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Digital phenotyping, Artificial intelligence, Parental perception, Behavioural monitoring, Preventive and restorative dentistry

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# Digital Phenotyping and AI for Paediatric Oral-Health Behaviour Monitoring: Parent Perspectives and Restorative Implications

## Abstract

**Background:** Digitalization of childhood has remodelled behavioural, cognitive and emotional development. As the utilisation of smartphones, wearables, and AI tools increases, digital phenotyping has become a new method to track behavioural and developmental health in children such as behaviours associated with oral health and preventive and restorative care. Nevertheless, there is little empirical data combining behavioural signs of children with the parental acceptance of AI-based surveillance systems, especially in the context of developing countries.

**Objective:** The purpose of this research was to investigate the patterns of behaviour in children at the age of 2-12 years and the parental awareness and intention to implement AI-based monitoring with a particular emphasis on behavioural or oral-health practices pertinent to preventive and restorative dentistry.

**Methods:** A quantitative and cross-sectional survey was carried out on 100 parents through a structured questionnaire. It contained behavioural measures (screen time, hours of sleep, attention span, frequency of brushing teeth, frequency of eating sugary snacks, frequency of visiting the dentist, frequency of caries/bruxism as reported by parents). Quantitative and qualitative data were interpreted by using descriptive, correlation, and thematic analysis.

**Results:** The mean daily screen exposure among children was 2.8 hours, while the average sleep duration was 8.7 hours. Screen time negatively correlated with both attention span ( $r = -0.43$ ) and sleep duration ( $r = -0.31$ ) highlighting meaningful relationships between digital exposure and behavioural outcomes. Parental awareness of digital phenotyping was 56%, and 59% of respondents expressed willingness to adopt AI-driven child monitoring tools. However, privacy and data security concerns persisted. Higher screen time was also associated with less favourable oral-health behaviours (e.g., reduced toothbrushing frequency and higher sugary-snack frequency), indicating potential pathways to increased restorative risk.

**Conclusion:** The findings indicate that while AI-based digital monitoring offers potential for enhancing early behavioural assessment, ethical considerations and parental trust remain critical. Integrating parental perspectives into AI design frameworks can foster responsible and family-centered digital health ecosystems. The paper adds empirical data in a developing-country setting to the current discussions on ethical and family-centred AI in child health. It also aids the integration of AI tools based on family concerns into the dental prevention strategies among paediatrics to enhance the behaviours that affect the restorative outcomes.

## 1. Introduction

### 1.1 Background of the Study

The growing digitalization of society has reshaped the way children develop, learn and communicate, making technology a part of almost all aspects of development. The use of digital technologies, including smartphones, tablets,

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and wearables, is now influencing the thinking process, communication patterns, and everyday life at an early age (Adelantado-Renau et al., 2019). This mass integration has attracted the interest of paediatric medicine, psychology, and data science, which resulted in a new paradigm of technology-aided behavioural observation. Conventional clinical assessments of the behaviour of children that rely on periodic observation or self-report are narrow in scope and frequency. The ever-increasing interaction of children with digital space opens up the possibility of continuous monitoring of behaviour in digital format to obtain ecologically valid real-time data (Sequeira et al., 2019; McGinnis et al., 2019).

In addition to the overall development of behaviour, the online habits of children are becoming more influential on the oral-health behaviours of snacking, frequency of toothbrushing, parafunctional sleep (e.g., bruxism) and compliance with preventive guidance. These behavioural patterns have clinical implications as they determine the risk of caries, risk of erosion, and the effectiveness of the restorative interventions in the long-term success of paediatric dentistry.

In this new paradigm, digital phenotyping has become a concept of interest which involves dynamically quantifying human behaviour with data obtained through digital devices. Digital phenotyping can avail continuous information regarding the mental and developmental condition by collecting and evaluating behavioural indicators, such as activity, mood, attention, as well as sleep. Such an approach can assist researchers in identifying the first indicators of cognitive or emotional disorders in children along with artificial intelligence (AI) and machine learning (ML) algorithms (Uddin et al., 2019; Paramasivan, 2020). Consequently, the sphere of paediatric medicine is moving to the stage of data-driven medicine where the data of behaviour will be utilized to complement the clinical decision and enhance the early intervention and personalised treatment (Subramanian et al., 2020).

