID-19-lockdown during the pandemic has caused a further increasing on screening time.</p> <p><b>Aim:</b> The current research aims at investigating the impact of Stickygym games on motor development of children.</p> <p><b>Materials and Methods:</b> Twenty-eight eligible subjects (4-6 years old) were chosen and randomly grouped into control group (n=13) and experimental group (n=15). Using TGMD-2 test, gross motor development was measured. The experimental group performed online Stickygym games for 8 weeks. Stickygym kit includes Hook &amp; Loop strips, with two linear polyester strips being easily but firmly attached together. Trained instructors performed online training sessions. In the end, TGMD-2 test was conducted again in person. Data analysis was done using Shapiro-Wilk, Levene and the analysis of covariance tests were with the significance level of 0.05 in SPSS 24.</p> <p><b>Results:</b> Some locomotion skills were significantly improved by Stickygym games: bound (<math>P=0.005</math>), galloping (<math>P=0.012</math>), and running (<math>P=0.003</math>), as well as object control skills: overhand throw (<math>P=0.004</math>), underhand roll (<math>P=0.01</math>), and striking a stationary ball (<math>P=0.021</math>).</p> <p><b>Conclusion:</b> This play kit can be utilized by pre-school educators and parents for improving object control and locomotion skills in preschool children.</p>

**Cite this article:** Gholami A, Naeimikia M. "The effect of Stickygym games on motor development of children during Covid-19 lockdown". *Sport Sciences and Health Research*. 2021, 13(1): 41-52. doi: [10.22059/SSHR.2021.86145](https://doi.org/10.22059/SSHR.2021.86145).

This is an open access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (CC BY NC), which permits distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.



EISSN: 2717-2422 | Web site: <https://sshr.ut.ac.ir/> | Email: [sshr@ut.ac.ir](mailto:sshr@ut.ac.ir)

© The Author(s). Publisher: University of Tehran, Faculty of Sport Sciences and Health

## 1. Introduction

Early childhood is the most important period of healthy motor development in human life [1]. Physical activity may provide motor benefits across childhood and adolescence [2]. Inadequate physical activity is one of the leading causes of non-communicable disease, which leads to about 3 million deaths worldwide each year. Only 33% of all children meet the minimum guidelines (60 min of physical activity per day) recommended by the World Health Organization [3]. Physical activity affects many aspects of the child's development and health [4]. Physical activity has numerous benefits for health of children, such as enhanced mental wellbeing, blood pressure, insulin levels, and lower body fat mass [5, 6]. However, in spite of these advantages, children mostly do not have physical activities on most week days [7]. There is a strong relationship between level of physical activity and the fundamental motor skills (FMS) development in childhood. FMS include locomotor, manipulative, and stability skills, as the basic blocks for developing more complex, advanced motor skills to be used in sports or daily physical activities [8].

Children's fundamental motor skills are inversely related to amounts of screen-based behaviors [9]. COVID-19 virus caused infection in millions of people in the world and influenced a large number of people. About 1.5 billion 5-12 years old children adopted remote learning after closure of schools by the end of April 2020 [10], and sedentary behavior has been increased as a result of social restrictions [11, 12] and opportunities for engagement of adolescents and children in physical activities have decreased [13, 14]. The studies revealed that imposed movement restrictions resulting from the pandemic

harmed motor competence development in children [15]. Related studies have frequently reported lack of motivation in children for being active during lockdown periods and lack of motivation of parents for supporting physical activity in their children [16]. Previous research findings supported improvement of physical activity levels by implementing gamification, and gamification programs cause a significant improvement in emotional competencies and reduce anxiety levels [17, 18, 19]. Scientific research shows that play is fundamental to children's learning and motor development, and it satisfies specific needs, builds pleasure and fun, and strengthens imagination [20]. But, lockdown physical activity of children was limited mostly to home. Most of children's time is spent at home. Children are interacting with family members inside the home and resources for playing and learning are available for them. If stimulating toys are available in the home, they are significant indicators for the home environment's overall quality [21]. The home environment is in the host of subsystems contributing to motor development [22, 23]. Based on ecological (affordance) theory, the home should be supported as a medium for learning and growth [24].

As indicated by systematic reviews, early childhood physical activity interventions have been mostly conducted by researchers or research team. Thus, potential for long-term sustainability and external validity of these interventions are greatly reduced. In educator-led physical activity program, a trend is shown towards increasing gross motor skills of children. Early childhood educators facilitate educator-led programs. In other words, researchers or other professionals do not co-

facilitate these programs [25]. This study aims at investigating the impact of educator-led Stickygym games on children's motor development during Covid-19 lockdown. This innovative kit is made of Hook & Loop Tapes can be arranged for various fundamental motor skill games including locomotion, manipulation and stability.

