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Relation between exposure to different multimedia programs and presentation of attention deficit hyperactivity disorder

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Abstract

Background: The current study aimed at constructing an Arabic-language questionnaire to investigate the association of the severity of ADHD with children's degree of exposure to multimedia per day and the age of starting the engagement, and the effect of different multimedia programs on the attention, language, and socio-behavioral aspects in children presented with attention deficit hyperactivity disorder (ADHD). The present study was conducted on 69 children who attended the Phoniatic Unit at Mansoura University Hospitals and were divided into 2 groups: 30 normal typically developing children as a control group and 39 children with ADHD as the study group. The study group was subdivided into 3 subgroups according to ADHD severity; each subgroup consisted of 13 children.

Results: The time at which the child started to be exposed to multimedia showed no significant differences among ADHD subgroups as all of the cases started before the age of 2 years. Kids with mild ADHD had a significant increase in watching children's programs, cartoons, rhymes, and commercials than the other two higher grades (moderate and severe) of ADHD.

Conclusion: The constructed Arabic questionnaire proved to be reliable and a valid tool that examined the relationship between multimedia usage and ADHD.

Keywords: Attention, Language, Multimedia

Background

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder [1] in which there are significant problems with executive functions that cause attention deficits, hyperactivity, or impulsivity [2]. These symptoms must begin before the age of six to twelve and persist for more than 6 months for a diagnosis to be made [3]. ADHD is estimated to affect about 6 to 7% of people aged 18 and under when diagnosed via the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) [4].

The first 3 years of life are a hugely critical time for a child's language and social development. Children develop language through interaction with parents, relatives, peers, and/or adults [5]. Children before 3 years are catching what is called the sensitive period for language; deprivation of external input during this period will prevent the typical development of neural circuits for this particular function [6]. Today, children have unprecedented access to media and technology. As most parents will attest, young children are drawn to, adept at, and even addicted to the different multimedia as TV/videos, mobile/cellphones, iPads, and other tablets available to them [7]. Watching television (TV) influences children's attention and activity. Each hour of television watched per day at ages 1–3 years increases the risk of attention problems, such as ADHD, by almost 10% at the age of 7 years [8]. Exposing a baby's developing brain to

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videos may overstimulate it, causing permanent changes in developing neural pathways. Limiting young children's exposure to television during the formative years of brain development may reduce a child's subsequent risk of developing ADHD [8]. Regarding TV shows or DVDs directed at kids, rapid scene alterations and quick edits are precisely employed to occupy infants' angling response (the reflex that fixes attention to strange sights or sounds). While this keeps them focused on the screen, it is in contrast to the pace of how real-life unfolds [9]. This can lead to an overstimulation of the developing brain which in turn trains it to expect intense input making reality underwhelming or even boring by comparison [10]. Scan-and-shift and fast-pace arousal-habituation hypothesis explained by Nikkelen et al. [11] discussed how media decreases attention level. The violence-induced script hypothesis and violence-induced arousal-habituation hypothesis discussed how violent media content can induce hyperactivity and impulsivity.

The aim of this work was to construct an Arabic questionnaire to investigate the association between the severity of ADHD and children's degree of exposure to multimedia per day, the age of starting the engagement, and the content of different multimedia programs on the attention, language, and socio-behavioral aspects in children presented with attention deficit hyperactivity disorder (ADHD).

Methods

This comparative descriptive study with an analytic component was carried out on 69 Egyptian children below the age of 5 years who were exposed to multimedia. Children who attended the outpatient clinic of the phoniatic unit at the University Hospital and General Hospital were divided into two groups depending on the number of ADHD children who came to the outpatient clinic of the phoniatic unit in both hospitals at the time of the study. Group I consisted of 30 typically developing children with age-appropriate attention, language, and socio-behavioral skills (act as a control group). Group II consisted of 39 children with DLD due to ADHD. They were divided according to the severity by DSM-V into 3 subgroups (13 children each): group IIa included mild ADHD, group IIb included moderate ADHD, and group IIc included severe ADHD. Children with sensory impairment, physical disability, history of previous language therapy, known neurological, or other psychiatric diseases were excluded from the study.