## 1.2 Conceptual Foundation

Digital phenotyping represents an intersection of behavioural science, data analytics and data computation undertaken by AI. It utilises the passive data that is received by cell phone sensors, wearable trackers and IoT networks to transform this data into behavioural insights used in actions. It may be helpful when used in the field of paediatrics, particularly in identifying minor shifts in the levels of attention, emotional control, and even social functioning development. Longitudinal datasets are huge and can be solved by AI and ML models to predict behavioural trends, detect abnormalities and prescribe intervention (Faria et al., 2020).

Such monitoring can be useful in the prevention of caries and other risk factors associated with restorative failures in paediatric dentistry, as well as the identification of sleep patterns that might be useful in assessing tooth wear and restoration retention. Moreover, AI-based technologies and wearables increase the possibility of early detection of attention and mood-related disorders in children (Melcher et al.,

2020, Chong et al., 2020). In the framework of this concept, the perception and trust of parents becomes a crucial element to the ethical and successful incorporation of AI-based digital phenotyping in the health conditions of childhood.

## 1.3 Literature Review

### 1.3.1 Evolution of Digital Phenotyping in Healthcare and Pediatric Research

The researches of this field investigate the ability of digital footprints to serve as biomarkers of developmental and emotional statuses (Sequeira et al., 2019). With AI/ML integration, the analysis of complex behavioural data has become possible, which can be analysed automatically, and the accuracy of psychological, developmental tests may be increased (Uddin et al., 2019).

It has been established that wearable computers and sensor technologies can develop the possibility of identifying internalizing disorders in children early before they occur. Similarly, game-based systems that utilize AI have been employed to determine the level of attention in children with attention-related challenges so that more individualized intervention plans can be created. These developments are part of a wider change in child healthcare, to be more proactive rather than reactive, and digital phenotyping is becoming a major basis of AI-assisted child healthcare. However, most existing studies prioritise technological capability and clinical detection accuracy, with limited attention to parental perception and acceptance of such monitoring systems.

### 1.3.2 Behavioural and Cognitive Dimensions of Digital Exposure in Children

Although digital technologies provide new means of behavioural testing, an overexposure to digital technologies has developmental risks. Some empirical studies also associate higher screen time with adverse cognitive and academic performance, including reduced attention span, worse performance, and slower development of mental imagery (Suggate and Martzog, 2020; Madigan et al., 2019). Results indicate that children who have a longer amount of time on screens might have less executive functioning and have slow responses to emotional reactions.

On the other hand, the positive learning outcomes can be achieved in case of balanced and structured digital engagement that is guided in the right direction. An example is the use of digital tools with interactive or AI-driven feedback features which prove to be more efficient at increasing concentration and behavioural regulation (Faria et al., 2020). Moreover, there are still strong socioemotional consequences of digital exposure, and the evidence suggests that the emotional health of children and the relationships with peers are inseparably connected to digital engagement patterns (Hollenstein and Colasante, 2020). These behavioural findings highlight the need for monitoring approaches that are both evidence-based and socially acceptable within family settings.

### 1.3.3 Parental Perception and the Integration of AI-Based Monitoring Systems

Parents play a central role in mediating between the contact of the children with technology. The way digital health innovations are adopted in households depends on their attitudes, awareness and trust. Research shows that the attitudes of parents to AI-based monitoring devices are diverse based on their knowledge of technology and the perceived ability to control its use (Russell and Gajos, 2020; Shic et al., 2019). Although the world has been digitising health, there is a dearth of evidence on the topic of parental involvement in AI-based monitoring, particularly in the developing environment. Western studies have focused mainly on the efficiency of the technology used and system validation, without focusing much on sociocultural and perception aspects (Chong et al., 2020). This disproportion shows that more inclusive and family-centered research methods on digital phenotyping are necessary. This imbalance in the literature underscores the need for empirical studies that integrate parental attitudes with measurable child behavioural indicators, particularly in developing-country contexts.