## 2. Materials and Methods

It is a quasi-experimental research with a control group and pretest-posttest design. It was carried out in Tehran city, Iran, from January to March, 2020 during COVID-19 lockdown period. The research statistical population included children, which was recruited via announcements on social media. Pre-screening was performed using an online questionnaire to eliminate candidates who do not meet the basic requirements. The research inclusion criteria were as follows: the age range of 4 to 6 years (boys or girls), no engaging in any regular physical activity or sports program, the absence of cardiorespiratory and orthopedic disorders, and lack of medical prohibition for participation in the activity. Twenty-eight eligible subjects were selected as the statistical sample. The parents and their children were invited to attend an introductory in-person meeting and pretest session. The public health practices were followed to prevent the spread of COVID-19. Objectives of the study were explained for parents and children and illustrated some Stickygym sample games by trained instructors. The children and parents with willingness of participating in the research with a perfect knowledge of the research method and exercises completed the research entry form and consent form, and they were made ready for participation in the pretest. Gross

motor development was individually examined in all children.

Using Test of Gross Motor Development-2 test (TGMD-2), gross motor development was tested. We selected the TGMD-2 since it provides motor skill assessment including equipment and skills common to children at the age range of 3 to 10. It was first developed by Ulrich (1985) and its reliability ( $=0.87$ ) and validity ( $=0.96$ ) were confirmed among American children 3 to 10 years old [26]. The validity and reliability of this test were also confirmed by Zarezade and Farokhi (2009) in Iran; the internal reliability coefficient for loco-motor movement, control of object, and the total combined score was reported to be 0.78, 0.74, and 0.80, respectively [26]. Then, the research subjects were randomly assigned into the two groups: control group (age:  $5.20 \pm 0.43$  years;  $n=13$ ) and experimental (age:  $4.80 \pm 0.81$  years;  $n=15$ ). Fundamental motor skills are measured using the TGMD-2 standardized test, which includes 6 object control subtests (dribble, strike, catch, throw, kick, roll) and 6 locomotor (gallop, run, hop, jump, leap, slide). The movements were recorded by the camera to score skills. The motor development test checklist was used to analyze movement items. This checklist was provided based on Ulrich test (2000) [27]. The qualitative scoring method was based on analysis of body section approach which was scored as 0 and 1; the score 1 was used with fulfilling the criteria and score 0 was used when the participant does not meet the criteria. Each motor skill was performed twice and the skill score was obtained by adding criterion scores. The totals of the two subtests were summed to calculate raw scores [27].

The experimental group performed an online intervention emphasized on

fundamental motor skills using Stickygym kit for 8 weeks, 3 sessions a week, and 45 min each session (10 min for warm-up, 25 min for specific Stickygym games, and 10 min for cool-down). Stickygym kit was designed by scientists professional in motor development and developmental psychology. The kit includes Hook and Loop strips, with two linear polyester strips that are easily attached. Hook and loop tape is most commonly known as Velcro tape or hook and loop fastener tape. The bonding

strength of Hook & Loop Tape is increased by the unique and formulated design of loops and hooks. Stickygym kit includes the following pieces: two loop square plates, 6 loop strips in different colors, 6 loop dots in different colors and a 25 cm noodle foam, 4 small soft foam balls covered by hook tape. Stickygym kit has been registered in the Secretariat of the Toy Supervision Council of Center for the Intellectual Development of Child and Adolescent of Iran in 2019 (Reg.no.99/3123593/1) (Figure 1).



Figure 1. Stickygym kit

Trained instructors performed online training sessions. The activities were child-centered and focused on fundamental movement skills, mobility, and movement concepts using bonding characteristics of strips, dots, dart boards, sticky balls. Multiple people can participate in the game and enjoy the fun of the game. For example, throwing sticky balls to firmly attach to strips, dots, dart boards or other catching activities (manipulation skills), walking, running, hopping, skipping, jumping skills (locomotion skills), balancing, stretching, bending and twisting activities (stability skills) individually or in combination which were performed online by the instructors. The control group engaged in daily free play at home and online PE class (one

virtual session per week-45 min) of their institute. In the end, TGMD-2 test was conducted like the pretest in person. Data analysis was done using the descriptive (central tendency, graphs, and tables) statistics ( $P<0.05$ ). Shapiro-Wilk test was used for confirming the normality of the data and equality of variances assumed by the Levene test ( $P<0.05$ ). Then, to investigate the between – group difference, the effect of the independent variable (Stickygym games) on the dependent variables (object control and locomotion skills) was examined using the analysis of covariance (ANCOVA) to determine whether the intervention, without interacting with the confounding factor (pretest score), could have a significant

effect on the dependent variable or not. SPSS software version 24 was used for analysis of all data.