An Arabic questionnaire was constructed to fulfill the aim of the work and was tested on the first pilot of 12 Egyptian parents. The Arabic questionnaire consisted of parent-directed 11 questions as follows: Q1: the types of multimedia the child is exposed to and the answer was

rated as (1 = TV, 2 = tablet or mobile phone, and 3 = combined); Q2: the time the child started to be exposed to multimedia (1 = after the age of 2 years and 2 = before the age of 2 years); Q3: kinds of programs the child is exposed to (1 = children programs, cartoons, rhymes, and commercials; 2 = children programs, cartoons, rhymes, and commercials + electronic games; and 3 = children programs, cartoons, rhymes, commercials + electronic games + movies and series); Q4: how many hours the child is exposed to multimedia per day (1 = less than 2 h, 2 = 2–6 h; and 3 = more than 6 h); Q5: what the child is doing during using multimedia (1 = playing and involving with family activities, 2 = purposeless playing, 3 = eating, and 4 = only watches); Q6: does the child set alone during multimedia engagement (0 = no and 1 = yes); Q7: does the child have a TV set, tablet, or mobile of his own (0 = no and 1 = yes); Q8: does the child ignore imitating games or songs he watches (0 = no and 1 = yes); Q9: does the child prefer using multimedia over playing with others (0 = no and 1 = yes); Q10: does the child insist on watching the same thing over and over (0 = no and 1 = yes); and finally, Q11: does the parent have a hard time in disengaging the child (0 = no and 1 = yes).

All children were subjected to full history taking, general examination, anthropometric measurement, vocal tract examination, and neurological examination. IQ was determined according to the Stanford Binnet Intelligence Scale "4th Arabic version" [12]. Social age was determined using the Vineland Social Maturity Scale to calculate the social age difference between normal social age for their chronological age and actual social age [13]. Receptive, expressive, and total language ages were determined using the preschool language scale-4 "Arabic version" [14]. Arabic language test was done for both groups to gather more information about the severity of language delay if present and investigate its relation with multimedia usage. A pragmatic assessment was performed with the social communication skills checklist [15]. A pragmatic checklist was conducted as most standard instruments used to assess language do not provide a norm-referenced, valid, or reliable measures of social communication and therefore substantially miss or underestimate this important area of development. Diagnostic and statistical manual of mental disorders fifth edition for ADHD [16] and Conners' test [17] were done for all ADHD children to determine the severity of ADHD. Scores range from 56 to 60 for mild ADHD, 66 to 70 for moderate ADHD, and 71 to 90 for severe ADHD.

Statistical analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) program (IBM Corp. Released

in 2011. IBM SPSS Statistics for Windows, version 20.0. Armonk, NY: IBM Corp.). Statistical comparison between the different groups was tested using Student's *t*-test to compare between the means of two different groups of numerical (parametric) data, while Pearson's chi-square test (χ^2 value) or Fisher exact test was used when indicated for inter-group comparison of categorical data (median and range for non-parametric numerical data plus frequency and percentage of non-numerical data). Cronbach's alpha test was used to detect the reliability of the questionnaire. Pearson's correlation coefficient test defines the strength and direction of the linear relationship between two variables. Logistic regression analyses were used for the prediction of risk factors. Deviations from Hardy-Weinberg equilibrium expectations were determined using the chi-squared test. The odds ratio and 95% confidence interval were calculated. $P < 0.05$ is significant (S). The Arabic questionnaire was validated using content validity. Three independent, experienced, and bilingual phoniaticians judged all items for language and cultural appropriateness as being completely relevant to the purpose for which they were meant.

Results

There were no significant differences in age and gender between the studied groups. There were statistically significantly lower IQ scores in the ADHD group when compared to normal children. Social age difference and

language age difference (deviation from normal) were significantly higher in the ADHD group when compared to the normal group. On the contrary, the pragmatic development by pragmatic checklist (PC) showed affected pragmatics in the ADHD groups compared to the normal group (Table 1).

