Determining factors in children’s screen time in early childhood

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Abstract  The use of media by children in early childhood is increasingly common, and it is necessary to investigate the determinants of screen time, which is understood as the total child screen exposure time, including television and interactive media. This is a descriptive, exploratory, and cross-sectional study conducted with 180 children between 24 and 42 months of age, allocated in Group 1, less than two hours daily screen exposure time; Group 2, daily screen exposure time equal to or more than two hours. Bivariate and binary logistic regression analyses were performed. Screen time determining factors studied were family environment, evaluated with the Family Environment Resource Inventory; socioeconomic factors; nutritional status and child development status, evaluated with the Bayley III test. As a result, 63% of children had daily screen time exceeding two hours, and television still is the main culprit for children screen exposure. We observed that screen time exposure was positively associated with family resources, economic level, and language development. However, only the last two factors explained the longer screen time.

Key words  Audiovisual media, Mobile applications, Television, Exposure time, Child development
Introduction

In the context of the modern world, once restricted to television\textsuperscript{1,2}, screens have evolved into pocket, mobile, and portable devices. Therefore, due to their portability, mobile phones, tablets, and smartphones have been incorporated into the routine of people from different social backgrounds and age groups, including children\textsuperscript{3-7}.

Childhood is characterized by biological and psychosocial modifications, which allow essential acquisitions in the motor, affective-social, and cognitive realms of development\textsuperscript{8}. At this moment, the central nervous system (CNS) experiences constant transformation, myelination and synaptic organization, whose apex is reached at 24 months, favoring learning. Thus, the environment has a significant influence by continuously and dynamically interrelating with the factors intrinsic to the child\textsuperscript{8,9}. Therefore, especially in early childhood, from 0 to 6 years of age as per Brazilian documents\textsuperscript{10}, children should be provided with healthy affective bonds, adequate space for freedom of movement, free play, and availability of toys or learning materials, among other factors\textsuperscript{8,9}.

Screen time, which is understood as the total time for which the child remains exposed to all screens, has increased\textsuperscript{2,11}. Studies indicate that the mean exposure is longer than the recommended time since the American Academy of Pediatrics (AAP)\textsuperscript{12} recommends that the children screen exposure time should not exceed 2 hours daily, with educational content suitable for the age group. Living in a multi-screen environment, such as television, tablets, computers, smartphones, can encourage early screen use\textsuperscript{13,14}.

Screen exposure time is considered a risk factor for sedentary behavior, for cardiovascular and metabolic diseases in adults. In children, it can cause obesity, higher blood pressure, and mental health-related problems\textsuperscript{15,16}, besides reducing the time for social and family interaction\textsuperscript{7} and favoring exposure to improper content\textsuperscript{5}. Some authors associate high screen exposure with language\textsuperscript{1,17} and fine motor skills\textsuperscript{18} development delays.

However, television screen time is widely addressed in the literature\textsuperscript{17,19,20}, while studies on interactive media (e.g., smartphones, tablets, video games) have emerged\textsuperscript{5,21-23}, depending on the widespread increase in children’s access and use of mobile devices\textsuperscript{24}. Interactive media can be defined by technological means that respond with content to users’ actions, facilitating dialogue and participation, which differs from television\textsuperscript{25}.

Thus, considering the relevance and contemporaneity of the theme, this study aimed to investigate the determinants of total screen time, including television and interactive media in children in early childhood.

Methods

This is a cross-sectional, descriptive, and exploratory study investigating screen time in children aged 24 to 42 months, and was conducted from September 2016 to February 2017. The research was approved by the Research Ethics Committee of the Federal University of Vales do Jequitinhonha and Mucuri.

The study included children aged 24 to 42 months and 15 days, regularly enrolled in public and private day-care centers in the headquarters of a small-sized Brazilian municipality with a high Human Development Index (HDI), whose parents signed the Informed Consent Form. Exclusion criteria were children who had congenital or acquired diseases that could affect cognitive and motor development or children.

The sample was calculated with OpenEpi software. The prevalence of electronic media use was estimated at 34\textsuperscript{\%}\textsuperscript{26}, with the desired accuracy of 5\textsuperscript{\%}, 90\textsuperscript{\%} confidence interval, 80\textsuperscript{\%} study power, resulting in 172 children after adjustment for finite populations.

Each child’s daily screen exposure time was considered to allocate it to the groups: Group 1 (G1) children with daily screen exposure time of fewer than two hours; Group 2 (G2): children with daily screen exposure time equal to or greater than two hours\textsuperscript{12}.

