

# Changes in social behavioral developmental risks in preschool children after the first COVID-19 wave – results from a prospective cohort study

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## Article

**Keywords:** COVID-19, social behavior, preschools, developmental risks, social inequalities

**Posted Date:** June 16th, 2022

**DOI:** <https://doi.org/10.21203/rs.3.rs-1745763/v1>

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**Additional Declarations:** No competing interests reported.

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**Version of Record:** A version of this preprint was published at Scientific Reports on April 6th, 2023. See the published version at <https://doi.org/10.1038/s41598-023-32877-x>.

## Abstract

Since the outbreak of the COVID-19 pandemic, in many countries preschool and school closures were common, especially at the beginning of the pandemic. The impact of the pandemic on developmental risks in the social-emotional domain of preschool children is largely unknown. In this prospective dynamic cohort study social behavioral developmental risks were longitudinally assessed with the "Dortmund Developmental Screening for Preschools (DESK 3-6 R)". Therefore, DESK 3-6-R data from 3-year-olds at survey wave 3 (DESK-R-SW3, 2019) and 4-year-olds at survey wave 4 (DESK-R-SW4, 2020) were used. In addition, data assessed in previous survey waves were analyzed to contextualize the observed changes. A total of  $N=786$  children were included in the analysis. In DESK-R-SW3 the proportion of children with social behavioral developmental risks/inconclusive findings was 18.2%, whereas in DESK-R-SW4 the proportion decreased to 12.4%. The prevalence rate ratio (PRR) was therefore 0.68 ( $p=0.001$ ). Compared to data from the previous survey waves (PRR=0.82; PRR=0.88), this result represents a notable improvement. No deteriorations in the prevalence of preschoolers' social behavioral development risks after the first COVID-19 wave could be observed. The results are discussed in the framework of the pandemic situation in the study region and the current literature.

## Introduction

Since the outbreak of the COVID-19 pandemic in March 2020, the lives of many people have drastically changed, with children in particular being affected in their daily lives by preschool and school closures and limited childcare options. In Germany, emergency child care services were offered to preschool children of parents with system-relevant occupations. For instance in Mecklenburg Western-Pomerania, the percentage of preschools that provided such services ranged between 0–15% (March until April 2020) and 15–77% (May until June 2020), respectively<sup>1</sup>. Regular operation of preschools was not possible until August 2020.

Several studies were initiated with a focus on transmission of SARS-CoV-2 and effects of hygiene measures among children<sup>2,3</sup>. However, little is known about the impact of the pandemic on developmental risks in preschool children. In particular, the promotion of social-emotional competencies in preschools is crucial for later school success and contributes to the reduction of social inequalities<sup>4-7</sup>. Therefore, the loss of pedagogical promotion of children's competencies in preschools might especially increase the prevalence of developmental risks in the social-emotional domain.

With regard to the effects of the lockdown on social-emotional competencies of preschool children, studies found that internalizing as well as externalizing problems significantly increased<sup>8</sup>. The subgroup of preschoolers who met the World Health Organization recommendations for physical activity had lower internalizing scores than non-active peers<sup>8</sup>. Most parents and children experienced lockdown-related stress and especially single parenthood and being an only child were associated with higher levels of child problems, e.g. more emotional symptoms<sup>9,10</sup>. Children and adolescents are more likely to experience high rates of depression and anxiety during and after enforced isolation<sup>11,12</sup>. Browne et al. showed that the mental health of Canadian preschool- to school-aged boys in early childhood education significantly deteriorated after the onset of the pandemic<sup>13</sup>. One study by Specht et al. showed a modest decrease in child-emotional behavioral functioning during the COVID-19 lockdown, potentially due to parental stress<sup>14</sup>. Another longitudinal study from Japan examined the social-emotional behavior with the Strengths and Difficulties Questionnaire (SDQ) of 4-6-year-old preschoolers during the first COVID-19 wave compared to after preschool closure and found no significant differences in preschoolers' socio-emotional behavior<sup>15</sup>. Shum et al. longitudinally examined psychosocial difficulties in 2-5-year-old preschool children from North West England starting mid-April to July 2020 and found no significant differences one month later<sup>16</sup>. Interestingly, in another study with the same study setting, the authors found an increase in socio-emotional difficulties in primary school aged children, and mixed results in secondary school-aged children: an increase in restlessness/attention difficulties, a decrease in emotional difficulties, and no change in behavioral difficulties<sup>17</sup>. When comparing the SDQ in preschoolers before (January 2020) versus during restrictions (May 2020), a Finnish study with a very small sample size ( $n = 22$ ) showed no longitudinal changes in the scales emotional and behavioral difficulties, hyperactivity, and peer relationship problems, however, prosocial skills were significantly reduced<sup>18</sup>.