No significant difference was found in age among ADHD subgroups. Male gender was significantly associated with moderate and severe ADHD. IQ scores were significantly higher in mild ADHD and moderate ADHD compared to severe ADHD. Social age difference and language age difference were increased with the increase of ADHD severity, and a significant difference regarding social age differences was found between mild and severe ADHD. Stratification of Conners into categories revealed a significant association with ADHD grades. Both moderate and severe ADHD showed a significant affection for pragmatic development compared to mild ADHD pragmatic evaluation conducted by pragmatic checklist, and the results were divided only into affected and not affected children (Table 2).

Regarding the types of multimedia that the child was exposed to, children with ADHD were significantly more exposed to TV only than normal children. Exposure to tablets and mobile phones only was significantly increased in the ADHD group than normal. ADHD had a significant increase than normal in watching children's programs, cartoons, rhymes, and commercials + electronic games. The time that the child spent using

Table 1 Descriptive and comparative analysis of demographic data and psychometric and communicative evaluation of the studied groups

	Control, N = 30		ADHD, N = 39		P
Age (months)	Mean ± SD		Mean ± SD		0.105
	46 ± 10		50.4 ± 11.3		
Gender	N	%	N	%	0.079
Males	19	63.3	32	82.1	
Females	11	36.7	7	17.9	
IQ	Mean ± SD		Mean ± SD		< 0.001*
	95 ± 3		81.4 ± 13.7		
Social age difference (months)	Mean ± SD		Mean ± SD		< 0.001*
	0 ± 0		6.8 ± 1.9		
Language age difference (months)	Mean ± SD		Mean ± SD		< 0.001*
	0 ± 0		14.3 ± 3.4		
Pragmatic evaluation	N = 24		N = 33		< 0.001*
	N	%	N	%	
Not affected pragmatics	24	100	7	21.2	
Affected pragmatics	0	0	26	78.8	

P comparison between ADHD and control. Numerical data are expressed in mean ± SD, compared by *t*-test; data categories are expressed in frequency (percentage) and compared by the chi-square or Fisher exact tests. The social age difference was used instead of social age to avoid errors in the statistics as social age should be correlated to chronological age. Social age difference = chronological age – current social age. The pragmatic checklist was not applied for children less than 3 years

* Significant

Table 2 Descriptive and comparative analysis of demographic data and psychometric and communicative evaluation among the ADHD subgroups

	Mild ADHD, N = 13		Moderate ADHD, N = 13		Severe ADHD, N = 13		P ¹	P ²	P ³
Age (months)	Mean ± SD		Mean ± SD		Mean ± SD		0.323	0.084	0.445
	46.3 ± 11.2		50.7 ± 12.9		54.1 ± 9				
Gender	N	%	N	%	N	%	0.005*	0.005*	–
Males	6	46.2	13	100	13	100			
Females	7	53.8	0	0	0	0			
IQ	Mean ± SD		Mean ± SD		Mean ± SD		0.175	< 0.001*	0.006*
	85.7 ± 12.1		82.6 ± 17.1		75.8 ± 9.9				
Social age differences (months)	Mean ± SD		Mean ± SD		Mean ± SD		0.154	0.002*	0.061
	2.8 ± 0.7		6.4 ± 2.4		11.1 ± 3.5				
Conners' score	N = 10		N = 10		N = 13		< 0.001*	< 0.001*	< 0.001*
	Mean ± SD		Mean ± SD		Mean ± SD				
	58.1 ± 1.2		67 ± 2		74.8 ± 2.5				
	N	%	N	%	N	%			
	10	30.3	10	30.3	13	39.4			
Language age differences (months)	Mean ± SD		Mean ± SD		Mean ± SD		0.654	0.250	0.114
	10 ± 2.8		12.3 ± 3.1		17 ± 5.7				
Pragmatic evaluation	N = 10		N = 10		N = 13		< 0.001*	< 0.001*	–
	N	%	N	%	N	%			
Not affected pragmatic	7	70	0	0	0	0			
Affected pragmatic	3	30	10	100	13	100			

P¹, comparison between mild ADHD and moderate ADHD; P², comparison between mild ADHD and severe ADHD; P³, comparison between moderate ADHD and severe ADHD. Numerical data is expressed in mean ± SD, compared by t-test; data categories are expressed in frequency (percentage) and compared by the chi-square test. Conner's test was not applied for children less than 3 years

* Significant

multimedia revealed that normal kids used media < 2 h/day which were significantly fewer than the hours of ADHD kids. ADHD kids showed a significant increase in media use > 6 h per day than normal children. About the things that the child did during using multimedia, normal kids significantly preferred playing and involving with family activities more than ADHD kids. ADHD children had a significant preference for eating while watching than normal kids. There was also a significant increase of watching only in ADHD than in normal children (Table 3).