A literature-based questionnaire was prepared by the authors\textsuperscript{27} to assess interactive media habits. The instrument addressed questions related to parents’ knowledge of mobile interactive media, their frequency of use, children exposure time to media (in months), and their age when they started accessing the media.

The economic classification was assessed using the Brazil 2015 Economic Classification Criteria (CCEB), of the Brazilian Association of Research Companies. This criterion is assigned a score as per the assets and educational level of the head of the household. The economic level of the family group is classified based on the score on an increasing ordinal scale ranging from E to A1\textsuperscript{28}.

Child development was measured using the Bayley III test, which is the third edition of the
Bayley scale, used in scientific research to assess child development, including in Brazil\textsuperscript{29,30}. The instrument aims to identify children with developmental delays in the 1-42 months’ age group, in the cognitive, (receptive and expressive) language, (fine and gross) motor, socio-emotional, and adaptive behavior realms. The cognitive, expressive language, fine, and gross motor scales were applied for this study. According to the manual\textsuperscript{11}, each scale is scored based on the sum of tasks performed by the child, generating gross scores, and from there, norm-based scores for age. The balanced score of each scale was used for this study, considering “10” as the mean score, with a standard deviation of ±3 points. The team conducted training for Bayley application and inter-examiner reliability before the study, achieving an Intraclass Correlation Index (ICC) of 95%.

The quality of the child’s living environment was assessed using the Family Environment Resource Inventory (FERI) with adaptations, i.e., question 8 was intended for children outside the study age\textsuperscript{22} and was removed from the instrument. The questionnaire aims to evaluate family environment resources in three realms: 1) resources that promote proximal processes: it involves participation in stimulating experiences for development, such as walks and trips, opportunities for interaction with parents; availability of toys and materials with features that challenge thinking; availability of books, newspapers, and magazines, adequate use of free time; 2) activities that signal stability in family life: such as regular family routines and meetings and the child’s cooperation in household chores; 3) parenting practices that promote the family-school bond: direct involvement of parents in school life, such as attendance at meetings\textsuperscript{23}. The sum of points, that is, gross values, were considered for the analysis.

Assessment of the nutritional status required anthropometric data collected using weight and height measurements for further treatment and to obtain the child’s nutritional status classification through Anthro Who version 3.2.2, a software developed by the World Health Organization\textsuperscript{24}.

The collected data were transferred to Statistical Package for the Social Sciences (SPSS) version 19.0 for exploratory analysis of the database. The chi-square test was used for the bivariate analysis, with a significance level of 5% (p<0.05). The dependent variable was “screen time”, a variable consisting of total daily child’s time of exposure to electronic (TV) and interactive (Tablets and Smartphones) media, as reported by parents or guardians. Independent variables were age (2 and 3 years), maternal and paternal education, economic level, family resource inventory (full-scale FERI and separate realms), language development, cognitive development, gross and fine motor development, and Body Mass (BMI).

All independent variables were categorized for comparison purposes between groups G1 and G2. The median was used as the cutoff point for FERI’s underlying variables, and in the total score of the “Inventory of family resources”, the score of “50” was considered for the establishment of the categories below and above the median. In the FERI realms titled “resources that promote proximal processes”, “activities that signal stability in family life” and “parenting practices that promote family-day care”, the values considered for categorization of the variables were, respectively, 26, 16 and 8. For the Bayley result, the variables were categorized by a score of “10” on the balanced score of the evaluated scales, as this is the mean test score, whose standard deviation is ±3 points. The variables paternal and maternal schooling were categorized into up to complete primary school and secondary school or higher. Concerning the economic level, the categories created were “A, B, C1” and “C2, D, E”, respectively, and for BMI, the criterion of leanness and eutrophy were observed for one category and individuals at risk of overweight to obese in another category.

The association between the independent variables and the dependent variable “screen time greater than two hours” was verified in the bivariate analysis by the chi-square test with a 5% significance level. Binary logistic regression was performed for multivariate analysis, using data whose independent variables obtained p-values≤0.20 in the univariate analysis, and only those with p<0.05 remained in the model.

The quality of the model was evaluated by the Hosmer-Lemeshow method and by the measure of fit -2 log likelihood (-2LL). Residual analysis in the final model was performed to detect significant outliers.

**Results**

Figure 1 shows the flow of study participants, in which 180 children participated, of which 84 were male (46.7%), and 96 were female (53.3%). The mean age of the children was 35.0 (±4.5) months. Of the children evaluated, 36 (20%)
studied in private institutions and 144 (80%) in public institutions; 48 (26.8%) belong to strata A and B of the economic classification, 90 (50%) to strata C, and 42 (23.3%) to classes D and E.