### 1.3.4 Digital Monitoring Technologies, Parental Engagement, and Ethical Adoption in Child Health

The adoption of digital monitoring technologies in the child health and developmental care has increased with the development of artificial intelligence, Internet-of-Things (IoT) systems, and data-driven analytics. It has been shown that IoT- and cloud-based monitoring systems have the potential to continuously observe the behavioural and physiological patterns of children in situations when early intervention and adaptive care is necessary (Kakkar and Garg, 2019). Likewise, sensor-based and crowdsourced surveillance systems have been analysed as high-capacity strategy to monitor child safety and behavioural activity in natural conditions, and it has been noted that technology enabled supervision can be helped by technology outside clinical settings (Chen et al., 2019). Although these technologies have important functional advantages, parental involvement and ethics are a powerful mediator to their successful adoption. Parents introduce a significant role as a gatekeeper of digital health technologies, and responsible use, trust, and continued engagement are impossible without their involvement.

Morgan (2020) highlighted the role of understanding children as digital citizens and bridging any parental-child involvement to make sure that the use of technology is formed according to the standards of development and ethics. Even systems, which are technologically sound, will not lead to significant health or behavioural changes without proper parental insight and engagement. Simultaneously, predictive analytics and machine learning algorithms have been used more and more to prescribe individual intervention approaches to children with developmental and behavioural requirements (Akhtar and Feeny, 2020). These directions emphasise the increasing trend towards more technology-based and precision child healthcare. They also, however, pose some questions on the data governance, transparency, and the autonomy versus

human supervision. All the literature implies that although digital monitoring technologies open up encouraging opportunities to improve child health and behavioural assessment, they require ethical design, parental trust, and culturally responsive frameworks of implementation. Such frameworks are especially applicable to a dental perspective, where parental involvement and routines-based behaviours have a decisive role in influencing oral-health behaviours and practices on preventive care. Ethically regulated digital tracking in paediatric dental practice can thus help identify potential risks early and uphold those behaviours associated with a positive outcome of restorative health in later life.

### 1.4 Research Gap

Despite the impressive advances in digital phenotyping in the healthcare sector, the area of childhood medicine still has a lot of gaps in its implementation. Majority of the research has focused on clinical or technical aspects and little has been done on the way parents perceive and interact with AI-based behavioural monitoring systems. Moreover, very little empirical studies have been conducted to correlate behavioural predictors of children like screen time, attention span, and sleep with parental favourable or unfavourable views of technologies in real life. The paper fills these gaps by incorporating behavioural measures and parental attitudes to give a holistic picture on AI-based behavioural monitoring in the paediatric population, specifically in India. Moreover, few studies have concurrently tested behavioural outcomes as well as parental approaches to AI-based monitoring in the context of developing countries. This gap is critical in informing digital health interventions based on ethics or those that are socially acceptable.

### 1.5 Significance of the Study

This research paper leads to the contribution of three significant areas. First, it augments the body of paediatric behavioural literature, which connects quantifiable child behaviours with parental awareness, and thus provides a basis of digitally health-related patterns with an evidence base. Second, it pushes the AI-based approach to healthcare innovation and focuses on the relevance of human factors particularly parental interpretation to the overall success of technological adoption. Third, it facilitates policy and educational efforts by offering information to developers, clinicians and educators to build in ethical and family-centred AI surveillance (Chong et al., 2020). It is predicted that the findings will inform the responsible integration of AI into paediatric care that will focus on creating a human balance between an electronic-based monitoring system and parental trust.

### To address the identified research gaps, the study pursues the following objectives:

1. To investigate the major behavioural predictors, such as screen time, duration of sleep, and attention span among the children aged 2-12 years, which are important in preventive and restorative dental risk pathways.

