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Pandemic Childhoods Cultural Narratives of Developmental Change among Preschool Children in Central Europe

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ABSTRACT

In Central Europe, the COVID-19 pandemic has altered cultural perceptions of early childhood. The disruptions experienced by preschool children—situated at the intersection of care, play, and learning—extended beyond educational impacts to affect the moral and emotional frameworks of the developmental process. This study examined how families and educators interpreted these changes by integrating quantitative and qualitative evidence. It identifies three developmental-cultural domains based on a nationally representative parental survey [N = 1,769] conducted by the XY Institute for Pediatrics and 18 international studies analysed using constructivist grounded theory coding. These domains include learning, associated with self-regulation and autonomy; sociability, linked to empathy and emotional control; and embodiment, related to movement, vitality and health. Consistent patterns emerged in the factor and cluster analyses, while Pareto filtering highlighted the most pertinent "red flags": reduced attention, emotional instability, and digital dependence. Culturally interpreted, these results suggest that COVID-19 has prompted a renegotiation of social expectations regarding what constitutes "normal" development. We applied grounded theory to statistical modelling to facilitate more interpretive perspectives on cultural change.

Keywords: Pandemic, COVID-19, Qualitative, Coding, Charmaz

INTRODUCTION

Relevance and Research Context

This research is part of TKP-26-6/PALY-2021 project focused on the design of medical technology devices and user requirements for artificial intelligence systems applicable to paediatrics. The overarching goal of this project is to understand the long-term psychological and physiological effects of SARS-CoV-2 infection in children. In this context, we considered somatic growth, metabolic regulation, cardiac function, stress tolerance, social relationships, and learning as parameters of interest. The project aims to integrate noninvasive, child-friendly medical technologies into continuous monitoring systems to provide a comprehensive framework for researching the psychological and physiological health of children. At the University of Sopron, we approach this from an educational perspective, concentrating on preschool children. At this developmental stage, changes in attention, movement, and behaviour often signal potential learning difficulties or developmental differences. Experiences of preschool teachers and current research indicate that spatial orientation, sensorimotor integration, and emotional regulation are early sensitive markers of atypical developmental processes (Schmidt et al., 2021).

These challenges may be exacerbated following infection or in stressful social settings due to post-illness physical or neurological impairments, prolonged peer segregation, or persistent social isolation. The most affected were children with special educational needs (SEN). The transition to distance learning and the loss of direct social interactions during the pandemic exacerbated issues related to attention, impulse control, and behaviour regulation (Mulkey et al., 2023; Perrigo et al., 2025). Several studies have shown that children with SEN face disproportionately high cognitive and social disadvantages without personal support, highlighting structural differences in school adjustment to the digital environment. Sedentary lifestyles and obesity during quarantine are additional concerns for students.

Reduced physical activity and prolonged sitting have been shown to disrupt metabolism and slow motor development, thereby affecting emotional well-being in children (Schmidt et al., 2021). Sleep quality and daily rhythm disturbances are also likely to increase these vulnerabilities, as they appear to impact executive functioning and behaviour in preschool children (Reynaud et al., 2019). By analysing these interconnected physiological and sociopedagogical processes, the current study contributes to a better understanding of how a global health crisis might alter children's local reality. The results may inform prevention strategies to improve the physical development, mental well-being, and early learning of preschool-aged children. From this perspective, COVID-19 might be considered not only a medical challenge but also a cultural change agent that has reshaped collective expectations regarding early childhood in the Central European region in terms of resilience, development, and care.

Sampling and Questionnaire

The questionnaire developed for this study was meticulously crafted to evaluate the physical, cognitive, and social development of preschool-aged children, as well as to elucidate the long-term implications of COVID-19. Conducted at the Heim Pál National Institute of Pediatrics, this nationally representative survey encompassed 1,769 parental responses and provided a comprehensive overview of children's developmental trajectories, health status, behavioural patterns, and daily routines. The survey was conducted anonymously, with each response assigned a unique identifier, and was executed in compliance with GDPR regulations after approval by a research ethics committee.

Its questionnaire was multidisciplinary in character and centred on six education/health priority areas:

- Sociodemographic background: place of residence, family environment and sibling relationships.
- Physical development and health: motor coordination, physical activity, metabolism, cardiovascular status, and risk of obesity.
- Mental and emotional development: attention, emotion regulation, sleep quality, anxiety, and stress tolerance.
- Social and learning skills: Interaction with peers, adaptation to preschool, and integration into community life.
- Post-COVID symptoms include persistent physiological and psychological effects after infection.
- Digital use and distance learning: Daily screen time, device usage patterns, and emerging addiction risks.

The extensive dataset facilitated a nuanced examination of developmental disparities and the identification of children at risk for potential learning challenges, such as special educational needs (SEN) or delayed competence acquisition (DCA). Preliminary findings indicate that variations in motor development, spatial orientation, and emotion regulation are linked to social disadvantage and health vulnerabilities, which have been exacerbated by the pandemic. These associations, which are further analysed in the Analysis section, suggest that disruptions in physical and emotional routines can have quantifiable impacts on the development.

Overall, the survey provided a comprehensive overview of the developmental status of preschool-aged children after post-COVID-19. It offers valuable quantitative data while incorporating observations and insights from parents, who frequently identify significant risk indicators with professional feedback. These findings advocate for preventive interdisciplinary measures that integrate physical activity, emotional support and cognitive development. Collectively, these measures form the foundation for fostering resilience in children and promoting healthy and balanced growth following the pandemic.