Despite some lessons learned, most studies to date have not analyzed longitudinally assessed data before Corona in preschool-aged children, or questionnaires were completed by parents only<sup>8,9</sup>. Most studies in Europe with regard to the effects of the first COVID-19 wave on mental health, health behavior, and well-being were restricted to adolescents and children of school age<sup>19-22</sup>.

The main aim of this study is therefore to analyze changes in preschoolers' social-emotional developmental risks by comparing child-specific data assessed in 2019 before Corona with data assessed in 2020 after the first COVID-19 wave. In addition, data from previous survey waves (2017/2018 and 2018/2019, respectively) were examined to contextualize the changes in preschoolers' social-emotional developmental risks.

## Methods

### Instrument

Developmental risks were assessed using the revised “Dortmund Developmental Screening for Preschools (Dortmunder Entwicklungsscreening für den Kindergarten, DESK 3–6 R)”. The DESK 3–6 R is an age-specific, standardized, reliable and valid instrument to monitor the developmental risks of 3- to 6-year-old preschool children in the domains of motor, linguistic, cognitive and social development<sup>23–25</sup>.

The DESK 3–6 R is designed in three age versions (one for 3-year-olds, one for 4-year-olds and one for 5-to-6-year-olds) with respective competence domains (see Table 1). It is taken into account that competencies differentiate and develop with each age group.

Table 1  
DESK 3–6 R competence domains covered according to age group

3-year-old children	4-year-old children	5-6-year-old children
Fine motor skills	Fine motor skills	Fine motor skills
Gross motor skills	Gross motor skills	Gross motor skills
Social behavior	Social behavior	Social competence
		Social interaction
Cognition and language	Language and communication	Language and communication
		Basic competence written language
	Cognition	Attention and concentration
		Basic competence mathematics

The DESK 3–6 R is completed by the pedagogical staff. There are different task formats applied in the DESK 3–6 R, such as observational tasks, group play tasks and individual tasks. It is advisable that the preschool teacher who knows the child well assesses the DESK 3–6 R. Scores are calculated from the respective tasks, which are transformed to "stanine" (standard nine) values per domain using norm tables, ranging from 1–9 points. The norm tables for the 3-4-year-olds are available at half-yearly age intervals, so that these additionally take age differences within the group into account (age-adjusted). A stanine value of 1 represents a conspicuous result (corresponding to the 1st-4th percentile of the norm sample) and a stanine value of 2 represents an inconclusive result (i.e. 5th-11th percentile). A conspicuous result implies that an expert (e.g. by a pediatrician) should be consulted to further examine the child for a developmental risk. If the result is inconclusive, the DESK 3–6 R should be repeated at a later time point. Furthermore, stanine values of 3–9 (i.e. 12th-100th percentile) indicate normal development.

The domain social behavior is included in DESK 3–6 R for 3-year-olds and 4-year-olds and consists of nine observation tasks in both age versions, which differ between the age versions (see Table 2). The response options are often/very often, sometimes, and rarely/never. Each task that was met with often/very often corresponds to one screening point, whereas the other response options correspond to zero screening points. A maximum of 9 screening points can be achieved. Regarding the domain social behavior, the DESK 3–6 R has an inter-rater reliability between 69.2% (DESK 3–6 R for 3-year-olds) and 88.2% (DESK 3–6 R for 4-year-olds) and is reliable with a Cronbach's alpha of  $\alpha = 0.91$  (DESK 3–6 R for 3-year-olds) and  $\alpha = 0.77$  (DESK 3–6 R for 4-year-olds), respectively. Furthermore, the DESK 3–6 has proven valid as a screening instrument<sup>26</sup>. Results in the DESK domain “social behavior” are strongly associated with subscales of the Strengths and Difficulties Questionnaire (SDQ)<sup>27</sup>, e.g. in 3-year-olds with the SDQ-subscale “emotional symptoms” ( $r = -0.41$ ;  $p < 0.01$ ) and in 4-year-olds with the SDQ-subscale “hyperactivity-impulsivity” ( $r = -0.59$ ;  $p < 0.01$ ).