2. To determine parental awareness, parental perceptions, and parental readiness to use AI-based digital phenotyping applications in the context of monitoring child behaviour, which could be applied in a clinical and preventive dental and prevention scenario.
3. To examine how the behaviour patterns of children and the technological attitudes of parents relate to each other to determine the emerging patterns of digital engagement that can be used to inform the risk base approach and preventive approaches in restorative dentistry.

## 2. Methodology

### 2.1 Research Design

The type of survey design used in this study was a quantitative and cross-sectional study design to examine behavioural patterns, exposure to technology, and parents perspectives towards digital phenotyping in childhood medicine. This design suited well to capture the existing behavioural patterns and parental perceptions in an emerging digital health environment. The study sought to identify the relationship between screen time of children, length of sleep, attention capacity and stable mood and parental awareness and acceptance of AI-driven behavioural monitoring devices. The design concept was a hybrid of quantitative and qualitative to be able to get quantifiable trends and qualitative parental responses on the subject of digital behavior and developmental health.

### 2.2 Participants and Sampling

The sample size is 100 valid responses that describe 100 children aged between 2 and 12 years. All the responses were collected by parents or the legal guardians, so the data are based on the personal observations of the parents on the behavioural and developmental patterns of children. The selection was done by a convenience sampling method mostly in schools, paediatric clinics and community networks in urban and semi-urban areas in India. The balance in the demographics was maintained, as there were 50 males and 50 females represented in the number of children, and 50 fathers and 50 mothers represented in the number of parental respondents.

### 2.3 Data Collection Procedure

The survey questionnaire used in the survey was a structured survey questionnaire that was designed by the researcher. To achieve both the quantitative and qualitative measure, the questionnaire had both closed-ended and open-ended questions. Parents gave extensive information about their child behavioural patterns, daily exposure to the digital world, and their daily routine. The instrument consisted of the following big portions:

- **Child-related variables:** age, gender, screen time, sleep hours, physical activity level, social interaction, attention span, mood stability, and academic performance.
- **Parent-related variables:** age, gender, education, occupation, and relationship to the child.
- **Technology-related variables:** parental monitoring behaviour, awareness of digital phenotyping, use of AI-

based applications, perceived benefits, and privacy concerns.

- **Open-ended responses:** qualitative reflections on children's behaviour and technology use.

The questionnaire was pre-tested among 10 parents to ensure content validity, clarity, and reliability before large-scale administration. Minor adjustments were made to improve language precision and readability.

### 2.4 Oral-Health and Restorative-Relevant Variables

The measures used in the qualitative research were an oral-health module to record those behaviours and indicators that are involved in preventive and restorative dentistry. Parents were asked (i) how often they brush their teeth (times/day), (ii) how often they have a sweet or sugary snack or drink with sugar (times/day), (iii) whether dental pain or caries had been diagnosed (yes/no), (iv) whether dental restorative treatment (fillings or crowns) had been done (yes/no), (v) how often they visited a dentist in the last 12 months, and (vi) whether they noticed their child grinded his teeth or sucked on a sweet (yes/no). These variables were compared with the digital exposure indicators in order to understand the pathways of behaviour that can help to alter restorative risk.

### 2.5 Dataset Description

The information applied in this research was gathered as a structured survey method applied to parents with children at the age range of two to twelve years. Every entry is linked to a particular child, and the answer is given by the mother, the father, or the guardian. The dataset is the balanced mixture of the quantitative, categorical, and qualitative variables that reflect different aspects of child behaviour and parental attitude. It contains data concerning the child age, gender, time spent on a screen, time spent sleeping, physical activities, interpersonal relationships, attention ability, mood stability and academic achievement. The demographic information of parents contained parent-related information age, gender, education level, occupation, and relationship to the child. Variables under technology include parental monitoring, digital phenotyping awareness, application of AI-based applications, perceived benefits, privacy concerns and intention to use AI-driven health monitoring tools. Moreover, qualitative feedback provides important contextual information on how the parents noted the behavioural pattern of the children and their attitude toward technology usage. Each of the responses was read, coded, and anonymized to prevent possible breaches of confidentiality and the violation of ethical principles of research.