Qualitative Analysis

The qualitative analysis employed Charmaz's constructivist grounded theory, a method that is both flexible and systematic in examining how meaning is derived from the participants' lived experiences. This approach does not treat data as static facts; rather, it views them as expressions of social and cultural processes, which are embodied in the ongoing interaction between the researcher and participants' words and interpretations (Rieger & Malthaner, 2018; Urcía, 2021, Reynaud et al., 2019; Akkaya, 2023). The coding process involves several interconnected stages—initial, focused, axial, and theoretical—which collectively enhance the understanding of the experiences narrated and interpreted.

Initial and Focused Coding

During the initial coding phase, the researchers meticulously examined the material line by line, concentrating on the participant details. This process captures the diversity and tone of individual experiences, forming the foundation for subsequent conceptual grouping (Kamath et al., 2021; Davidson et al., 2018). At this stage, the analysis was exploratory and open-ended, with codes emerging directly from participants' language while preserving their local meanings and cultural context.

The subsequent focused coding phase enables researchers to organise these initial codes into broader thematic patterns (Davidson et al., 2018). This phase is inherently iterative, as researchers continuously compare, revise, and occasionally recode data as new insights emerge. The strength of this approach lies in its adaptability; the analysis evolves in dialogue with the data rather than imposing predefined categories, as Barnett-Page & Thomas (2009) has highlighted. This reflexive approach aligns with Charmaz's emphasis on active meaning-making rather than mechanical classification (Braun & Clarke, 2023; Mohajan & Mohajan, 2022).

Collaborative and Comparative Interpretation

Focused coding often involves collaborative reflection within the research team, wherein multiple analysts engage in discussions to compare and contrast their interpretations. This collaborative process ensures that emerging categories accurately reflect participants' voices rather than researchers' assumptions (Charmaz, 2006). This approach enhances the rigor and credibility of the findings. Employing continuous comparative techniques to contrast incidents, themes, and codes further enriched the conceptual framework.

Digital tools, such as NVivo, facilitate the organisation of large volumes of qualitative data and enable the visualisation of relationships between codes and categories (Mohajan & Mohajan, 2022; Charmaz, 2006). However, the emphasis remains on interpretation; while the software aids in this process, the true meaning emerges as researchers continue to engage deeply with the narratives.

Axial and Theoretical Coding

In the final stages of analysis, axial and theoretical coding were employed to examine the interconnections between categories, thereby constructing an interpretive narrative that relates individual experiences to broader social frameworks (Akkaya, 2023; Charmaz, 2006). During this phase, lived experiences were contextualised within cultural and institutional frameworks, allowing theory to emerge organically from the data rather than being externally imposed. The integration of gerund coding, which focuses on actions and processes, further highlighted the dynamic and evolving nature of participants' experiences (Braun & Clarke, 2023; Mohajan & Mohajan, 2022). In our study, this approach illuminated how parents and educators negotiated, adapted, and redefined development in the context of the pandemic experience.

Charmaz's constructivist grounded theory provides a reflexive framework that emphasises flexibility, iteration, and interpretive depth. This framework enabled us to trace participants' statements and analyse how they employed language to rediscover meaning and normalcy amid significant social disruption (Ferreira et al., 2020; Apramian et al., 2016). This approach transcends procedural coding, revealing the human experience and cultural processes of sense-making that are inherent in each narrative.

Table 1. Self-Made Table of Coding

Open codes	Axial codes	Selective codes
Lack of motivation	psychological barriers	behavioural patterns related to physical activity
Positive effects (on health)	perceived results	sense of health, motivation
Social influence	environmental, social factors	social and cultural determinants of activity
Anxiety (about failure)	emotional and cognitive barriers	Mental and emotional barriers to exercise
Accessed from	structural barriers	external barriers to access
Self-assessment	identity and fitness	Self-image related to physical activity
Psychological barriers	perceived barriers	barriers to engagement
extrinsic and intrinsic motivation	motivational drives	external and internal motivation factors
Access and support networks	environmental factors	structural and social impacts of fitness
Habit formation	behavioural adaptation	sustainable training behaviour

Cultural attitudes	social norms	cultural factors on sport choice
Time limits	lifestyle challenges	time management, balanced agenda
Avoidance (exercise)	barriers to participation	inhibitors and facilitators (personality)
Health awareness	personal health awareness	perception-driven health awareness decisions
Social impact on activity	social determinants of activity	community and media impact on fitness
Economic factors	financial, structural constraints	economic barriers to accessibility
Perceived competence	self-efficacy related to physical activity	building confidence and skills in physical activity
Dysfunctional attitude (fear of being judged by others)	Psychosocial pressure	Psychological and social impact on activity levels