Concerning maternal schooling, 26.3% have up to eighth grade, 45% have completed secondary school or have incomplete higher education, and 28.7% have higher education or postgraduate education. Regarding paternal schooling, 43.1% of respondents have up to eighth grade, 36.9% secondary school, and 20.0% have higher education or postgraduate education.

From the sample of 180 participants, 10 children (5.5%) were not exposed to any media. Figure 2 shows the distribution of children by daily screen time exposure, where 63.3% of children are exposed to a time equal to or greater than two daily hours.

Table 1 describes the interactive media used by children, indicating that the most used device was TV, followed by smartphones and tablets. Few children in this range make use of video games (4% of the sample).

The results of the association of screen time with independent variables are shown in Table 2.

Table 2 shows that groups G1 and G2 were similar regarding gender and age distribution, maternal and paternal schooling, family resource inventory, parenting practices that promote family-day care, cognitive development, gross/fine motor, and BMI. However, they are different regarding the other variables studied. Thus, we can state that the economic level and the FERI resources that promote proximal processes and language development showed a statistically significant association with longer screen time.

Residual analysis was performed when binary logistic regression was carried out, and two outliers were excluded. Also, the interactions between the variables of the final model were examined, and “maternal schooling” and “family environment resource inventory - total FERI” were removed. Table 3 shows the variables that remained in the binary logistic regression model.

The independent variable “economic level” was considered a significant predictor for distinguishing between children with screen time of two hours or more and screen time of fewer than two hours. Children from the upper strata of the economic classification were 3.5 times more likely to have greater exposure to the screens.

The independent variable “language development” was also considered a significant predictor for distinguishing between children with a screen time of two hours or more. Children with better expressive language performance were 3.57 times more likely to have greater exposure to the screens.

Discussion

This study investigated the determinant factors for the screen time of children aged 24–42 months, considering that this is a crucial period for child development. In the survey, 63.3% of children had a daily screen time higher than two hours, in agreement with the Common Sense Media reports, and the Read Aloud Survey Report, which were also developed in the United States, which also found a child exposure time value higher than two daily hours. Studies in Singapore also found a prevalence of more than two daily hours of exposure in children in early childhood.

The results of the research, as mentioned above, as well as those evidenced in this study, contradict the AAP’s guidelines, which recommend daily exposure of up to two hours for children aged 2-5 years, including the use of all media. However, in a new guidance document for parents and pediatricians, the AAP recommendation has become more conservative, i.e., screen time is up to 1 hour/day for 2-5-year-olds. The Brazilian Association of Pediatrics also advocates this last recommendation; however, the literature points to studies that state that parents...
have difficulty incorporating the recommendation of screen time limitation into their children’s routine since adult screen time is also high39,40.

In this study, 94.5% of children were exposed to screens, especially television (61%), followed by portable interactive media, smartphones (41%), and tablets (22%). Few children in this age group were found to use video games (4% of the sample), a popular media among older children35. As for TV, the literature associates its intense exposure to language delay, difficulty in social interaction, sedentary lifestyle formation, and low stimulus to creativity1,16,17,20,41. Although television is still the most popular media among children, it is relevant to consider the trend and increasingly prominent role of mobile interactive media2,11,42. Since it is considered a recent technology, studies on interactive media and its impact on health and child development are beginning to emerge in the literature5. While still controversial, studies indicate that the thrifty use of these media, unlike television, because they allow a child’s touch screen and interaction with their content, can contribute positively to children’s cognitive, linguistic, and fine motor development5,27,37,43-45.

The independent variables associated with screen exposure time in the bivariate analysis were economic level, resources in the family environment that develop proximal processes and language development. Paternal and maternal schooling, while not showing statistical significance of 95%, obtained values p<0.20, and proceeded to logistic regression.

Paternal schooling is associated with better opportunities for home stimulation46. This stimulation can be understood, for example, as providing an environment that contains learning resources in which interactive media are also present. It is also suggested that parents with higher schooling make more use of media in their routine, which may directly influence the child’s screen time39,40.

Maternal education has been pointed out as an essential predictor for growth, health, and child development47,48. Mothers with higher maternal education may facilitate resources for child development, using interactive media as a resource for learning promotion. Vectore et al.49 reflect on the child in contemporary times and affirm that life in highly competitive societies has intensified the concern and desire of the modern

| Media     | Do not use | Use up to 2 hours/day | Use more than 2 hours/day |
|-----------|------------|-----------------------|----------------------------|
|           | n | % | n | % | n | % | n | % |
| Smartphone| 76| 38.8 | 34 | 20.0 | 70 | 41.2 |
| Tablet    | 147 | 80.6 | 4 | 2.3 | 39 | 23.0 |
| Videogame | 171 | 94.7 | 2 | 1.2 | 7 | 4.1 |
| TV        | 16 | 3.5 | 50 | 29.4 | 114 | 67.0 |

n: absolute number of children; %: proportion of children.