### 2.6 Data Analysis Procedure

100 surveys that were conducted by parents were collected and analysed systematically to examine the behavioural and technological trends in children and parents. The descriptive statistics were used to summarise the key variables that include the screen time, sleep duration, attention span and the parental awareness of AI-based monitoring tools. Categorical data were analysed with frequency and percentage while

cross-tabulations were done to detect relationships between demographic and behavioural variables. Correlations among the measures of behaviour of the children were examined in the correlation analysis, and visual charts were drawn to be interpreted. The thematic review of qualitative responses was used in order to reach the parental insights and background understanding.

**2.7 Ethical Considerations**

Every research process was in accordance with the ethical principles of social and behavioural sciences. All the participating parents were informed before the data collection and gave their consent. There was none of personal identifiable information, as addresses, and contact details were not taken. A high level of confidentiality was upheld, and the answers were anonymized prior to their analysis. The participation was made voluntary and parents were made aware of their right to withdraw at any point and remain at any point without any reprisal.

**3. Results**

**3.1 Overview of Findings**

100 parents were analysed in terms of behavioural, technological, and perceptual patterns concerning the digital exposure of children and the awareness of their parents concerning AI-based behavioural monitoring tools. The results are displayed in the form of descriptive statistics, categorical data analysis, correlation outcomes and qualitative observations which give a detailed picture of the data received.

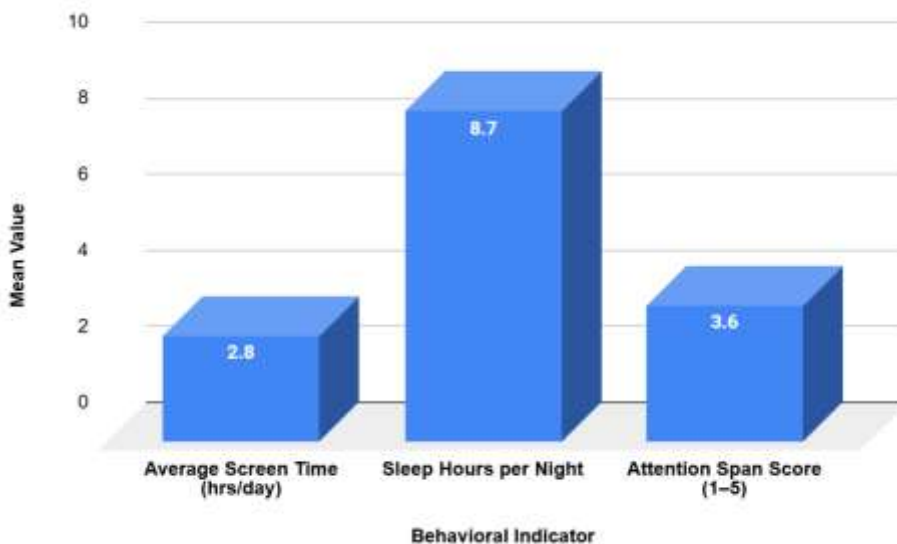
**3.2 Descriptive Statistics of Child Variables**

Descriptive statistics were done to describe the major behavioural measures, such as average screen time, sleep duration, attention span, social interactions, and perceived AI tools pros. Table 1 demonstrated that the average hours of screen time in children were 2.8/day, and the average duration of their sleep was 8.7 hours. The mean attention and social interaction capability was 3.6 and 3.8 respectively, indicating a normal behaviour pattern. The perceived advantage of the AI tools scored 3.9 on a five-point scale with the overall positive responses of the parents.

**Table 1. Descriptive Statistics of Key Child Variables**

Variable	Mean	SD	Minimum	Maximum
Average Screen Time (hrs/day)	2.8	0.9	0.6	5.1
Sleep Hours per Night	8.7	0.8	6.5	10.5
Attention Span Score (1-5)	3.6	0.9	1	5
Social Interaction Score (1-5)	3.8	0.8	2	5
Perceived Benefit of AI Tools (1-5)	3.9	0.7	2	5

To provide a visual comparison, Figure 1 illustrates the mean values of the main behavioral indicators, including screen time, sleep hours, and attention span, showing balanced trends across variables. These descriptive findings indicate generally moderate digital exposure and behavioural functioning among children in the sampled population.