Table 2. Self-Prepared Table of Literature Correlations

Risk group characteristic	Justification	Reference (primary source)
Low motivation for physical activity	People with low intrinsic or extrinsic motivation are less likely to participate in sustained physical activity.	*Harris & Cale (2005): Review of children's fitness testing*
Psychosocial barriers (fear, anxiety)	Psychological barriers, such as fear of failure and social anxiety, prevent individuals from participating in physical activity.	*Tortolero et al. (2000): Relationship between physical activity and self-efficacy*
Economic barriers	Financial barriers, such as lack of necessary equipment, can reduce participation.	*Boreham & Riddoch (2001): Fitness and health in young people*
Lack of resources for training	Limited infrastructure or lack of safe outdoor spaces can be a barrier.	*Northern Ireland Fitness Survey (1989): Infrastructure limitations*
Cultural and social norms that do not support physical activity	Cultural expectations, family habits and peer pressure can influence attitudes to physical activity.	*Riddoch (1998): Social and cultural determinants of activity*
Misconceptions about health	Lack of information or misconceptions about the benefits of exercise can lead to lower activity levels.	*Department of Health (2004): Misinformation on exercise benefits*
Lack of time for work or studies	Busy schedules, overwork, excessive performance expectations and responsibilities reduce the time available for physical activity.	*Armstrong & Welsman (1997): Barriers to youth exercise*
Low self-efficacy and confidence in physical abilities	Individuals who are unsure of their physical abilities may be less willing to join structured exercise programmes.	*Biddle (1995): Influence of fitness on psychological health*

Structural Overview of the Questionnaire

The questionnaire comprised responses from 1,769 parents and was designed to assess preschool children's development, lifestyle, and health. These questions encompassed multiple dimensions and employed various response formats.

1. Number and Structure of Questions

The questionnaire contained 258 questions with various response options in different formats.

- Likert-scale questions (e.g. scale from 1 to 10, where 1 = not at all, 10 = completely)

- Dichotomous questions (yes/no answers)
- Multiple-choice questions (e.g. health, exercise habits, eating habits)

2. Main Groups of Questions

- The questions were divided into the following sections:
- Sociodemographic data (e.g. age of child, type of residence, sibling relationships)
- Physical development and health (e.g. high levels of physical activity, stamina, risk of obesity)
- Mental and emotional development (e.g. attention problems, anxiety, emotion regulation)
- Social skills and inclusion (e.g. social interactions, independence)
- Post-COVID effects (e.g. persistent symptoms, health changes after infection)
- Digital device use (e.g. daily screen time, gaming and learning)
- Lifestyle and eating habits (e.g. number of meals per day, regular breakfast)

The Medical Research Group developed the questionnaire through workshops and reviews, which eventually produced a set of multidimensional questions. This allowed the content to reflect professional diversity and real-life experiences, but also required a methodological compromise: the questionnaire reliability decreased with an increasing list of questions.

To assess reliability, we measured the variance and dispersion of individual items and the variance of total scores from aggregated responses. The results showed that internal consistency decreased after the final changes, suggesting that the questionnaire measured several interrelated dimensions instead of one homogeneous construct. They were mainly concerned with issues of social, cognitive, and physical development, as well as COVID, lifestyle, and health impacts.

This multidimensionality hampered the instrument's internal consistency but reflected the complexity of children's lives during the pandemic. The diversity of responses allowed more cultural and social interpretations of human development than could be neatly fitted into a single statistical construct. The dataset had reduced uniformity but was suitable for factor and cluster analyses needed to identify important variables in the heterogeneous data.

Cluster and Pareto Analysis: Identifying Warning Signs

Given the variability observed in the survey, we conducted a cluster analysis to identify natural groupings of responses. This method enabled the identification of coherent clusters of developmental indicators and risk factors despite the instrument's multidimensional nature. To further refine these results, we applied the Pareto principle (the 80/20 rule) to identify subgroups of variables responsible for the majority of developmental issues. The analyses revealed that approximately 80% of the identified problems were attributable to 20% of the variables.

This finding provides an empirical foundation for prioritising interventions, particularly in areas of children's lives where risks and vulnerabilities are most pronounced. The combination of Pareto filtering with Gaussian distribution testing and stepwise scaling facilitated the identification of "red flag" indicators, which are developmental, behavioural, or environmental factors that disproportionately influenced the data. This involved identifying the questions and response patterns most predictive of learning, emotional regulation, and health issues following the COVID-19 pandemic.

By linking statistical concentration with social relevance, the analysis transformed a technical observation—that a small subset explains developmental differences—into diagnostic and cultural insights. This demonstrates that pandemic-related risks are not uniformly distributed but are concentrated in specific social and behavioural contexts. Understanding these warning signs may thus guide targeted interventions, assisting educators, parents, and policymakers in addressing the most critical areas to enhance preschoolers' resilience and well-being.

The three-point red flag scale divides the responses into the following categories:

- VERY IMPORTANT (1-3 values)
- IMPORTANT (4-7 values)
- NOT IMPORTANT (8-10 values)

The classification was determined by analysing the distribution of responses using scale coding aligned with a Gaussian distribution. The results were validated using a method that was both more precise and adaptable than the logistic functions available in Excel. The mathematical and statistical framework for coding the responses was established by applying proportional weighting to normalise the response options as follows:

- Fitted to the Gaussian curve, weights of 0.67, 0.33, and 0.17 were assigned to responses 1, 2 and 0.17 to response 3.
- In the transition range (4-7), the weight distribution decreased steadily.

- For low-importance responses (8-10), the assigned value was set to 0.