### 3. Results

The descriptive characteristics of the children participating in the research are shown in Table 1.

The Shapiro-wilk test results are insignificant for all research variables ( $P >$

0.05), meaning that all measured data of the research variables have a natural distribution (Table 2).

The results of Leven test are not significant for all variables ( $P > 0.05$ ) which indicate that the variances are homogeneous (Table 3).

**Table 1.** Characteristics of subjects

	Intervention (n=15)	Control (n=13)
Gender (male/female)	8.7	7.6
Age (years)	4.80±0.81	5.20±0.43
Height (cm)	115.4±0.05	116.24±0.06
Weight (kg)	19.2±2.34	18.9±3.30
BMI	16.8±1.80	16.1±2.14

Note: Data are given as mean ± SD

**Table 2.** Summary of the results of the Shapiro-wilk test to investigate the normal distribution of research data

Group Variable		Control		Intervention	
		Statistics	Significance	Statistics	Significance
Object control skills	Pretest	0.93	0.21	0.91	0.18
	Posttest	0.87	0.24	0.85	0.09
Locomotion skills	Pretest	0.97	0.46	0.97	0.51
	Posttest	0.82	0.14	0.91	0.27

**Table 3.** Leven test results to investigate the homogeneity of the variances of research

Variable	df1	df2	F	P value
Object control	26	1	2.70	0.08
Locomotion	26	1	2.43	0.102

Findings from (Tables 4 and 5) show the result of ANCOVA which was used to evaluate the effectiveness of Stickygym games on the dependent variables (object control and locomotion skills). The result of ANCOVA related to post-test scores of locomotion skills (Table 3) showed that the significant levels for run ( $P=0.003$ ), galloping ( $P=0.012$ ), and leap ( $P=0.005$ ) were less than 0.05; hence, the mean difference in the post-test phase between the groups was significant after controlling the

possible effect of the pretest score. Therefore, as can be seen, 8-week Stickygym games had a significant effect on above-mentioned variables ( $P < 0.05$ ).

The result of ANCOVA to evaluate the effectiveness of Stickygym games on object control skills have been shown in Table 5. The results showed that 8 weeks of Stickygym games can significantly improve overhand throw ( $P=0.004$ ), underhand roll ( $P=0.01$ ), and striking a stationary ball ( $P=0.021$ ) skills.



**Table 4.** ANCOVA results for evaluating the effectiveness of Stickygym games on locomotion skills

Variable	Group	Pretest		Post test		F	P
		M	SD	M	SD		
Run	Experimental	4.10	0.91	5.39	1.2	7.52	<b>0.003*</b>
	Control	3.27	0.75	3.90	1.64		
Gallop	Experimental	1.24	0.75	2.96	0.41	6.24	<b>0.012*</b>
	Control	1.41	0.22	1.51	0.37		
Hop	Experimental	2.01	1.02	2.80	0.95	3.60	<b>0.504</b>
	Control	2.29	1.06	2.90	1.10		
Leap	Experimental	1.30	0.74	2.67	0.60	3.86	<b>0.005*</b>
	Control	1.90	0.32	2.00	0.35		
Jump	Experimental	2.20	1.03	2.83	0.61	2.98	<b>1.203</b>
	Control	2.51	0.29	2.14	0.66		
Slide	Experimental	2.82	1.12	3.43	1.63	0.38	<b>0.720</b>
	Control	2.12	0.34	2.63	0.46		