**Figure 1. Average screen time, sleep hours, and attention span scores among children**

**3.3 Parental Awareness and Attitudes**

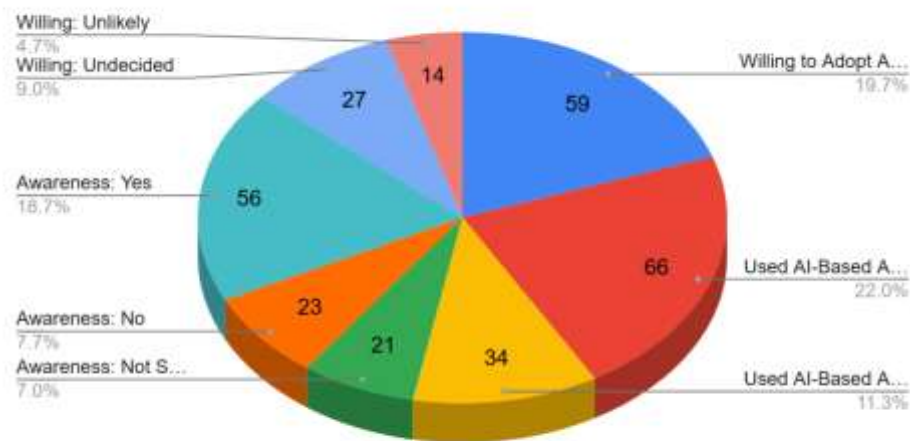
Parental awareness and technological attitude were analysed and indicated different rates of understanding and acceptance of AI-based monitoring tools. According to the summary presented in Table 2, over 56 % of the participants stated that they were aware of what digital phenotyping is, and thirty-four percent reported using AI-based applications to monitor

their children. A large proportion 59 % of them were ready to embrace AI-based health technology, indicating a broad readiness to use technology in the upbringing of children.

**Table 2. Distribution of Parental Awareness and Attitudes**

Variable	Category	Frequency	Percentage (%)
Awareness of Digital Phenotyping	Yes	56	56.0
	No	23	23.0
	Not Sure	21	21.0
Use of AI-Based Apps	Yes	34	34.0
	No	66	66.0
Willingness to Adopt AI Tools	Likely	59	59.0
	Undecided	27	27.0
	Unlikely	14	14.0

The proportional representation of awareness, app usage, and willingness is further visualized in Figure 2, which displays the distribution of responses among parents regarding their familiarity with digital phenotyping and openness to AI technologies. These results suggest a moderate level of parental awareness and a cautiously positive attitude toward the adoption of AI-based child monitoring tools.



**Figure 2. Distribution of parental awareness of digital phenotyping**

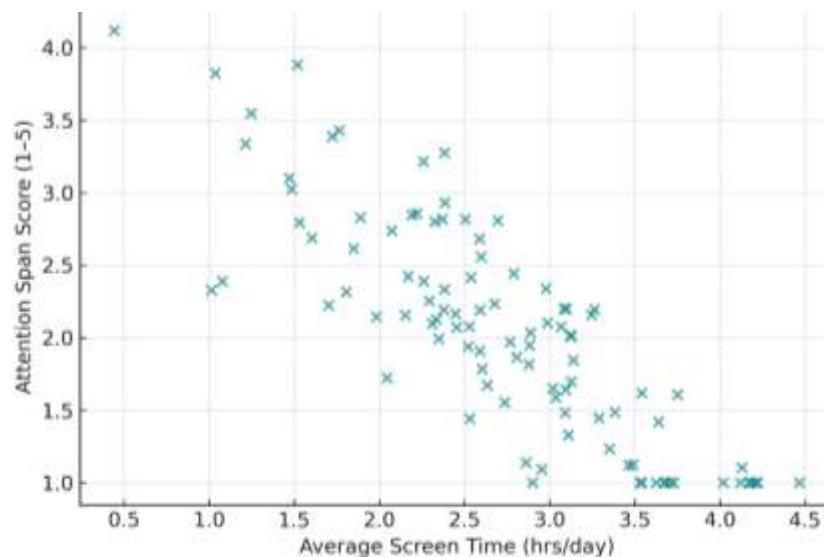
**3.4 Correlation Between Behavioural and Technological Variables**