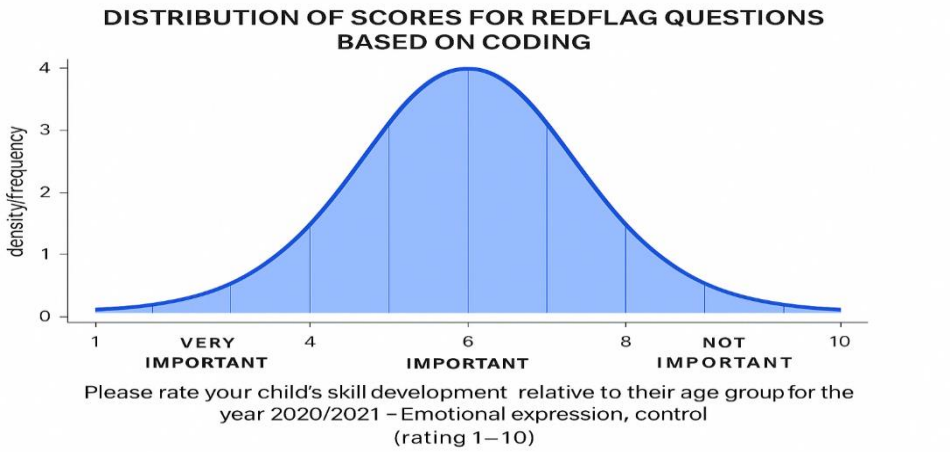

Figure 1: Self-made figure about the Gaussian distribution

This procedure ensured that no arbitrary thresholds were established during data analysis; instead, the actual sample distribution was utilised. Red flag filtering and cluster boundaries were also derived from this distribution, as the coding provided definitive cut-off values to identify questions that posed a particularly high risk, in accordance with the Pareto principle of 20% relevance. By categorising the data on a scale of 1 to 10, we differentiated between typical and atypical respondent groups. Scores pertaining to attention and task retention, social interaction, and learning skills were used to identify high-risk children.

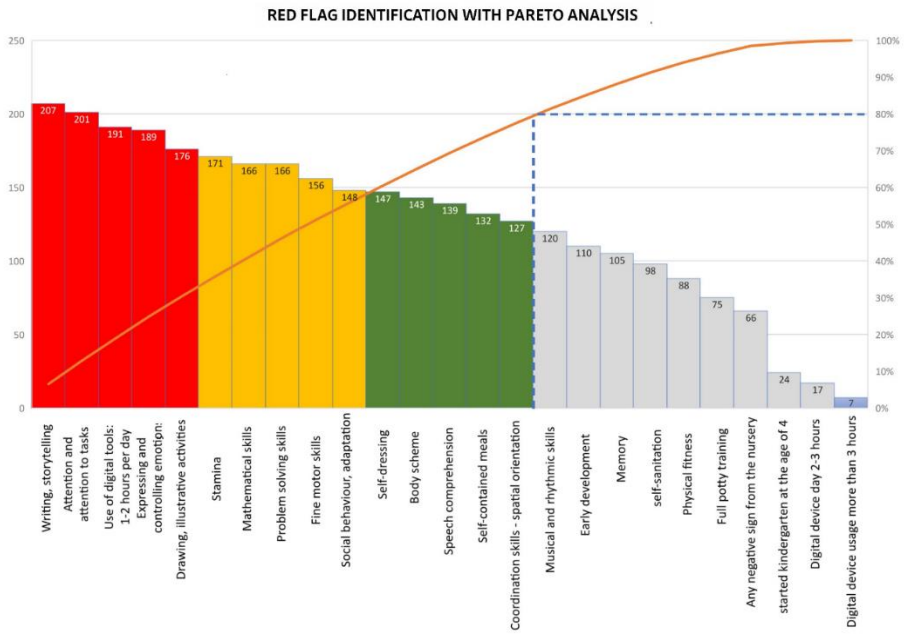

Figure 2: Redflag and Pareto analysis by groups of questions SPSS 21.0

Building on the findings of the preceding cluster analysis, we identified risk groups within the child population and subsequently employed a Pareto analysis to ascertain the primary factors contributing to the majority of developmental disparities. Using the questionnaire data, we delineated three principal risk levels:

- High risk group
- Medium risk group
- Mild risk group

This categorisation has facilitated the development of tailored interventions, particularly for children with severe neurological impairments (SEN, *special educational needs*) and populations experiencing learning and

behavioural challenges. Using Pareto analysis, the following critical areas of concern were identified, demonstrating a significant correlation with various developmental trajectories and the impact of COVID-19.

1. Writing, storytelling (for low scores)
2. Attention and task retention (scores decreased in the 1-7 point range)
3. Digital device use (2 hours or more of use per day is associated with higher risk)
4. Expressing and controlling emotions
5. Drawing, illustrative activity
6. Stamina and physical fitness
7. Decrease in mathematical skills
8. Problem-solving skills
9. Underdevelopment of fine motor movements
10. Social behaviour and adjustment difficulties
11. Lack of independent dressing
12. Poor body schema and spatial orientation
13. Problems of speech understanding
14. Self-meal delay
15. Weak coordination skills

The identified warning signs could be meaningfully linked to the results of the medical research team's physiological studies, which observed somatic, metabolic, and psychological disorders in children. In particular, musculoskeletal and sensorimotor disorders showed a strong correlation with post-COVID-19 effects and significant decrease in physical activity during quarantine. Using the Pareto principle, these patterns made it possible to prioritise the areas at the greatest risk of developmental delay, allowing both medical and educational interventions to be focused on the most affected groups.