Table 2  
Translated observational tasks for the domain social behavior for 3-year-olds and 4-year-olds

No.	Tasks for 3-year-olds	Tasks for 4-year-olds
1	Turns to reference person in the preschool.	Plays constructively and builds up something without immediately destroying it again.
2	Speaks of him- or herself in the first-person.	Puts away the things after playing with them, if necessary after being asked to do so.
3	Can differentiate between boys and girls.	Follows the rules of age-appropriate games (board games, card games).
4	Judges the behavior of other children.	Reacts adequately to emotional expressions of other children.
5	Plays together with two children.	Takes an active role in role games.
6	Puts away the things after playing with them, if necessary after being asked to do so.	Has a temporary (over a few weeks) friendship with another child.
7	Knows different places and names them correctly.	Considers wishes of other children.
8	Says his or her name and knows where he or she lives.	Has the confidence to approach other children on his or her own.
9	Develops play themes with animal characters or dolls.	Wait for his or her turn.

## Study design

In this prospective dynamic cohort study, the data were collected as part of the project "Evaluation of the targeted individual promotion in preschools in Mecklenburg-Western Pomerania (GIF M-V)". The project was initiated in 2011 as part of the evaluation of the federal state law for children's day-care and preschools in Mecklenburg-Western Pomerania (Kindertagesförderungsgesetz – KiföG M-V) and is funded by the Ministry for Social Affairs, Integration and Equality. The primary aim of this project is to identify children with developmental risks at an early stage so that they can receive targeted, tailored, individualized and child-centered support conducted by the pedagogic staff of their preschool, based on reliable information from a scientifically recognized instrument, namely the DESK 3–6 R. To this end, an annual developmental screening is carried out in preschools in economically deprived areas.

The study was approved by the ethics committee of the University Medicine Greifswald (BB109/11). All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

## Study region

Mecklenburg-Western Pomerania is the north-easternmost federal state in Germany. The unemployment rate with 7.8% is higher than in most other German states (as of 2020, national average: 5.9%)<sup>28</sup>. As such, Mecklenburg-Western Pomerania has the third highest unemployment rate in Germany in 2020<sup>28</sup>. One in five residents in Mecklenburg-Vorpommern was at risk of poverty in 2019 (19.4%, national average: 15.9%)<sup>29</sup>. The proportion of children attending preschool among 3- to 6-year-olds is 95.6% (2020), the second-highest attendance rate in this age group in all of Germany<sup>30</sup>.

With regard to the first COVID-19 wave, Mecklenburg-Western Pomerania was the first German state to introduce restricted regular preschool operation and had one of the highest preschool return rates<sup>1</sup>. As of August 01, 2020, a further opening step has been taken with the introduction of regular operation under pandemic conditions<sup>31</sup>. Thereby, open or partially open childcare programs were permitted, but only in separate, consistent subareas with up to 100 children, whereby the same children were assigned to one pedagogical staff. If possible, the groups should be assigned to fixed rooms.

## Implementation of the project

Each year, the Ministry for Social Affairs, Integration and Equality provides the evaluation team a list of participating DESK-preschools. Those DESK-preschools were selected according to an above-average proportion of parents in a given region, whose parental fees were subsidized by the youth welfare offices. In 2020, N = 152 DESK-preschools were eligible for support based on the federal state law, which represents a proportion of 14% of all preschools in Mecklenburg-Western Pomerania<sup>32</sup>. The preschools participate over a period of at least three years. The preschools can use the annual financial support from the ministry for pedagogical support of the children (preferably for additional staff hours<sup>33</sup>).

The annual implementation of the DESK 3–6 R is required by law for the participating preschools. The parents are asked to give their written informed consent for the data to be forwarded to the project team. This is voluntary. For this project, standardized privacy statements were

developed in accordance with the GDPR (General Data Protection Regulation) requirements, as well as a parent information sheet. The consent to forward the data can be revoked at any time with effect for the future. From the time of revocation, the data will no longer be processed. There are no disadvantages in case of non-participation. The consent forms remain in the preschools.