Figure 2. Screen time distribution in minutes by exposure to television or interactive media. Diamantina, Minas Gerais, Brazil, 2019.
Table 2. Screen time and associated factors. Diamantina, Minas Gerais, Brazil, 2019.

| Variable                          | Screen time                      | Less than two hours (n=66) | Two hours and over (n=114) | X² Test | P     |
|-----------------------------------|----------------------------------|----------------------------|----------------------------|---------|-------|
|                                   |                                  | n     | %     | n     | %     |       |
| Gender                            |                                  |       |       |       |       |       |
| Female                            |                                  | 35    | 47.0  | 61    | 53.5  | 0.04  | 0.95  |
| Male                              |                                  | 31    | 53.0  | 53    | 46.5  |       |       |
| Age                               |                                  |       |       |       |       |       |       |
| 2 years                           |                                  | 35    | 53.0  | 55    | 48.2  | 0.20  | 0.53  |
| 3 years                           |                                  | 31    | 47.0  | 59    | 51.8  |       |       |
| Maternal schooling                |                                  |       |       |       |       |       |       |
| Up to complete primary school     |                                  | 21    | 34.4  | 24    | 21.8  | 3.21  | 0.07  |
| Secondary school or Higher Education |                              | 40    | 65.6  | 86    | 78.2  |       |       |
| Paternal schooling                |                                  |       |       |       |       |       |       |
| Up to complete primary school     |                                  | 32    | 52.5  | 37    | 34.7  | 3.50  | 0.06  |
| Secondary school or Higher Education |                              | 29    | 47.5  | 62    | 65.3  |       |       |
| Socioeconomic level               |                                  |       |       |       |       |       |       |
| A, B and C1                       |                                  | 23    | 34.8  | 65    | 58.0  | 8.93  | <0.01*|
| C2, D and E                       |                                  | 43    | 65.2  | 47    | 42.0  |       |       |
| Family Resource Inventory (RAF) - total |                            | 39    | 59.1  | 54    | 47.4  | 2.30  | 0.12  |
| Score up to 50                    |                                  | 38    | 59.1  | 54    | 47.4  |       |       |
| Score above 50                    |                                  | 27    | 40.9  | 60    | 52.6  |       |       |
| Resources that promote proximal processes (FERI) | | 20    | 34.5  | 58    | 55.2  |       |       |
| Score up to 26                    |                                  | 38    | 65.5  | 47    | 44.8  | 6.45  | 0.01* |
| Score above 26                    |                                  | 20    | 34.5  | 58    | 55.2  |       |       |
| Activities that signal family life stability (FERI) | | 28    | 48.3  | 54    | 51.8  | 0.14  | 0.70  |
| Score up to 16                    |                                  | 30    | 51.7  | 51    | 48.6  |       |       |
| Parenting Practices that Promote Family-Day Care (FERI) | | 47    | 71.2  | 81    | 71.1  | 0.01  | 0.98  |
| Score up to 8                     |                                  | 19    | 28.8  | 33    | 28.9  |       |       |
| Language Development              |                                  | 16    | 45.7  | 14    | 22.6  | 5.60  | 0.01* |
| Score above 9.9                   |                                  | 19    | 54.3  | 48    | 77.4  |       |       |
| Cognitive development             |                                  | 18    | 48.6  | 29    | 43.3  | 0.27  | 0.59  |
| Score above 9.9                   |                                  | 19    | 51.4  | 38    | 56.7  |       |       |
| Gross Motor Development           |                                  | 42    | 77.8  | 63    | 69.2  | 1.23  | 0.26  |
| Score up to 9.9                   |                                  | 21    | 22.2  | 28    | 30.8  |       |       |
| Fine Motor Development            |                                  | 12    | 27.9  | 26    | 33.3  | 0.37  | 0.58  |
| Score above 9.9                   |                                  | 31    | 72.1  | 52    | 66.7  |       |       |
| BMI                               |                                  | 37    | 66.1  | 66    | 71.7  | 0.52  | 0.46  |
| Leanness and eutrophy             |                                  | 37    | 66.1  | 66    | 71.7  | 0.52  | 0.46  |
| Risk of overweight, overweight and obesity | | 19    | 33.9  | 26    | 28.3  |       |       |

n: absolute number of children; %: proportion of children; BMI=Body Mass Index; p: level of significance adopted (<0.05).