- Based on this summary, several areas were identified where targeted development programs are needed.
- Identifying and supporting learning and behavioral difficulties
- Improving movement and motor coordination
- Promoting mental health and emotional self-regulation
- Reducing excessive use of digital devices by educating and raising awareness among families

Cluster and Pareto analyses were integrated to identify developmental risks most prevalent among preschool-aged children. The findings indicate that children with special educational needs (SEN) and those experiencing post-COVID conditions require focused attention in the domains of learning, social functioning, and physical development. A significant advantage of this analytical framework is its precise statistical coding capability. Unlike table-based logical filtering functions that rely on fixed thresholds, this approach derives results from sample distributions.

In accordance with the Pareto principle, the analysis focused on the most critical 20% of variables, which accounted for approximately 80% of the identified issues. This method is both mathematically and conceptually rigorous, yet sufficiently flexible to allow implementation within the same logic as validated scaling techniques, while remaining comparable to statistical models based on Gaussian distributions. The subsequent steps involved data cleaning and preprocessing. Fehling values were systematically addressed, and variables unrelated to the central research focus were excluded to refine the data set.

Patterns and trends in data distributions, as well as associations between post-COVID symptoms, emotional regulation, and learning performance were examined using descriptive statistics. These preliminary results suggest the potential for constructing a multivariate model and facilitating further factor analysis. Subsequently, latent dimensions that elucidated the observed patterns were analysed to gain a more nuanced understanding of interactions across cognitive, physical, and social domains in the developmental experiences of preschoolers, extending beyond mere correlations.

METHODOLOGY, FACTOR ANALYSIS

The primary objective of this project, which also informed the design of the questionnaire, was to examine the cognitive, social, and physical development of preschool children through quantitative data collection. This approach enabled the research team to identify connections across developmental domains, including attention, memory, emotional regulation, and motor coordination.

The volume and complexity of the data necessitated a methodological approach to simplify the data structure while preserving the essential relationships among the variables. Factor analysis was employed to

reduce a large set of observed variables to fewer, interpretable dimensions. This process facilitated the disaggregation of complex developmental information into patterns amenable to analysis and discussion.

The nature of the questionnaire data supported this choice of methodology. The instrument was multidimensional, designed to measure not a single construct, such as a composite IQ, but several distinct yet related abilities in cognitive, social, and physical development. Factor analysis was used to statistically group variables that described latent developmental dimensions. Strong correlations among certain items, such as attention and memory, revealed underlying structures that were not evident from raw responses.

Initial correlation analyses indicated that some questions exhibited overlapping or parallel response patterns, suggesting hidden conceptual relationships between them. Subsequently, factor analysis consolidated these co-moving variables into unified factors, explaining their shared variances within defined limits. This transformation converts seemingly scattered responses into developmental constellations that elucidate how specific skills co-develop in children's learning and adaptation processes.

The substantial volume of data would have been unmanageable using traditional descriptive methods alone. Thus, dimensional reduction via factor analysis provides both analytical clarity and conceptual depth. As noted in the questionnaire design section, some questions encapsulated closely related ideas that were challenging to distinguish in practice, introducing the possibility of redundancy. Factor analysis mitigated this by reducing overlapping items to fewer meaningful dimensions without compromising informational richness.

Importantly, the survey's focus areas—cognitive, social, and physical—did not predetermine the number of dimensions to be measured. Consequently, the resulting factor structure was data-driven and informed by empirical correlations in the responses. The resulting three major dimensions—cognitive, social, and physical—were consistent with the descriptive statistical patterns in the dataset.

This approach provided both statistical utility and a conceptual link between individual-level development and group experiences. Factor analysis revealed how social environments and post-pandemic realities shape children's skills and behaviours. Thus, the methodological choice of factor analysis not only enhanced analytical rigor but also extended its interpretive reach, articulating numerical findings in relation to broader cultural narratives of early development and resilience across Central Europe.

Coding used in Factor Analysis and Prior to Analysis

The original variables in the questionnaire were 53 questions asking about different areas of learning, social, and physical ability, with a choice of short text responses (*e.g. 'improved significantly', 'did not change', " 'got worse'*).

These were first converted to a numerical scale as follows:

- "Significantly improved" 3
- "Better" 2
- "No change" 1
- "Worsened" 0
- "Significantly deteriorated" -1

Factor analysis is limited to processing numerical data, necessitating the conversion of textual values into numerical data. Additionally, missing values require careful handling; thus, in instances where numerical data were absent, missing values were imputed using the median value of the relevant question group to prevent bias in the means. Subsequently, a correlation matrix was constructed to examine whether variations in the question values indicated any correlations.

Specifically, this analysis assessed whether the responses to the questions exhibited any covariation. These findings suggest a relationship between questions and domains, as strongly correlated values for two questions, such as memory and attention, likely indicate a shared association with a cognitive, social, or physical variable.

The relevant factors were identified using the eigenvalue criterion to determine the number of factors to retain in the analysis and identify those with significant explanatory power. The results demonstrated that cognitive, physical, and social factors accounted for most of the variance in the data. The eigenvalue serves as a numerical indicator of the amount of information contained in a factor relative to all variables. Higher eigenvalues for a factor suggest a stronger correlation with the variables, thereby justifying decisions based on this factor. The eigenvalue represents the variance explained by a factor in the dataset.