Pedagogical staff at each participating preschool receive training upon enrollment in the project. Subsequently, they annually conduct the DESK 3–6 R from beginning of May until the end of November among all 3-6-year-old children (referred to as one survey wave).

The pedagogical promotion of social-emotional competencies in the participating DESK-preschools in general, but also especially for children with developmental risks is complex. The contents of the intervention in the domain of social behavior have a designated focus on the promotion of social competencies and use standardized programs and/or cooperate with external specialists for this purpose. The program content focuses on strengthening self-confidence, interacting with peers through games, and reflecting and communicating emotions.

## Data management and Data protection

The pseudonymization and longitudinal matching of DESK 3–6 R data for each child is carried out before the actual data evaluation in the Independent Trusted Third Party of the University Medicine Greifswald using the ID Management solution E-PIX (Enterprise Identifier Cross Referencing)<sup>34</sup>. E-PIX enables unique participant management and efficient aggregation of research data<sup>35,36</sup>. For child-related evaluations, the child-related data of the subsequent survey years must be reliably linked to each other for this purpose. Therefore, pseudonyms (Master Patient Index (MPI-ID)) are generated that do not change over time, including surname, name, birth date, gender, and preschool ID. This procedure allows, for example, to clearly assign DESK 3–6 R data from one survey year to DESK 3–6 R data from the following survey year and to compare the results from both years on a child-specific level. After linkage, data is provided for analysis in a pseudonymized format. Thus, it is not possible for the project staff to identify the respective child. All identifying information is stored in the Trusted Third Party of the University Medicine Greifswald.

## Data analysis and statistical methods

For the longitudinal analysis DESK 3–6 R data from 3-year-olds at survey wave 3 (DESK-R-SW3, conducted in 2019) and 4-year-olds at survey wave 4 (DESK-R-SW4, conducted in 2020) were used, each during the period from beginning of August to end of November, since regular preschool operation started on August 01, 2020, in Mecklenburg-Western Pomerania concomitantly with the end of the first corona wave. Missing values were excluded from the analysis. Stanine values of 1–2 were grouped into the developmental risk/inconclusive finding category, whereas stanine values of 3–9 were categorized as normal development.

In addition, as supplemental analyses, data from 3-year-old children at survey wave 1 (DESK-R-SW1, conducted in 2017) were longitudinally compared with data from 4-year-old children at survey wave 2 (DESK-R-SW2, conducted in 2018), and data from 3-year-olds at survey wave 2 (DESK-R-SW2) were compared with data from 4-year-olds at survey wave 3 (DESK-R-SW3). Here, the same methodology as described above was applied.

For descriptive data analysis, absolute and relative frequencies are reported for nominal variables, and the median and 25th and 75th percentiles are reported for ordinal variables. For the calculation of the prevalence rate ratio (PRR) the proportion of children with developmental risks/inconclusive findings in DESK-R-SW4 was divided by the proportion of children with developmental risks/inconclusive findings in DESK-R-SW3. Thereby, a PRR < 1 indicates that the proportion of children between DESK-R-SW3 and 4 with “developmental risk / inconclusive finding” decreased, whereas a PRR > 1 indicates that the proportion has increased. A PRR = 1 indicates no change between the two survey waves. The PRR is reported with its 95% confidence interval.

Additionally, we calculated the ratio of the rate of improvements (developmental risk/ inconclusive finding at DESK-R-SW3, normal development at DESK-R-SW4) divided by the rate of deteriorations (normal development at DESK-R-SW3, developmental risk/inconclusive finding in DESK-R-SW4). Thereby, the number of children with improvement was divided by the number of all children with a developmental risk/inconclusive finding at DESK-R-SW3 and compared to children with deterioration divided by all children with normal development at DESK-R-SW3<sup>37</sup>. A ratio > 1 indicates that the rate of improvements is higher than the rate of deteriorations, whereas a ratio < 1 indicates that the rate of improvement is lower than the rate of deteriorations.

For longitudinal univariate analysis Mc-Nemar (for categorical variables) test was applied. A *p*-value of *p* < 0.05 was considered statistically significant.

IBM SPSS Statistics (Version 28, IBM, Armonk, USA) was applied for statistical analysis, and STATA (Version 14.2, StataCorp, College Station, USA) was used to calculate the prevalence rate ratio. The stanine values were calculated using the SAS statistical software package (Version 9, SAS Institute Inc., Cary, USA).