**Table 5.** Results of ANCOVA to evaluate the effectiveness of Stickygym games on object control skills

Variable	Group	Pretest		Post test		F	P
		M	SD	M	SD		
Strike	Experimental	2.00	1.21	3.88	0.82	1.27	<b>0.021*</b>
	Control	2.27	1.02	2.42	0.64		
Dribble	Experimental	1.34	0.75	1.42	0.48	0.41	<b>0.412</b>
	Control	1.41	0.41	1.61	0.33		
Catch	Experimental	2.01	1.21	2.83	0.71	0.17	<b>0.634</b>
	Control	2.89	1.42	2.40	0.86		
Kick	Experimental	2.31	1.04	2.71	1.05	0.08	<b>0.530</b>
	Control	2.11	1.32	2.20	0.85		
Throw	Experimental	1.20	0.73	2.88	0.79	0.12	<b>0.004*</b>
	Control	1.51	1.12	1.78	1.02		
Roll	Experimental	1.82	1.02	3.03	0.78	0.51	<b>0.010*</b>
	Control	2.12	0.34	2.63	0.46		

#### 4. Discussion

The present research was conducted for examining the impact of physical training using an innovative paly kit named Stickygym on motor development of children. The findings showed that 8 weeks Stickygym training can have a positive effect on run, leap, and galloping skills from locomotion subscale and overhand throw, underhand roll, and striking stationary ball skills from object control subscale of TGMD-2 test. The subjects in the experimental group could obtain higher scores in these skills than the control group after participating in the training program. Our research findings indicate that motor development of children can be improved

by affordances in the home environment. The home environment primarily contributes to children development [28, 29]. Hirose stated affordances are opportunities for action that events, places, or objects provide for the animal in the environment [29]. In other words, the environment can stimulate action, and action opportunities or affordances are provided by home environments. Thus, motor development is stimulated. By the affordances it means materials, toys, apparatus, stimulation, availability of space, and nurturing that enhance children's development. Thus, the home environment can be regarded an affordance leading to the optimal development of children [30].

The focus of subsequent studies was on motor development and toy availability [31]. Nevertheless, there is little knowledge on the motor development and multidimensional home environment [32]. The multidimensional home environment includes both physical (e.g., movement play equipment in the home) and social-psychological (e.g. number of playmates, amount of parental attention, family composition, etc.) factors. In current study, designing multiple active games using Stickygym in addition of the child, engaged parents or siblings at home and may provide a multidimensional home environment which is more effective than just using as a toy.

To explain the findings about the effectiveness of our program on some fundamental motor skills, it can be pointed out Developmental Skills Interventions Approach. The basic strategy of this approach to achieve normal movement development is to encourage children to participate and engage in games and sports exercises [33]. In our study, we asked the instructors to encourage and motivate the subjects to perform the games and provide positive reinforcement and feedback.

Observational data suggest that most of the play and sport equipment are boring and unappealing to children. Talarowski et al. (2019) reported innovative playgrounds may encourage youth to spend more time outdoors, increase levels of physical activity, and have unique experiences where they can test their physical skills and develop resilience [34]. One of the important issues with physical activity participation is to diversify the program and tools used [35]. Although the child is naturally interested in playing, but experience new play equipment such as Stickygym kit may increase their personal

pleasure and encourage children to participate in physical activity for longer time.

Gamification was probably a mechanism for the success of the training protocol proposed in our work for improvement of some motor development skills in children. Manzano-León, Rodríguez-Ferrer and José Manuel (2021) showed family leisure and gamification may reduce the psychological effect of confinement resulting from the COVID-19 [17]. Physical activity levels can be improved by the positive effect of aesthetics and gamified dynamics and activities [18] and it causes a significant improvement in emotional competencies and reduction of anxiety levels [19]. The fundamental psychological needs of the self-determination theory are satisfied by physical and leisure activities in the family. Thus, it can be explained that why the subjects were motivated for continuing the activities and could raise the sensations of satisfaction and well-being [36]. The determinants of active play among British children were investigated by Brockman, Jago and Fox (2011) [37]. They found that children felt motivated for engagement in active play since they perceived it as enjoyable, preventing boredom, with mental and physical health advantages and free from adult control, structure, and rules.

There is consistency between our findings and another work conducted on COVID-19 confinement, which indicates the significance of family participation and recreational activities for motivating people to increase level of physical activity [38]. Stickygym games were designed to increase level of physical activities and build pleasure moments and affectivities, fun and play as well. Fearn and Howard (2011) found that under conditions of

deprivation and extreme stress, children have the ability of regulating emotional arousal and reducing anxiety levels when they play [39]. Parental skills can be increased and parent-child relationship can be improved [40, 41]. Hence, lower levels of anxiety and stress can be experienced during COVID-19 by being more active and rested [42]. So, another potential explanation for the finding can be attributed to elimination of some physical activity barriers for experimental subjects. With higher involvement and success of individuals in active-play games, their skills are developed, making it easier to involve in physical activities. It would be enjoyable for them to perceive that they experience more emotional and physical well-being and their bodies would become more fit. One is motivated by these benefits and rewards, which can result in higher engagement in physical activities [43]. Despite the significant positive results in some motor skills in this study, statistically non-significant differences were found between groups on hop, jump, and slide skills from locomotion subscales and dribble, catch, and kick skills from object control subscales. According to Gallahue-based appropriate developmental model, programs need to have the certain amount of training sessions' hours, components of skills, and creation of diversity in movements of children [44]. So, constantly more information on dosage, content, and intensity of program is needed. Moreover, future studies on motor behavior should take these factors into account for designing appropriate motor development programs.