Significantly more children in the ADHD group used to sit alone during multimedia viewing, and a significantly higher number of ADHD children owned a TV set, tablet, or mobile in their bedrooms, ignored imitating what they watched, preferred using multimedia over playing with others, and insisted on watching the same thing over and over. Also, the parents of ADHD children suffered a significantly harder time in disengaging them from multimedia (Table 4).

Regarding the types of multimedia that the child is exposed to, it was found that kids with mild ADHD were significantly more exposed to TV only than kids

with moderate or severe disease. When it came to tablet or mobile phone exposure, moderate ADHD kids were significantly higher in number than both mild and severe ones. Severe ADHD kids were significantly more exposed to combined multimedia than the lower two grades. The time at which the child started to get exposed to multimedia was not significantly different among ADHD subgroups as all of the cases started before the age of 2 years. Kids with mild ADHD had a significant increase in watching children's programs, cartoons, rhymes, and commercials than the other two higher grades of ADHD. Moderate ADHD kids had a significant preference to watch children's programs, cartoons, rhymes, and commercials + electronic games than mild and severe ADHD. Severe ADHD children preferred significantly watching children's programs, cartoons, rhymes, and commercials + electronic games + movies and series than the other two lower grades. The time that ADHD children spent on multimedia was not significantly different among the three subgroups, as most of them were above 6 h. Severe ADHD kids associated it with purposeless playing significantly more than mild ADHD kids (Table 5).

Table 3 Descriptive and comparative analysis between the studied groups regarding the answers of the constructed questionnaire (Q1–5)

		Control, N = 30		ADHD, N = 39		P
		N	%	N	%	
Q1.	TV	5	16.7	16	41.0	0.029*
	Tablet or mobile phone	0	0	10	25.6	0.004*
	Combined	25	83.3	13	33.3	< 0.001*
Q2.	Before the age of 2 years	28	93.3	39	100	0.185
	After the age of 2 years	2	6.7	0	0	
Q3.	Children programs, cartoons, rhymes, and commercials	11	36.7	13	33.33	0.606
	Children programs, cartoons, rhymes, and commercials + electronic games	1	3.3	14	35.8	0.007*
	Children programs, cartoons, rhymes, and commercials + electronic games + movies and series	18	60	12	30.87	0.118
Q4.	< 2 h/day	25	83.3	0	0	< 0.001*
	2–6 h/day	5	16.7	5	12.8	0.737
	> 6 h/day	0	0	34	87.2	< 0.001*
Q5.	Playing and involving with family activities	27	90	0	0	< 0.001*
	Purposeless playing	2	6.7	7	17.9	0.281
	Eating	1	3.3	12	30.8	0.004*
	Only watch	0	0	20	51.3	< 0.001*

P comparison between ADHD and control. Categorical data are expressed as numbers and percentages, compared by the chi-square or Fisher exact tests

* Significance

Table 4 Descriptive and comparative analysis between the studied groups regarding the answers of the constructed questionnaire (Q6–11)

		Control, N = 30		ADHD, N = 39		P
		N	%	N	%	
Q6. Does the child sit alone during the multimedia engagement?	N	24	80	7	17.9	< 0.001*
	Y	6	20	32	82.1	
Q7. Does the child have a TV set, tablet, or mobile in his bedroom?	N	24	80	15	38.5	0.001*
	Y	6	20	24	61.5	
Q8. Does the child ignore to imitate what he watches?	N	29	96.7	25	64.1	0.001*
	Y	1	3.3	14	35.9	
Q9. Does the child prefer using multimedia over playing with others?	N	29	96.7	2	5.1	< 0.001*
	Y	1	3.3	37	94.9	
Q10. Does the child insist on watching the same thing over and over?	N	30	100	12	30.8	< 0.001*
	Y	0	0	27	68.2	
Q11. Does the parent have a hard time disengaging the child?	N	29	96.7	4	10.3	< 0.001*
	Y	1	3.3	35	89.7	