## Results

### Developmental risks in the domain social behavior before Corona and after first COVID-19 wave

In DESK-R-SW3 and DESK-R-SW4,  $N = 152$  preschools participated in the project. In DESK-R-SW3,  $N = 1,434$  3-year-old children participated in DESK during the period from early August to late November, whereas in DESK-R-SW4,  $N = 1,709$  4-year-olds participated. Longitudinally assessed data at DESK-R-SW3 and DESK-R-SW4 for the domain social behavior were available for  $N = 786$  children (see Fig. 1).

Consequently, at the time of DESK-R-SW3, children were 3 years old and at the time of DESK-R-SW4, children were 4 years old. Figure 2 shows the monthly distribution of DESK completion for the two survey waves (for the included children in this study only).

In DESK-R-SW3 (before Corona) the proportion of children with developmental risks/inconclusive findings was 18.2%, whereas in DESK-R-SW4 (after Corona) the proportion of children with developmental risks/inconclusive findings was 12.4% (see Table 3). Accordingly, a decrease in the prevalence rate of developmental risks/inconclusive findings was observed when comparing pre-Corona to during Corona. The prevalence rate ratio is 0.68 (95% CI [0.54, 0.87],  $p = 0.001$ ).

Table 3

Categorized changes of results in the DESK domain "Social behavior" from DESK-R survey wave 3 (DESK-R-SW3; conducted in 2019) to DESK-R survey wave 4 (DESK-R-SW4; conducted in 2020) ( $N = 786$ )

Social behavior		DESK-R-SW4			PRR	95% CI	$p$ -value	Ratio of the rate of improvements <sup>1</sup> divided by the rate of deteriorations <sup>2</sup>
		No finding	Developmental risk / inconclusive finding	Total				
		n (%)	n (%)	n (%)				
DESK-R-SW3	No finding	600 (76.3)	43 (5.5)	643 (81.8)	0.68	[0.54–0.87]	0.001	9.31
	Developmental risk / inconclusive finding	89 (11.3)	54 (6.9)	143 (18.2)				
	Total	689 (87.6)	97 (12.4)	786 (100)				

Note: CI = confidence interval; PRR = Prevalence rate ratio; DESK-R-SW3 = DESK-R survey wave 3; DESK-R-SW4 = DESK-R survey wave 4; <sup>1</sup>Improvements: risk at DESK-R-SW3, no risk at DESK-R-SW4; <sup>2</sup>Deteriorations: no risk at DESK-R-SW3, risk in DESK-R-SW4

Furthermore, 76.3% of all children showed no findings in both survey waves, while 6.9% of the children consistently showed developmental risks/inconclusive findings. 11.3% of the children improved (i.e. children with developmental risks/inconclusive findings in DESK-R-SW3 who had no findings in DESK-R-SW4), whereas 5.5% of the children deteriorated (no findings in DESK-R-SW3 but developmental risks/inconclusive findings in DESK-R-SW4). As a result, the proportion of children who improved was 9.31 times higher than the proportion of children who deteriorated.

### Developmental risks in the domain social behavior in previous survey waves

To place the results in the context of the children's individualized targeted promotion as part of this project, two additional longitudinal analyses were conducted using data from previous assessments comparing 2017 to 2018 (DESK-R-SW-1 to DESK-R-SW-2,  $N = 979$ ) and 2018 to 2019 (DESK-R-SW-2 to DESK-R-SW-3,  $N = 948$ ) (see Supplementary Table S1 and Supplementary Table S2). The proportion of 3- to 4-year-old-children with developmental risk/inconclusive finding decreased in both longitudinal comparisons with a PRR = 0.88 ( $p = 0.287$ ) for DESK-R-SW-1 to DESK-R-SW-2 and a PRR = 0.82 ( $p = 0.092$ ) for DESK-R-SW-2 to DESK-R-SW-3. Interestingly, the proportion of children with a persistent developmental risk/inconclusive finding increased gradually over the three longitudinal comparisons (DESK-R-SW-1 to DESK-R-SW-2: 5.0%; DESK-R-SW-2 to DESK-R-SW-3: 5.5%; DESK-R-SW-3 to DESK-R-SW-4: 6.9%), whereby the proportion of children with deterioration gradually decreased (DESK-R-SW-1 to DESK-R-SW-2: 7.5%; DESK-R-SW-2 to DESK-R-SW-3: 6.6%; DESK-R-SW-3 to DESK-R-SW-4: 5.5%). The rate of improvement was relatively constant at 9.1–9.3% in the first two longitudinal comparisons and then increased to 11.3% from DESK-R-SW-3 to DESK-R-SW-4. However, one can see that the proportion of 3-year-olds with developmental risks/inconclusive findings (18.2%) at DESK-R-SW-3 was considerably higher than in the previous comparisons (14.1–14.8%).