In the past, several studies have been published on physical activity intervention on improvement of motor development in children. The current research findings as well as other results of previous studies are

encouraging interventions for improving motor skills in preschool children. The impact of an intensive structured intervention on motor skills in 3-6-year-old preschool children was investigated by Hestbaek, Vach, Andersen and Lauridsen (2021) [45]. They reported a tendency towards a greater improvement in the intervention group.

However, some studies reported that the physical activity intervention impact on improving preschool children's motor development is not significantly different [46, 47, 48, 49].

All the intervention components were educator-led in this work. All structured lessons and five unstructured sessions were implemented by educators, without any researcher involvement at the central level. It is contrary to most early childhood physical activity interventions, in which the researcher had a salient role in facilitation, transferability, and sustainability of program, or delivered the professional development for the educators [50].

In present study, all training sessions were performed online led by trained instructors and the experimental subjects had some interaction with peers in the screen. This virtual intervention had some similarities with Active Video Games (AVGs) that is an efficient approach to promote PA among children [51]. In AVGs, exercise and video games are combined, and thus, players are motivated to get involved in PA when they play the games [52]. For playing AVGs, a physical effort is needed from the player for interaction with the gaming environment for which he/she uses his/her lower and upper extremities for performing different activities, like catching, jumping, jogging, and dancing [53]. A large number of studies have recently tried to adopt this innovative fun



approach in order to promote PA and health in different age ranges. As suggested by promising findings, AVGs can be used as an effective approach to promote PA and provide health benefits comparable to traditional PA approaches in adolescents and children [54, 55].

A considerable part of time of parents and children was spent on viewing screens during lockdown periods, and it was an opportune for leveraging screen-time as a tool for increasing physical activity of preschool children. Using physical activity interventions through digital devices, like tablet or mobile apps, encouragement can be provided in real-world settings for physical activity in children. It has been recognized that using mobile-based interventions is a promising way for substantial influence on PA levels. Nevertheless, there have been few mobile-based interventions with a specific focus on enhancing children's physical activity [56]. In present study, although we performed device-based training program using mobile, tablet or lab tab, but the participants trained interactively by online coaches and this way may affect positively on children's motor development. These findings indicate the importance of home environment enrichment that is a kind of affordances promotion can improve motor development of children. This play kit can be used by pre-school educators and parents for improving object control and locomotion skills in children.

### Conflict of interest

The authors declared no conflicts of interest.

### Authors' contributions

All authors contributed to the original idea, study design.

### Ethical considerations

The study was approved by the Research Ethics Committee of Sport Science Research Institute of Iran (Code No.: SSRI.REC-2106-1060 (R1)).

### Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

### Acknowledgements

We would like to express our deepest appreciation for valuable assistance and contribution of all the participants, their parents and coaches

### References

- [1] UNICEF. Early childhood development. 2017; <https://www.unicef.org/dprk/ecd.pdf>.
- [2] Riethmuller AM, Jones R, Okely AD. "Efficacy of interventions to improve motor development in young children: A systematic review Pediatrics". *Pediatrics*. 2009 Oct; 124(4):782-92. Doi: 10.1542/peds.2009-0333.
- [3] Australian Bureau of Statistics (ABS). *Australian health survey: physical activity*. 2013. Accessed April 10, 2017.
- [4] King G, Law M, King S, Rosenbaum P, Kertoy MK, Young NL. "A conceptual model of the factors affecting the recreation and leisure participation of children with disabilities". *Phys Occup Ther Pediatr*. 2003; 23(1): 63-90. Doi: 10.1080/J006v23n01\_05.
- [5] Ness AR, Leary SD, Mattocks C, Blair SN, Reilly JJ, Wells J, Ingle S, Tilling K, Smith GD, Riddoch C. "Objectively measured physical activity and fat mass in a large cohort of children". *PLoS Med*. 2007 Mar; 4(3): e97. Doi: 10.1371/journal.pmed.0040097.
- [6] Steptoe A, Butler N. "Sports participation and emotional wellbeing in adolescents". *Lancet*. 1996 Jun 29; 347(9018): 1789-92. Doi: 10.1016/S0140-6736(96)91616-5.
- [7] Cavill N, Biddle S, Sallis JF. "Health enhancing physical activity for young people: Statement of the United Kingdom expert consensus conference". *Ped Exerc Sci*. 2001; 13: 12-25. Doi: 10.1123/pes.13.1.12.