A correlation study was employed to determine the association between behavioural measures of children, and perception of parent of AI tools. Table 3 above indicates that there are significant relationships among screen time, attention span, sleep duration, and perceived AI application benefits. Screen time had a negative correlation with the attention span ( $r = -0.43$ ) and sleep hours ( $r = -0.31$ ), whereas the attention span took a positive correlation with the perceived benefit of AI tools ( $r = 0.36$ ).

**Table 3. Correlation Matrix Between Behavioural and Technological Variables**

Variables	Screen Time	Attention Span	Sleep Hours	Perceived AI Benefit
Screen Time	1.00	-0.43	-0.31	0.25
Attention Span	-0.43	1.00	0.28	0.36
Sleep Hours	-0.31	0.28	1.00	0.19
Perceived AI Benefit	0.25	0.36	0.19	1.00

The association between screen time and attention span is visually represented in Figure 3, highlighting the observed trend between increased digital exposure and reduced focus levels. Overall, the observed correlations indicate meaningful associations between children’s behavioural indicators and parental perceptions of AI-based monitoring technologies.



**Figure 3. Relationship between children's screen time and attention span**

Based on the behavioural associations identified, a proposed framework is presented for future integration of digital phenotyping with paediatric oral-health monitoring. Key behavioural indicators such as screen exposure, sleep duration, and parental supervision may be linked to oral-health behaviours (e.g., snacking frequency, oral hygiene practices, and sleep-related parafunction), which are known risk factors for caries and restorative failure. Future studies should empirically test these relationships using clinical and parent-reported oral-health data

#### Qualitative Findings

According to the research aims, qualitative data obtained through parents were analyzed to put behavioural signs into perspective and parental views on AI-based monitoring. Parents were regularly observed to stress the importance of screen time control and organized daily routines, which was an indication of understanding behavioural signs including fluctuation of attention and regular sleeping. The majority of the respondents displayed different degrees of comprehension and acceptance of the AI-enabled behavioural monitoring by showing apprehensive interest in the possibility of detecting behavioural changes earlier as well as indicating privacy and overdependence concerns. Also, parents emphasized the intersection of digital habits and daily health-related behaviour, such as food habits and oral-hygiene habits such as consistency in brushing their teeth. The understanding of these insights shows that parental supervision and technological attitudes can potentially alter behavioural pathways that are important in health surveillance and preventive measures to add to the quantitative relationships between child behaviours and parental technological perceptions that were observed. In general, the qualitative data support the concept of parents as important mediators in the implementation and successful application of AI-based monitoring in family-centred health.

#### 4. Discussion

##### 4.1 Digital Behavioural Patterns and Restorative Risk Pathways

The results of the study show that the digital exposure of children is significantly related to behavioural parameters including attention span and duration of sleep that are clinically important to dental treatment in children. The negative correlations between screen time, attention and sleep are expected given the available literature on the topic that suggests that excessive use of digital devices can interfere with regular activities and control of behaviour (Williams et al., 2019a). Such disruptions can have an indirect role in the development of behaviours that put people at risk of caries, such as irregular oral-hygiene, frequent snacking, and decreased compliance with preventive information, in a restorative-dentistry perspective. Notably, the findings support the dual identity of digital technology in childhood. Parents will feel more positively about the use of digital tools when they are applied in a more structured and controlled way, which represents more general parental attitudes in relation to AI-driven health technologies in paediatric care (Sisk et al., 2020). This opens a avenue where AI-based digital phenotyping can help in early detection of behavioural risk profiles that can be used to determine oral-health outcomes and, by extension, the overall success of restorative interventions. Instead of being a diagnostic alternative, digital monitoring can be used as a complementary resource to contribute to preventive counselling and risk-based recall plans in paediatric dentistry, which aligns with the use of data-driven options in behavioural health management (Paramasivan, 2020).