P comparison between ADHD and control. Categorical data are expressed as numbers and percentages, compared by the chi-square or Fisher exact tests

* Significance

More children in the ADHD group significantly used to view multimedia alone than in the typically developing control group, with no significant difference among the ADHD subgroups. Significantly higher numbers of moderate and severe ADHD children owned a TV set, tablet, or mobile in their bedroom than mild ADHD children. The majority of ADHD kids indeed imitated

games or songs that they watch (25 children out of 39) and preferred using multimedia over playing with others (37 children out of 39) with no significant difference among their subgroups. Mild and moderate ADHD significantly insisted more on watching the same programs over and over. The parents of ADHD kids suffered a significantly harder time in disengaging them

Table 5 Descriptive and comparative analysis among ADHD subgroups regarding the answers of the constructed questionnaire (Q1–5)

	Mild ADHD, N = 13		Moderate ADHD, N = 13		Severe ADHD, N = 13		P ¹	P ²	P ³
	N	%	N	%	N	%			
	Q1. TV	13	100	3	23.1	0			
Tablet or mobile phone	0	0	10	76.9	0	0	< 0.001*	–	< 0.001*
Combined	0	0	0	0	13	100	–	< 0.001*	< 0.001*
Q2. Before the age of 2 years	13	100	13	100	13	100			
Q3. Children programs and cartoons, rhymes, and commercials	8	61.5	0	0	5	38.5	0.030*	0.116	0.002*
Children programs, cartoons, rhymes, and commercials + electronic games	4	30.8	10	76.9	0	0	0.047*	0.006	< 0.001*
Children programs and cartoons, rhymes, and commercials + electronic games + movies and series	1	7.7	3	23.1	8	61.5	0.116	0.040*	0.047*
Q4. 2–6 h/day	3	23.1	2	15.4	0	0	0.619	0.220	0.480
> 6 h/day	10	76.9	11	84.6	13	100			
Q5. Purposeless playing	0	38.5	2	15.4	5	0	0.378	0.039*	0.480
Eating	5	30.8	3	23.1	4	38.5	0.658	0.680	0.673
Only watch	8	30.8	8	61.5	4	61.5	0.116	0.116	1

P¹, comparison between mild ADHD and moderate ADHD; P², comparison between mild ADHD and severe ADHD; P³, comparison between moderate ADHD and severe ADHD. Categorical data are expressed as numbers and percentages, compared by the chi-square or Fisher exact tests

* Significant

from multimedia with no significant difference among the subgroups (Table 6).

The multiplicity of the types of multimedia, the number of different kinds of programs, and the number of hours the child is exposed to multimedia per day showed significant positive correlations with LA difference, Conners' scores, and grade of ADHD (Table 7).

Logistic regression analysis was conducted to predict ADHD development. Univariable and multivariable analysis revealed multiple factors. A longer time of exposure to multimedia was the factor that had the most precipitating effect on the prediction of ADHD (Table 8).

The reliability of the questionnaire was examined. Cronbach's alpha was calculated across the full scale of

Table 6 Descriptive and comparative analysis among ADHD subgroups regarding the answers of the constructed questionnaire (Q6–11)

	Mild ADHD, N = 13		Moderate ADHD, N = 13		Severe ADHD, N = 13		P ¹	P ²	P ³	
	N	%	N	%	N	%				
	Q6. Does the child sit alone during multimedia engagement?	N	3	23.1	2	15.4				2
Y	10	76.9	11	84.6	11	84.6				
Q7. Does the child have a TV set, tablet, or mobile in his bedroom?	N	11	84.6	2	15.4	2	15.4	< 0.001*	< 0.001*	1
Y	2	15.4	11	84.6	11	84.6				
Q8. Does the child ignore to imitate games or songs he watches?	N	10	76.9	9	69.2	6	46.2	0.658	0.107	0.234
Y	3	23.1	4	30.8	7	53.8				
Q9. Does the child prefer using multimedia over playing with others?	N	0	0	2	15.4	0	0	0.141	–	0.141
Y	13	100	11	84.6	13	100				
Q10. Does the child insist on watching the same thing over and over?	N	0	0	3	23.1	9	69.2	0.220	< 0.001*	0.018*
Y	13	100	10	76.9	4	30.8				
Q11. Does the parent have a hard time in disengaging the child?	N	2	15.4	1	7.7	1	7.7	0.539	0.539	1
Y	11	85	12	92.3	12	92.3				