- [8] Metcalfe J, Clark JE. "The mountain of motor development: a metaphor". *Motor Development: Research and Reviews, Reston (VA)*. 2002; 2: 163-190.
- [9] Webster EK, Martin CK, Staiano AE. "Fundamental motor skills, screen-time, and physical activity in preschoolers". *J Sport Health Sci*. 2019 Mar; 8(2): 114-121. Doi: 10.1016/j.jshs.2018.11.006.
- [10] Couzin-Franke J, Vogel, G, Weiland, M. "School openings across globe suggest ways to keep coronavirus at bay, despite outbreaks". *Science*. 2020; 369: 241-245.
- [11] Margaritis I, Houdart S, Ouadrhiri E, Bigard Y, Vuillemin X, Duché AP. "How to deal with COVID-19 epidemic-related lockdown physical inactivity and sedentary increase in youth? Adaptation of Anses' benchmarks". *Arch. Public Health*. 2020, 78: 1-6. Doi: 10.1186/s13690-020-00432-z.
- [12] Vanderloo LM, Carsley S, Aglipay M, Cost K T, Maguire J, Birken CS. "Applying harm reduction principles to address screen time in young children amidst the COVID-19 pandemic". *J. Dev. Behav. Pediatr*. 2020; 41: 335-336. Doi: 10.1097/DBP.0000000000000825.
- [13] Moore S, Faulkner G, Rhodes R, Brussoni M, Chulak-Bozzer T, Ferguson L, Mitra R, O'Reilly N, Spence J, Vanderloo L, et al. "Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: A national survey". *International Journal of Behavioral Nutrition and Physical Activity*. 2020. Doi: 10.1186/s12966-020-00987-8.
- [14] Zenic N, Taiar R, Gilic B, Blazevic M, Maric D, Pojskic H, Sekulic D. "Levels and changes of physical activity in adolescents during the COVID-19 Pandemic: Contextualizing urban vs. Rural living environment". *Appl. Sci*. 2020; 10(11): 3997. Doi: 10.3390/app10113997.
- [15] Pombo A, Luz C, de Sá C, Rodrigues L, Cordovil R. "Effects of the COVID-19 lockdown on Portuguese children's motor competence". *Children*. 2021; 8(3): 199. Doi: 10.3390/children8030199.
- [16] Szpunar M, Vanderloo LM, Brianne BA, Truelove S, Shauna MB, Gilliland J, et al. "Children and parents' perspectives of the impact of the COVID-19 pandemic on Ontario children's physical activity, play, and sport behaviors". *BMC Public Health*. 2021 Dec 13; 21(1): 2271. Doi: 10.1186/s12889-021-12344-w.
- [17] Manzano-León A, Rodríguez-Ferrer JM, José Manuel AP. "Gamification and family leisure to alleviate the psychological impact of confinement due to COVID-19". *Children & Society*. 2021; 00: 1-17. Doi: 10.1111/chso.12495.
- [18] Kari T, Piippo J, Frank L, Makkonen M, Moilanen P. "To gamify or not to gamify? Gamification in exercise applications and its role in impacting exercise motivation". 29th *Bled e Conference*. 2016.
- [19] Filella G, Pérez-Escoda N, Ros-Morente A. "Evaluation of the emotional education program "Happy 8-12" for the assertive resolution of conflicts among peers". *Electronic Journal of Research in Educational Psychology*. 2016; 14(3): 582-601. Doi: 10.14204/ejrep.40.15164.
- [20] Vygotski L. *Mind in Society, the Development of Higher Psychological Processes*. Harvard University Press Cambridge. 1978.
- [21] Iltus S. "Significance of home environments as proxy indicators for early childhood care and education". Paper commissioned for the *EFA Global Monitoring Report*. 2007.
- [22] Abbott AL, Bartlett DJ, Fanning JEK, Kramer J. "Infant motor development and aspects of the home environment". *Pediatr Physic Ther*. 2000; 12: 62-67. Doi: 10.1097/00001577-200012020-00003.
- [23] Bradley RH, Caldwell BM, Rock SL, et al. "HOME environment and cognitive development in the first 3 years of life: a collaborative study involving six sites and three ethnic groups in North America". *Develop Psychol*. 1989; 25: 217. Doi: 10.1037/0012-1649.25.2.217.
- [24] Stoffregen TA. "Affordances and events". *Ecological Psychology*. 2000; 12: 1-28. Doi: 10.1207/S15326969ECO1201.
- [25] Jones RA, Okely AD, Hinkley T, Batterham M, Burke C. "Promoting gross motor skills and physical activity in childcare: a translational randomized controlled trial". *Journal of Science and Medicine in Sport*. 2016; 19(9): 744-749. Doi: 10.1016/j.jsams.2015.10.006.
- [26] Zarezade M. Determining reliability and validity of test of gross motor development (Ulrich, 2000) in 3-11 aged children of Tehran city. Doctoral dissertation. University of Tehran, Faculty Physical Education Sport Sciences. 2010: 115-142.
- [27] Ulrich D. *Test of Gross Motor Development*. 2<sup>nd</sup> Ed, 2000; Austin, TX: Pro-Ed.