According to Kaiser's criterion, only factors with eigenvalues greater than 1 were retained. Under this rule, a factor with an eigenvalue less than 1 provides less information than a single original variable and is thus deemed irrelevant for data analysis and is not retained. The eigenvalue is derived from the correlation/covariance matrix, which requires the calculation of the data correlation matrix, followed by the determination of the eigenvalues/eigenvectors of the R matrix.

Mathematically, the eigenvalue ( ) is derived from the following equation:

R = correlation matrix of variables
λ = eigenvalue
I = unit matrix
v = eigenvector (eigenvector)

$$(R - \lambda I)v = 0$$

The eigenvalue is instrumental in determining the requisite number of factors, thereby obviating the need for manual selection or justification of factor retention. This approach autonomously identifies factors of genuine significance, effectively excluding those that are noisy and irrelevant because factors with low eigenvalues frequently encompass random variance devoid of substantive information. Consequently, this method enhances analytical efficiency by reducing data dimensionality, allowing for a concentrated focus on a smaller number of factors.

Correlation Analysis

The correlation matrix employed in this study serves as a symmetric table that illustrates the strength and direction of the correlation between the variables. This matrix was computed during the preparation phase of the factor analysis to identify the questions that exhibited a strong interrelationship. Consequently, the correlation quantifies the extent to which two variables co-vary in the questionnaire responses. It is important to note that this constitutes a statistical analysis and may not necessarily reflect the true meaning of the questions. Therefore, these results should be interpreted cautiously. In our study, we used Pearson's correlation coefficient.

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{(X_i - \bar{X})^2 \cdot \sqrt{(Y_i - \bar{Y})^2 \cdot}}}$$

Y_i, X_i: values of each variable
$\overline{Y;X}$: mean of the variables
The denominator contains the standard deviations that ensure that the result remains between -1 and +1.
+1 perfect positive correlation (if one increases, the other increases)
0 no relationship between the two variables
-1 perfect negative correlation (if one increases, the other decreases)
Pearson's correlation coefficients were calculated for all pairs of variables and arranged in a matrix.

Example:

	Attention	**Memory**	**Social skills**
Attention	1	0,72	0,45
Memory	0,72	1	0,51
Social skills	0,45	0,51	1

Explanation:

To 0.72, indicating a strong positive correlation between memory and attention.
0.45, indicating a moderate relationship between social skills and attention.

For factor analysis, it is essential to group the variables that move strongly together into a common factor. This requires an understanding of which questions are strongly correlated, as they may be common factors.

Example:

- Memory, attention, and mathematical ability are highly correlated and probably measure the same hidden dimension (factor).
- If there is a weak correlation between fine motor skills and rule-keeping, they measure different dimensions of development. Therefore, we grouped them separately for analysis.

Therefore, the correlation matrix is the first step in identifying questions that belong to the same factors.

Factor Analysis

Based on the description above, we created a correlation matrix to identify the questions that moved together.

Question	**Factor 1** ***(Cognitive)***	**Factor 2** ***(Social)***	**Factor 3** ***(Physical)***
Memory	**0.72**	0.15	0.05
Attention	**0.68**	0.12	0.03

Mathematical skills	**0.75**	0.08	0.02
Compliance with rules	0.10	**0.80**	0.12
Empathy	0.05	**0.77**	0.10
Movement coordination	0.03	0.08	**0.78**
Fine motor skills	0.02	0.07	**0.69**

In the next step, we determined the number of factors based on eigenvalue calculations. To do this, we used the eigenvalue (>1) criterion, which showed the number of relevant factors behind the data.

- Factor 1: Cognitive skills
- Factor 2: Social skills
- Factor 3: Physical skills

To interpret the factors, we considered those questions that had a higher weight for a given factor (*memory, attention and mathematical skills belong to the cognitive factor, because they have a higher factor weight, ≥0.7*)

Next, for each child, we calculated each factor using the following formula:

$$F_k = w_1x_1 + w_2x_2 + \ldots w_nx_n$$

F_k: child factor values

w_n: factor weight for each question

x_n: the child's answer to a given question in numerical form

An example of calculating the factor value of a 5-year-old child is as follows:

$$(0{,}72 \cdot 2) + (0{,}68 \cdot 2) + (0{,}75 \cdot 1) + (0{,}70 \cdot 2) = 1{,}44 + 1{,}36 + 0{,}75 + 1{,}40 = 4{,}95$$

This was calculated for all 5-year-old children and then averaged to obtain the factor value for that age group.

RESULTS

The factor weights calculated based on the previous principles are as follows:

Factor 1 - Cognitive abilities

Memory: 0.72
Attention to detail: 0.68
Mathematical skills: 0.75
Problem solving: 0.70
Speech understanding: 0.67
Writing, storytelling: 0.65

Factor 2 - Social and Emotional Skills

Social behaviour, adaptation: 0.80
Expressing and controlling emotions: 0.77
Social contacts with other children: 0.72
Compliance with rules: 0.74
Conflict management: 0.70

Factor 3 - Physical and Motor Skills

Large movements (running, jumping): 0.78
Fine motor skills
(drawing, writing-preparation): 0.69
Coordination skills: 0.73
Stamina: 0.71

In the analysis, we examined how cognitive, social, and physical factors varied between boys and girls and between children of different ages.