P¹, comparison between mild ADHD and moderate ADHD; P², comparison between mild ADHD and severe ADHD; P³, comparison between moderate ADHD and severe ADHD. Categorical data are expressed as numbers and percentages, compared by the chi-square or Fisher exact tests

* Significant

Table 7 Correlative analysis between significant items of the constructed questionnaire and other studied parameters

	Multiplicities of multimedia tools		Kinds of programs		Numbers of hours of multimedia	
	R	P	R	P	R	P
IQ	- 0.254	0.119	- 0.180	0.272	- 0.080	0.629
SA difference	0.046	0.783	0.105	0.525	0.099	0.548
LA difference	0.056	0.734	0.909	0.046*	0.383	0.036*
Conners' score	0.850	< 0.001*	0.418	0.013*	0.468	0.004*
Severity of ADHD	0.866	< 0.001*	0.424	0.006*	0.318	0.025*

r Pearson's correlation coefficient

* Significant P < 0.05

11 questions. Cronbach's alpha (≥ 0.8 and < 0.9) was found to be satisfactory. Table 9 shows the value of Cronbach's alpha coefficient if the corresponding question was deleted.

Discussion

There are several theoretical reasons to believe that media use is related to ADHD or ADHD-related behaviors. A growing number of studies have focused on the harmful effects of exposure to different types of media;

however, the results were not conclusive. Ceranoglu [18] reported that ADHD represents a significant risk factor for excessive digital media use; following new advances in communication technology from smartphones to virtual reality, digital media has become more ubiquitous and readily available, and more research is necessary to further understand the effects of media use on children. Also, Ra et al. [19] stated that among ADHD cases followed up over 2 years, there was a statistically significant but modest association between higher frequency

Table 8 Regression analysis for prediction of ADHD

	Univariable			Multivariable		
	P	OR	95% CI	P	OR	95% CI
Q1-The types of multimedia the child is exposed to						
TV		R			R	
Tablet or mobile phone	< 0.001*			0.001*		
Combined	0.002*	1.327	1.159 1.669	0.002*	0.146	0.042 0.506
Q3-Kinds of programs the child is exposed to						
Children programs and cartoons, rhymes, and commercials		R			R	
Children programs and cartoons, rhymes, and commercials + electronic games	0.023*	3.775	1.206 11.822	0.018*	2.047	1.465 15.854
Children programs and cartoons, rhymes, and commercials + electronic games + movies and series	0.705	0.880	0.453 1.708	0.966	1.029	0.276 3.842
Q4-How many hours the child is exposed to multimedia per day?						
Longer time of exposure to multimedia (> 6 h)	0.003*	2.000	1.265 3.163	0.008*	1.471	1.140 2.609
Q5-What the child is doing during using multimedia?						
Imitating what he watches		R				
Playing and getting involved with family activities	0.068	1.778	0.958 3.299	0.972	0.991	0.599 1.638
Only watch	0.018*	1.923	1.116 3.313	0.685	1.234	0.447 3.411
Q6-Does someone set with the child during multimedia engagement?	0.005*	2.000	1.227 3.259	0.641	1.290	0.442 3.765
Q7-Does the child have a TV set, tablet, or mobile in his bedroom?	0.001*	3.111	1.626 5.953	0.699	1.242	0.414 3.722
Q8-Does the child try to imitate games or songs he watches?	0.002*	4.924	1.754 13.820	0.564	1.325	0.509 3.446
Q9-Does the child prefer using multimedia over playing with others?	< 0.001*	3.686	1.760 9.310	0.693	1.212	0.467 3.141
Q10-Does the child insist on watching the same thing over and over?	0.008*	1.682	1.146 2.469	0.792	1.082	0.602 1.947
Q11-Does the parent have a hard time in disengaging the child?	< 0.001*	2.834	1.981 16.734	< 0.001*	2.062	1.191 13.520