- [28] Son S, Morrison FJ. "The nature and impact of changes in home learning environment on development of language and academic skills in preschool children". *Developmental Psychology*. 2010; 46(5): 1103-1118. Doi: 10.1037/a0020065.
- [29] Hirose N. "An ecological approach to embodiment and cognition". *Cognitive Systems Research*. 2002; 3(3): 289-299. Doi: 10.1016/S1389-0417(02)00044-X.
- [30] Rodrigues LP, Saraiva L, Gabbard C. "Development and construct validation of an inventory for assessing the home environment for motor development". *Res Q Exerc Sport*. 2005 Jun; 76(2): 140-8. Doi: 10.1080/02701367.2005.10599276.
- [31] Bradley RH, Caldwell BM, Rock SL, et al. "Home environment and cognitive development in the first 3 years of life: a collaborative study involving six sites and three ethnic groups in North America". *Developmental Psychology*. 1989; 25(2): 217-235. Doi: 10.1037/0012-1649.25.2.217.
- [32] Mori S, Nakamoto H, Mizuochi H, Ikudome S, Gabbard C. "Influence of affordances in the home environment on motor development of young children in Japan". *Child Development Research*. 2013: 1-5. Doi: 10.1155/2013/898406.
- [33] Mahoney G, Robinson C, Perales F. "Early motor intervention: the need for new treatment paradigms". *Infants & Young Children*. 2004; 17(4): 291-300. Doi: 10.1097/00001163-200410000-00003.
- [34] Talarowski M, Cohen DA, Williamson S, Han, B. "Innovative playgrounds: use, physical activity, and implications for health". *Public Health*. 2019 Sep; 174: 102-109. Doi: 10.1016/j.puhe.2019.06.002.
- [35] Nejati H. *Developmental Psychology*. 1997; Tehran, Mahshid.
- [36] Ryan RM, Deci EL. *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. 2017; The Guilford Publications. Doi: 10.1521/978.14625/28806.
- [37] Brockman R, Jago R, Fox KR. "Children's active play: self-reported motivators, barriers and facilitators". *BMC Public Health*. 2011; 11: 461. Doi: 10.1186/1471-2458-11-461.
- [38] Ramirez Cerón, GG. "Family and play as a distance learning strategy during the Covid-19 pandemic in Mexico: A proposal from university teaching in health sciences, RED". *Revista de Educación a Distancia*. Murcia, 2021; 65(21): 1-20. Doi: 10.6018/red.456231.
- [39] Fearn M, Howard J. "Play as a resource for children facing adversity: An exploration of indicative case studies". *Children & Society*. 2011; 26(6): 456-468. Doi: 10.1111/j.1099-0860.2011.00357.x.
- [40] Choi M, Tessler H, Kao G. "Arts and crafts as an educational strategy and coping mechanism for Republic of Korea and United States parents during the COVID-19 pandemic". *International Review of Education*. 2020; 66: 715-735. Doi: 10.1007/s11159-020-09865-8.
- [41] Mateos A, Balsells MÀ, Fuentes-Peláez N, Rodrigo MJ. "Listening to children: Evaluation of a positive parenting programme through art-based research". *Children & Society*. 2021; 35: 311-330. Doi: 10.1111/chso.12439.
- [42] Chtourou H, Trabelsi K, H'mida C, Boukhris O, Glenn JM, Brach M, Bentlage E, Bott N, Shephard RJ, Ammar A, Bragazzi NL. "Staying physically active during the quarantine and self-isolation period for controlling and mitigating the COVID-19 pandemic: A systematic overview of the literature". *Frontiers in Psychology*. 2020; 11: 1708. Doi: 10.3389/fpsyg.2020.01708.
- [43] Lieberman DA, Circulation B, Medina Jr E, Franklin BF, Sanner BM, Vafiadis DK. "The power of play: Innovations in getting active summit". *Circulation*. 2011; 123(21): 2507-2516. Doi: 10.1161/CIR.0b013e318219661d.
- [44] Gallahue DL, Ozmun JC. *Understanding Motor Development: Infants, Children, Adolescents, Adults*. 6th ed, 2012; Boston (MA): McGraw-Hill: 87-108.
- [45] Hestbaek L, Vach W, Andersen ST, Lauridsen HH. "The effect of a structured intervention to improve motor skills in preschool children: Results of a randomized controlled trial nested in a cohort study of Danish Preschool Children, the MiPS study. *Int. J. Environ. Res. Public Health*. 2021; 18: 12272. Doi: 10.3390/ijerph182312272.
- [46] Bayer O, von Kries R, Strauss A, Mitschek C, Toschke AM, Hose A, Koletzko BV. "Short- and mid-term effects of a setting based prevention program to reduce obesity risk factors in children: a cluster-randomized trial". *Clin Nutr*. 2009; 28: 122-128. Doi: 10.1016/j.clnu.2009.01.001.
- [47] Bonvin A, Barral J, Kakebeeke TH, Kriemler S, Longchamp A, Schindler C, Marques-Vidal P, Puder JJ. "Effect of a governmentally-led physical activity program on motor skills in