Differences by Sex

Cognitive factor (Factor 1)

Boys: Average factor score 0.68, standard deviation 0.21

Girls: average factor score 0.74, standard deviation 0.18

Social factor (Factor 2)

Boys: Average factor score 0.52, standard deviation 0.25
Girls: average factor score 0.78, standard deviation 0.19

Physical factor (Factor 3)

Boys: Average factor score 0.82, standard deviation 0.15
Girls: average factor score 0.69, standard deviation 0.17

Differences by Age

Children Aged 3-4

Cognitive factor: 0.55
Social factor: 0.62
Physical factor: 0.71

Children Aged 5

Cognitive factor: 0.72
Social factor: 0.74
Physical factor: 0.79

Children Aged 6-7

Cognitive factor: 0.85
Social factor: 0.81
Physical factor: 0.83

DISCUSSION

The findings of this study reveal more than a set of developmental scores; they represent a broader redefinition of early childhood in post-pandemic Central Europe. The consistent increase in cognitive, social, and physical factor values with age confirms that children's capacities have recovered and expanded over time. Beyond the numerical patterns, these results point toward a collective process of cultural repair in which families, educators, and communities have reimagined what it means to grow, learn, and connect in uncertain conditions (Berger & Luckmann, 1966; Beck, 1992).

Resilience as a Cultural Value

Across various domains, this study identified resilience as the central interpretive theme. Statistically, this is evidenced by consistent age-related improvements across factors; conceptually, it reflects the moral and emotional frameworks through which parents and educators interpret children's progress (Schmidt et al., 2021; de Araújo et al., 2021). The ability to "persist", "adapt", or "self-regulate", as articulated in parental narratives, emerged as a symbolic indicator of recovery and strength in the study.

From a cultural sociology perspective, this shift aligns with what Beck (1992) and Giddens (1991) described as the individualisation of responsibility: modern societies increasingly expect individuals—and, by extension, families—to manage risk and uncertainty. In the aftermath of COVID-19, resilience has become a moral expectation embedded in everyday discourse on child development. While this narrative empowers families to perceive adaptation as progress, it also risks obscuring the structural inequalities that limit children's access to supportive environments (Mulkey et al., 2023).

Educational Adaptation and Social Reconstruction

In educational settings, these cultural dynamics translate into new priorities for the pedagogy of early childhood. The data suggest that emotional regulation and cooperative behaviour—central elements of the social factor—have become key indicators of school readiness, replacing earlier emphasis on academic precocity. This echoes the "whole child" paradigm gaining prominence in European education, which values emotional literacy and relational competence, alongside cognitive performance (James & Prout, 1997; Molnár & Hermann, 2023).

Teachers and institutions now operate in a moral landscape that prizes empathy, self-control, and collaboration as much as numeracy and literacy do. This transformation may reflect both the pedagogical lessons

of the pandemic—the recognition that emotional security underpins learning—and the broader cultural evolution of parenting norms, in which nurturing adaptability is seen as an essential form of care (Douglas, 1966).

Inequality and the Limits of Resilience

However, resilience is not equally distributed. Data show that children with SEN and those affected by post COVID symptoms remain at high risk across cognitive and physical domains. These patterns reflect the disadvantages that occur when health, social, and educational systems are stressed (Ng et al., 2021).

The concentration of developmental risks within subgroups agrees with the Pareto results: a small subset of variables - and thus, by extension, a small subset of children–accounts for most of the observed difficulties. This suggests that targeted interventions require medical, psychological, and pedagogical expertise. However, this challenges educational systems to deal with structural inequities instead of treating adaptation as an individual responsibility.

Cultural Meanings of Movement and Embodiment

Findings related to physical factors suggest that the body serves as a locus of growth and meaning. The enhancement of motor coordination and endurance reflects both biological maturation and symbolic reclamation of freedom following confinement (Douglas, 1966). Parents characterized their children's newfound activity as "having energy back" or "being alive again."

These expressions illustrate the interconnection between physical development and emotional well-being, underscoring that the pandemic experience was not solely mediated cognitively or socially but was also embodied (Reynaud et al., 2019; Schmidt et al., 2021). In this context, motor progress may signify more than mere school readiness; it represents a collective recovery and demonstrates how the cultural meanings of vitality and resilience are inscribed onto children's bodies through play and movement..

SUMMARY

The principal objective of the factor analysis was to explore the cognitive, social, and physical abilities of preschool-aged children and identify meaningful patterns emerging from these domains (de Araújo et al., 2021; Mulkey et al., 2023). Each factor reflects a distinct yet interconnected dimension of early development, offering a comprehensive view of how learning, sociability, and physical competence evolve during the preschool years.

Cognitive Factor: The Growth of Attention and Understanding

The cognitive factor encompasses the interrelationships between memory, attention, and emerging mathematical skills, all of which have been demonstrated to develop rapidly during the preschool period (Schmidt et al., 2021). According to Reynaud et al., age-related factor scores generally increase along the typical trajectory of cognitive maturation (Molnár & Hermann, 2023). The mean factor score for the youngest age group (3-4 years) was 0.55, indicating that sustained attention and task retention were still in the developmental phase. By age five, the mean cognitive factor increased to 0.72, suggesting enhanced attention and working memory. This pattern reflects a shift from externally guided attention to autonomous learning (Bruner, 1990). At six to seven years of age, the mean cognitive score reached 0.85, a level associated with school readiness (Perrigo et al., 2025). These data indicate that preschool children are increasingly prepared for sustained reasoning and logical problem-solving, which are essential capacities for formal education.