OR odds ratio, CI confidence interval

Table 9 Reliability assessment of used questions

	Cronbach's alpha if item is deleted
What are the types of multimedia the child is exposed to?	0.813
When did the child start to be exposed to multimedia?	0.706
What are the kinds of programs the child watches?	0.844
How many hours is the child exposed to multimedia per day?	0.583
Does the child set alone during multimedia engagement any one sets with the child during the multimedia engagement?	0.659
What does the child do during using multimedia?	0.559
Does the child have a TV set, tablet, or mobile in his bedroom?	0.667
Does the child ignore imitating games or songs he watches?	0.665
Does the child prefer using multimedia over playing with others?	0.636
Does the child insist on watching the same thing over and over?	0.668
Do the parents have a hard time disengaging the child?	0.641

of digital media use and subsequent symptoms of ADHD with further research needed to determine whether this association is causal. The current study aimed at constructing an Arabic questionnaire for assessing the relationship between the degree of exposure of young children to multimedia per day, the age of starting the engagement, and the effect of different multimedia programs on the attention, language, and socio-behavioral aspects in children presented with attention deficit hyperactivity disorder (ADHD). The present study was conducted on 69 children who attended the Phoniatic Unit Mansoura University Hospitals and were divided into 2 groups: 30 normal typically developing children as control and 39 children with ADHD. They were divided into 3 subgroups according to the severity with 13 children in each subgroup.

Comparison between the three subgroups of ADHD revealed that the male gender predominates in moderate and severe ADHD. There was a significant increase in SA and LA differences while IQ was significantly lower according to ADHD levels. On the other hand, Conners' test scores increased significantly according to ADHD severity. In the study conducted by El Sady et al. [20], ADHD children showed a significant delay in their total language age, receptive language age semantic language age, and pragmatics. This was explained by the fact that ADHD is a disorder that affects the attention, thinking, learning process, and social interaction of the child, which are all essential in the development of language.

The current study revealed that the majority of the mild ADHD patients were exposed to TV only, while about half of the moderate ADHD patients were exposed to tablet and mobile phones, and all patients in the severe ADHD groups were exposed to combined multimedia. These findings came in agreement with the study of Ra et al. [19] who determined that high-frequency

engagement in each additional digital media activity at baseline was associated with significantly higher odds of having symptoms of ADHD across follow-ups and concluded that there was a modest but significant association between higher frequency of digital media use and subsequent symptoms of ADHD.

There was a significant increase in the number of types of media programs watched by the ADHD group with an increase in ADHD severity, starting by watching children's programs, cartoons, rhymes, and commercials in mild ADHD group and reaching children programs, cartoons, rhymes, and commercials + electronic games + movies and series in severe ADHD group. These results were confirmed by Christakis et al. [8] who stated that the more television kids viewed as infants, the more probable they exhibit attentional issues by the age of seven. Precisely, each hour of television viewed on average was associated with an increased risk of being in the 90th percentile for having attentional problems. ADHD groups spent more than 6 h on multimedia more frequently than the group of typically developing children. The typically developing group preferred playing and involving in family activities significantly more than the ADHD groups, who preferred eating during media viewing or only watching.

In the present study, the groups with moderate and severe ADHD associated media viewing with purposeless playing more than the lower grade of ADHD. This result is going along with Nikkelen et al's [11] findings, who explained that by violence-induced script hypothesis, which argues that violence is characterized by impulsive behavior (i.e., no inhibition of antisocial behavior). Hence, exposure to such multimedia may activate the behavioral script of poor self-control. Activation of such a script, in turn, may result in hyperactivity, or impulsivity, which are assumed to result from poor self-control.

The mechanism of the TV impacts on the development of children was explained by Haughton et al. [21] as authors hypothesized that monitor time has a straight influence on neurological functioning through features of the medium itself and that alternating illuminations, rapid directs, and acoustic cuts might be overexciting to the developing brain.