##### 4.2 Implications for Preventive and Restorative Dentistry

The research has indirect implications on the restorative risk assessment and prevention. Behaviours like excessive screen time, disturbed sleep, have been linked in the previous literature with the dietary practices, the lack of self-care, and technology-mediated routines affecting health behaviours in children (Tsuei and Hsu, 2019). AI-supported behavioural surveillance can thus be helpful in assisting clinicians to identify children at

increased risk of restorative intervention by identifying modifiable lifestyle factors that pre-empt clinical disease should data quality and ethical management be guaranteed (Willemink et al., 2020). Clinically, the incorporation of AI- advised behavioural information in paediatric dental care may positively impact dental care by improving preventive measures, reinforcing oral-hygiene education, and facilitation of parent-between dental care. These and similar strategies can be relevant to better restorative results in the long term, including encouraging caries-reducing behaviours, tooth wear reduction, and restorations life cycle, especially with AI systems integrated into educational and family-based systems (Williams et al., 2019b). With risk-based and patient-centred care models becoming more popular in restorative dentistry, digital phenotyping provides a new tool of converting behavioural data into practical preventive advice.

#### 4.3 Ethical Integration of AI-Based Monitoring in Clinical Dental Practice

The value of ethical considerations appeared to be the key factor in the willingness of parents towards AI-based monitoring systems. The ability to adopt digital phenotyping tools was largely determined by trust, transparency and cultural context. Parents were also cautiously optimistic as they supported AI use when it strengthened their role of caregiving as opposed to overriding human judgement. This point of view is especially applicable in the field of paediatric dental practice when parental participation is crucial towards continuation of oral-health habits and compliance to preventive and restorative prescriptions. There is a high need to protect privacy through system design, provide clear data governance, and informed consent, since implementing AI-driven monitoring with minors (Ishii, 2019, Washington et al., 2020). To adopt new technologies in an ethical way, prosthodontic and restorative practitioners should focus on the balance between innovation and patient autonomy and safety of the information. Topics of educational programs promoting the digital literacy of parents can also be used to increase adoption and appropriate introduction of AI tools into regular dental care. All in all, digital phenotyping can help preventive and restorative dentistry by being used as a transparent, family-centred and ethically controlled clinical adjunct.

#### 5. Conclusion

The paper emphasises how childhood behavioural development is becoming more and more converged with AI-advanced digital surveillance, and what its advantages and the challenges are. The results illustrate the close relationship between screen exposure, attention, and sleep behaviors of children and the digital environment as well as their strong mediating relations with parental supervision and attitudes. Although parental consciousness and readiness to use AI-related monitoring devices serve as evidence of increased openness to technology-focused behavioural assessment, the same issues related to privacy, data security, and over-reliance imply the necessity to approach the topic of AI-related monitoring tools with

caution and responsibility. These findings would indicate that the digital phenotyping in the field of pediatrics would be most effective in case technological innovation is accompanied by transparency, data protection, and family-centred design principles. Human judgement and caregiving have always been the key elements that require AI tools to be helpful as opposed to substituting human judgements and involvement. With the help of culturally responsive frameworks and education programs, digital literacy could be further boosted, and the adoption of AI in the child health could become more ethically justified. In general, the research will add empirical data points, which represent a developing-country study setting that will be valuable to determine the correlation between child behavioural indicators and parental acceptance of AI-based monitoring technologies. It is necessary to conduct future studies with larger and longitudinal designs that can illuminate causal mechanisms and enhance the evidence base of the responsible and clinically meaningful integration of AI-driven digital phenotyping in pediatric healthcare. Connecting AI-based behavioural surveillance and preventive and restorative risk paths, the present study is among the current applications of the emerging digital technologies in modern restorative dentistry.

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