Table 3. Hierarchical binary logistic regression for dependent variable "Screen Time". Diamantina, Minas Gerais, Brazil, 2019.

| Independent variables | Screen time | b±S.E | OR   | 95%CI         | p     |
|-----------------------|-------------|-------|------|--------------|-------|
| Economic level        |             | 1.26±0.59 | 3.538 | 1.11-11.25   | 0.03* |
| Language development  |             | 1.27±0.59 | 3.570 | 1.12-11.34   | 0.03* |
| Resources that promote proximal processes | |       |       |              |       |
| Paternal schooling    |             | 0.75   |      |              |       |

Quality of model per Hosmer and Lemeshow=0.92. *p=level of significance <0.05. b=coefficient of regression. S.E=Standard Error. OR=Odds Ratio, CI=Confidence Interval.
mother in search of overqualification of children, with diversified activities and early exposure to the highly technological adult world, aiming at a distant future of success in adulthood, but built from the earliest years of life.

Resources that promote proximal processes were positively associated with longer screen time. The more availability of toys and materials than home learning, the higher the possibility of technological resources such as interactive media, computers, and television, and therefore, more prolonged exposure to screens.

In this research, the independent variables that were associated with screen time and remained in the multivariate analysis were, respectively, economic level and language, considered significant predictors for distinguishing between groups with screen time equal to or greater than two hours and screen time lower than two hours. Each increases the likelihood of longer screen time by 3.5 and 3.57, respectively.

The higher the economic level, the greater the possibility of acquiring different media; consequently, the longer the screen time. Although TV has become more popular at more affordable prices, smartphones, and especially tablets, are of higher purchasing value. Studies state that in the United States, the availability of smartphones, and particularly tablets, is lower in low-income families, a trend also observed in Brazil.

In this regard, in a survey conducted in Portugal, Simões et al. state that the possession of tablets is more evident in homes of middle socioeconomic strata compared to the lower strata on the European continent; therefore, the upper classes have both tablets and portable computers, among other media, while those with lower socioeconomic backgrounds have less equipment for their individual use. The literature states that the digital divide between economic levels is apparent in the program content of mobile devices, and, according to Common Sense Media, higher-income families install more apps, specifically for their children, including games and educational apps.

Regarding language, an association is found between TV use and language delays in children. However, this study investigated screen time, including interactive media. In a review of children’s screen-related learning research, Reich et al. say that well-designed eBooks provide children with learning equally well, and sometimes more than printed books. However, the authors point out that eBooks enhanced with sounds, animations, and games can distract children and reduce learning.

There is evidence in the literature that educational applications contribute to a lexical increase in children and can teach reading and literacy skills. Consistent with this understanding, Russo-Johnson et al. positively associated tablet use in word learning with probable transfer of learning to the real object in their study on interactivity, touch screen and child learning, corroborating Huber et al., who identified in their research with children aged 4-6 years the ability to learn and transfer learning from a touch screen device, applying this knowledge to their interactions.

However, the literature emphasizes the importance of taking into account some factors for the use of interactive media by children in early childhood: the restriction of time and its content; interactive versus passive activities; use for fun or learning as opposed to use to “keep the child quiet” and especially the importance of adult presence as a mediator. The presence of an adult sharing with the child the reading experience to interpret, dialogue, and discuss provides a better interpretation and stimulates language development, which differs from the fact that children interact with interactive media themselves.

Studies on screen time and associated factors are still incipient in Brazil, but one can observe that there is a current demand in the care of the pediatric population, regarding the construction of parameters for the use of screens by children in early childhood, since time, means and quality of exposure to screens influence development. Thus, this pioneering study sought to understand the screen time-associated factors in a representative sample of Brazilian children in order to contribute to the construction of evidence for applicability in future interventions beneficial to child development.

The limitations of the research are the use of a questionnaire completed by parents, which favors memory bias and social desirability; however, this is still the most used form in other studies. We suggest, as future prospects, to investigate the screen time of parents, in order to verify a possible association with the use of media by children, given the need to increase studies of this nature for the public health area, whether quantitative as this study, or qualitative, in order to understand in depth the phenomena associated with children screen time.
Conclusion

The children in this study evidenced screen time above the recommended for their age. Television was still primarily responsible for children’s screen exposure, contributing substantially to this contact. We observed that the screen exposure time was positively associated with family resources, economic level, language development. However, only the last two explained the longer screen time.

Collaborations

JNP Nobre data collection and interpretation; drafting and critical review of the manuscript. JM Costa, LR Santos, SC Guedes and I Pereira data collection and critical review of the manuscript. JN Santos and RLS Morais conception and orientation of work; data interpretation; drafting and critical review of the manuscript.

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