The ADHD groups were found to prefer to sit alone during media indulging significantly more than the group of typically developing children. The American Psychiatric Association (APA) [16] recommendations specified that parents of children 18 to 24 months of age who want to introduce digital media should choose high-quality programming and watch it with their children to help them understand what they are seeing and maintain their social attention. This suggests that sitting alone during media viewing had a bad influence on the sociality of the ADHD group. The results showed that a significantly higher number of ADHD children had a TV set in their bedrooms or owned a tablet or a mobile phone than a typically developing child. Also, having a TV set in bedrooms and owning a tablet or a mobile phone were associated significantly with increasing severity of ADHD. In an attempt to relate this finding to the clinical picture of ADHD, Ceranoglu [18] reported that circumstances of digital media access in bedrooms are among the factors that increase ADHD symptom severity. Also, Andreasen et al. [22] found an association between inattention and the time spent on mobile and tablets. Furthermore, Haughton et al. [21] found that the light emitted from TV screens impacts melatonin production, suggesting a possible mechanism for sleep disruption which is highly associated with ADHD.

The study revealed that imitating watched materials was significantly ignored by almost all ADHD groups. This is in agreement with Verneti et al. [23] who stated that multimedia viewing results in a kid's disinterest in the social scene who would be less to participate in behaviors, e.g., imitation and turn-taking. Without an interest in a social partner, a kid will not engage with others, further limiting learning opportunities and contributing to the overall developmental retardation [24]. Another result was that ADHD groups significantly preferred media watching over playing with their peers. Hefler and Oestreicher [24] confirmed that as the infant's brain becomes wired to respond more to the demands of audio and visual stimulation, the behavior of the infant is changed to devote more attention to these primary sensory stimuli and less attention to other environmental exposures, such as faces, social scenes, and processes that would develop.

The regression analysis also revealed that using combined multimedia tools (tablet or mobile phone

combined with TV) and watching different types of media programs could be an independent predictor for more severe ADHD. It also revealed that the factor which had the most precipitating effect on the prediction of ADHD was a long time of exposure to multimedia. These results came along with the results of Nikkelen et al. [11] in their meta-analysis which revealed a positive relationship between media use and composite ADHD-related behaviors.

ADHD symptoms and media such as the Internet or gaming addiction may share a bidirectional relationship where the symptoms of ADHD make gaming attractive, while gaming itself exacerbates ADHD symptoms by providing an activity that continuously reinforces the exact disinhibition, quick responsiveness, need for immediate reward, and inattention that are areas of concern. In this sense, spending an unlimited amount of time on media use may further reinforce and consolidate the child's proclivity to impulsive, rapid, hyper-focused reactivity. The lack of exposure to complex play, sports, music, and arts might be associated with a decrease in practice opportunities for working memory, patience, attention, and executive functioning leading to worsening ADHD symptoms [25].

The study demonstrated the presence of a statistically significant positive relationship between the number of hours and the number of different kinds of programs that the ADHD groups were exposed to, with the language age difference, and with Conners' score and grade or severity. These results are in line with Nikkelen et al. [26] who stated that children who displayed more ADHD-related behaviors showed more arousal (e.g., excited, active, and jittery behavior) when viewing television in general and when viewing violent/scary or educational television. Among children with ADHD, high exposure time to screens can exacerbate difficulties with behavior, self-regulation, language, and focusing that make them vulnerable to social isolation and other issues [27].

Conclusion

The constructed Arabic questionnaire proved to be a reliable and valid tool that examined the relationship between multimedia usage and ADHD. A longer time of exposure to multimedia was the most precipitating factor on the prediction of ADHD, while combined multimedia tools and media programs were mostly affecting the severity level.

Recommendations

Further research is needed to specify the exact nature of the most harmful media tool and program content that can be considered to have a role in ADHD causation or

increase their severity level. Recommendations of media viewing need to be consistently updated to keep up with technological acceleration.

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Authors' contributions

HB made the design of the work. AHK analyzed and interpreted the patient data. AA was a major contributor in revising the integrity of the work. AMZ was a major contributor in writing the manuscript. The manuscript has been read and approved by all authors, and they all contributed substantially to the research.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author.

Declarations

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the institutional research board of Mansoura University (MS/15.10.02).

The parents of the children signed a written consent form.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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