## Discussion

The development of social behavior in children in the context of the pandemic is influenced by various factors, such as cultural differences between countries, differences in the pandemic course and socioeconomic status of the families, which are, taken all together, difficult to account for in one study. Thus, it is not surprising that previous studies examining differences in children's social behavior during the initial COVID-19 lockdown reached different conclusions. Complicating matters further, the study designs of most previous longitudinal studies differed, sometimes substantially; some examined rather short-term periods of one month, others had small sample sizes, and some studies conducted the baseline assessments during the lockdown<sup>14–18</sup>. To date, there is a lack of clear evidence of the impact of the COVID-19 pandemic on the development of social behavior. The present study examined changes in developmental risk in social behavior among more than 700 preschool children after the first COVID-19 wave using a standardized and validated instrument in a longitudinal comparison from 2019 (before Corona) to 2020 (after the first Corona wave) in relation to results from assessments conducted in previous years.

Surprisingly, in our study the prevalence of developmental risks decreased from 2019 before the pandemic to 2020 after the first COVID-19 wave. Compared to the longitudinal analyses from the previous survey waves, it should be emphasized that across all comparisons, the proportion of children with improvement was greater than the proportion of children with deterioration (PRR < 1), and since the scales are age-adjusted, this can for the most part be explained by the targeted individual promotion of children with developmental risks. With regard to the first-time significant change in developmental risks in the comparison from before Corona to after the first Corona wave, it should be noted that all three longitudinal analyses each examined changes in the domain social behavior among 3- to 4-year-old children and, accordingly, different children are considered in all three comparisons. Thus, differences in the socioeconomic status of families, child promotion, or secular trends across years cannot be ruled out.

The key finding of our study, we would like to highlight, is that we could not detect any deterioration in the prevalence rate ratio after the first COVID-19 wave compared to previous survey waves, whereby several aspects must be considered:

With regard to the COVID-19 pandemic, only short-term effects can be described, since only 4.5 months passed from the start of the nationwide lockdown in mid-March to the first DESK assessment in early August. Mecklenburg-Western Pomerania was also the first German state to allow limited regular care and had one of the highest preschool return rates, so that from the beginning of May every third child was allowed to attend preschool and by the end of May three quarters were already able to attend preschool again<sup>1</sup>. Apart from Saxony, which had a preschool attendance rate of 78% of the children by end of May, all other German federal states ranged between 22% and 47%<sup>1</sup>. However, child care programs were still partially restricted after August 2020, so preschools with a number of more than 100 children could not continue open or partially open child care concepts as they used to before Corona. The pedagogical staff was urged to stay with the same children, if possible, and to place children in the same cohorts in fixed rooms so that COVID-19 outbreaks could be avoided. Regarding the development of social behavior, this may have made it easier for children to approach other children in the preschool, strengthening cohesion and creating a more familiar environment.

Due to the more favorable child-adult ratio during the lockdown, closer supervision was provided. Family cohesion may have increased, which may have created a more emotionally stabilizing home environment<sup>15</sup>. On the other hand, one could assume that the COVID-19-induced lockdown may have increased demands on family resources and sociodemographic risks<sup>18</sup>. In general, with regard to the social-emotional development it was found that higher levels of family resources and more sensitive parenting predicted lower levels of aggression, whereas higher sociodemographic risk and less sensitive, less involved parenting, assessed from infancy through third grade, predicted higher and more stable aggression<sup>38</sup>. Studies conducted so far in relation to the pandemic have shown a decreased quality of life of children, an increased stress experience of parents and a lockdown-related increase in mental health problems<sup>39–42</sup>. Furthermore, Sun et al. showed that parental distress significantly predicted both externalizing and internalizing child behavior problems in primary school aged children<sup>43</sup>. Since these studies did not include 3-4-year-old children, however, no clear conclusions can be drawn.