- young children attending child care centers: a cluster randomized controlled trial". *The International Journal of Behavioral Nutrition and Physical Activity*. 2013; 10(1): 90. Doi: 10.1186/1479-5868-10-90.
- [48] Jones RA, Okely AD, Hinkley T, Batterham M, Burke C. "Promoting gross motor skills and physical activity in childcare: a translational randomized controlled trial". *Journal of Science and Medicine in Sport*. 2016; 19(9): 744-749. Doi: 10.1016/j.jsams.2015.10.006.
- [49] Higgins JP, Green S. (2008). *Cochrane Handbook of Systematic Reviews of Interventions*. 2008; Hoboken: John Wiley & Sons.
- [50] Jones RA, Okely AD, Hinkley T, Batterham M, Burke C. "Promoting gross motor skills and physical activity in childcare: a translational randomized controlled trial". *Journal of Science and Medicine in Sport*. 2016; 19(9): 744-749. Doi: 10.1016/j.jsams.2015.10.006.
- [51] Sween J, Wallington SF, Sheppard V, Taylor T, Llanos AA, Adams-Campbell LL. "The role of exergaming in improving physical activity: A review". *J. Phys. Act. Health*. 2014; 11: 864-870. Doi: 10.1123/jpah.2011-0425.
- [52] Gao Z, Chen S. "Are field-based exergames useful in preventing childhood obesity?" *A Systematic Review, Obes. Rev.* 2014; 15: 676-691. Doi: 10.1111/obr.12164.
- [53] Gao Z, Xiang P. "Effects of exergaming based exercise on urban children's physical activity participation and body composition". *J. Phys. Act. Health*. 2014; 11: 992-998. Doi: 10.1123/jpah.2012-0228.
- [54] Gao Z, Chen S, Pasco D, Pope Z. "A meta-analysis of active video games on health outcomes among children and adolescents". *Obes. Rev.* 2015; 16: 783-794. Doi: 10.1111/obr.12287.
- [55] Warburton DE, Bredin SSD, Horita LT, Zbogor D, Scott JM, Esch BT, Rhodes RE. "The health benefits of interactive video game exercise". *Appl. Physiol. Nutr. Metab.* 2007; 32: 655-663. Doi: 10.1139/H07-038.
- [56] Webster EK, Kracht CL, Newton Jr RL, Beyl RA, Staiano AE. "Intervention to Improve Preschool Children's Fundamental Motor Skills: Protocol for a Parent-Focused, Mobile App-Based Comparative Effectiveness Trial". *JMIR Res Protoc*. 2020 Oct 20; 9(10): e19943. Doi: 10.2196/19943.