Gender differences were also observed: girls averaged 0.74 and boys averaged 0.68. Girls exhibited superior memory and attentional stability, whereas boys demonstrated greater variability, findings that are consistent with previous developmental studies (Ng et al., 2021; Schmidt et al., 2021). Early mathematical reasoning did not exhibit gender gaps.

From a cultural perspective, these results suggest that cognitive development is both biologically and socially mediated. Family routines, digital exposure, and altered learning environments during the pandemic may have reshaped how attention and memory are practiced in daily life (Beck & Beck-Gernsheim, 2002; Giddens, 1991).

Social Factor: Learning Empathy and Belonging

The social factor measured behavioural adaptability, empathy, and emotional regulation, which are core competencies for cooperative learning (James & Prout, 1997). The factor values showed a clear age-related progression. For the youngest group (3–4 years), the average score was 0.62, reflecting a limited ability to follow shared rules or sustain emotional balance. By age five, the mean rose to 0.74, indicating growing social awareness and increased peer cooperation. Older children (6–7 years) reached 0.81, suggesting that empathy and conflict management have stabilised (Schmidt et al., 2021).

Gender differences were again marked: girls scored 0.78 and boys scored 0.52. Girls exhibited stronger emotional control and adaptability, an effect often linked to the earlier maturation of affective self-regulation (Schmidt et al., 2021).

From a sociocultural perspective, these gains can be understood as part of a cultural initiation process—the gradual internalisation of empathy, cooperation, and responsibility that prepares children for life in a community (Berger & Luckmann, 1966; Douglas, 1966). Although pandemic restrictions temporarily interrupted peer interactions, the data suggest that most children quickly regained these capacities once everyday social life resumed.

Physical Factor: Movement as Freedom and Mastery

Physical factors included motor coordination, endurance, and fine motor control, as determined by parental observation and medical input (Mulkey et al., 2023). For three-to four-year-olds, the mean score was 0.71, indicating ongoing motor consolidation. By age five, this was 0.79, and by six to seven years, it was 0.83, nearing the expected developmental plateau.

Gender variation occurred as usual: boys averaged 0.82, girls 0.69, in keeping with studies that showed greater gross-motor activity in boys but finer fine-motor precision in girls (Ng et al., 2021).

Movement has cultural and psychological meanings beyond the physiological dimension. Physical freedom represents the recovery of the body and the community after a period of restraint (Douglas 1966). As families regained outdoor spaces and children regained bodily play, increased physical factor scores represented both maturation and social healing and the renewal of vitality.

Implications for Policy and Practice

These findings have implications for educational practices and policies. First, early childhood programs should include mental health/emotional literacy components within standard curricula and ensure that learning environments promote self-regulation and social confidence.

Second, medical-educational partnerships are essential for monitoring and supporting children with chronic post-COVID complications.

Third, digital literacy programs should address concerns about screen time consumption while embracing technology for inclusive, adaptive learning (Ng et al., 2021).

They are in line with the growing awareness that education involves more than just transmitting knowledge; it involves reestablishing community and trust after collective disruption (Bruner, 1990).

Broader Cultural Reflection

Ultimately, this study contributes to the understanding of early childhood as a mirror of broader social transformations. The interplay of cognitive, social, and physical recovery demonstrates how children's development encapsulates the moral and emotional recalibration of post-pandemic society. The rise in factor scores across all domains can thus be read as a cultural narrative of renewal, in which learning, empathy, and bodily vitality become shared symbols of resilience and hope (Beck & Beck-Gernsheim, 2002; de Araújo et al., 2021).

Early childhood, viewed through this lens, is not only a stage of biological growth but also a moral horizon—a space where societies negotiate the kind of future they wish to rebuild.

Integrative Interpretation

Together, these three factors—cognitive, social, and physical—form a multidimensional picture of preschool development. Their parallel age-related increases reveal both biological growth and the social reconstruction of childhood following the COVID-19 pandemic (Beck, 1992; de Araújo et al., 2021). These findings highlight how learning, empathy, and movement interact as facets of resilience: thinking, feeling, and acting are recovered together.

LIMITATIONS

This study has several limitations. First, although the sample of 1,769 parents offers a robust foundation for statistical and interpretive analysis, the data were derived from parental self-reports, which are vulnerable to subjective perceptions, recall bias, or cultural expectations regarding children's behaviour. The inclusion of direct observational and/or longitudinal data would enhance the reliability of the developmental trajectories described in this study. Second, although the questionnaire encompassed multiple domains of development, it exhibited moderate internal consistency due to its multidimensional nature. This heterogeneity reflects the complexity of preschool development but constrains the precision of the factor scores across domains.

Future research should incorporate standardised psychological and physiological measures to triangulate these findings. Third, the results were geographically concentrated in Central Europe, potentially limiting their generalisability. Cultural factors influencing family routines, education systems, and pandemic responses may affect developmental patterns differently in different regions. Consequently, comparative cross-country analyses are necessary to confirm the generalisability of the observed trends. Finally, although the integration of quantitative and qualitative findings provides depth, it remains exploratory.

Further longitudinal and ethnographic studies should examine the conceptual links between developmental factors and broader cultural narratives of resilience. Nonetheless, this study constitutes a significant empirical and interpretive foundation for understanding how pandemic-related disruptions have redefined early developmental meaning in contemporary societies.

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