Two studies from the United Kingdom conducted by the same authors with a comparable design found no differences in emotional and behavioral problems in 2-5-year-old children over a one-month period starting during the first lockdown, whereas primary school aged children (4–10 years old) showed an increase in child emotional and behavioral difficulties<sup>16,17</sup>. For secondary school aged children (11–16 years old), emotional difficulties decreased and behavioral difficulties did not change. Therefore, it can be assumed that the lockdown affected the social-emotional development of children in different age groups to different degrees<sup>44</sup>. Accordingly, our findings support results from previous studies that found no deterioration in social behavior among preschool children during the first COVID-19 wave<sup>15,16</sup>.

So far studies in toddlers and preschoolers found, in terms of daily activities, that during early stages of the pandemic, time spent in physical activity decreased, recreational screen time, and sleep duration increased, and sleep quality declined<sup>8,45</sup>. However, Kurz et al. could not find substantial differences in sleep quality, physical activity, and time spent with books in 6-7-year-old children in South Germany during the first COVID-19 wave<sup>46</sup>. One study of 2-4-year-olds estimated that every additional hour per day that children watched TV or digital media is associated with a higher mean SDQ score for conduct problems<sup>47</sup>. Another study in primary school children found that playing and learning

activities were linked to lower behavioral problems, active leisure was positively associated with physical well-being, and socialization and family activities were linked to better social well-being<sup>48</sup>.

Furthermore, the study included preschools from economically disadvantaged regions as part of the project. Data from previous studies have shown that economically disadvantaged children of mentally burdened parents are particularly affected by the negative consequences of the lockdown, for example due to cramped housing or lack of parental support and encouragement<sup>39-41, 49</sup>. Furthermore, studies found that a lower socioeconomic status was associated with higher media use and less outdoor activity<sup>48,50</sup>.

However, one limitation of this study is that the influence of the household on the change in developmental risks could not be considered, as these were not assessed. This includes social living conditions, families' socioeconomic status but also the influence of siblings or the childcare situation during the lockdown. A major limitation of the DESK 3–6 R is that not all domains of competence are measured across all age groups, so that the domain social behavior is only determined for 3-4-year-old children. Social behavior is further differentiated in the 5-6-year-olds into social competence and social interaction, so for consistency of the outcome measure we have restricted this analysis to children of 3–4 years.

Furthermore, it should be noted that the categorization of the stanine values into two groups (developmental risk vs. no developmental risk) results from the fact that the DESK 3–6 R is rather designed to sensitively identify which children are at risk for developmental risks and need targeted, individualized support. The calculated stanine values are therefore not “performance points”, but primarily indicate whether support is needed or not.

One major strength of this study is that longitudinal data from a prospective cohort study from over 700 3-4-year-old children in the domain social behavior were assessed using a standardized, validated instrument contextualized with data from previous survey waves. To date, limited data of the impact of the COVID-19 pandemic on developmental risks in this domain are available for this age group. One further major strength of this study is that the instrument was administered by trained pedagogical staff who knew the children over a longer period of time and were therefore able to assess them well. The completion by parents bears the risk that the children are assessed more positively and, in addition, the perception might change during the lockdown due to the increased child-parent time or parental stress.

In conclusion, despite the first COVID-19 wave, no negative effects on developmental risks in the domain of social behavior were observed among 3-4-year-old preschool children in economically deprived regions in northeastern Germany. On the contrary, despite preschool closures due to the COVID-19 pandemic, decreases in developmental risks were observed in the longitudinal comparison, although besides the individual, targeted promotion of children with developmental risks provided by preschools in the context of this project, secular trends cannot be completely ruled out. Further studies are needed to examine long-term effects of the pandemic on social behavior in preschool children.

## Declarations

### Author contributions

Conceptualization: AK and MF; methodology: AK and MF; data collection: AK, VSE and MF; writing—original draft preparation: AK and MF; writing—review and editing: VSE, WH and MF; funding acquisition: MF and WH. All authors have read and agreed to the published version of the manuscript.

### Data availability statement

The datasets generated and analyzed during the current study are not publicly available after consultation with the data protection commissioner of Mecklenburg-Western Pomerania due to data protection reasons and contractual regulations.

### Competing Interests Statement

The authors declare no competing interests that are relevant to the content of this article.

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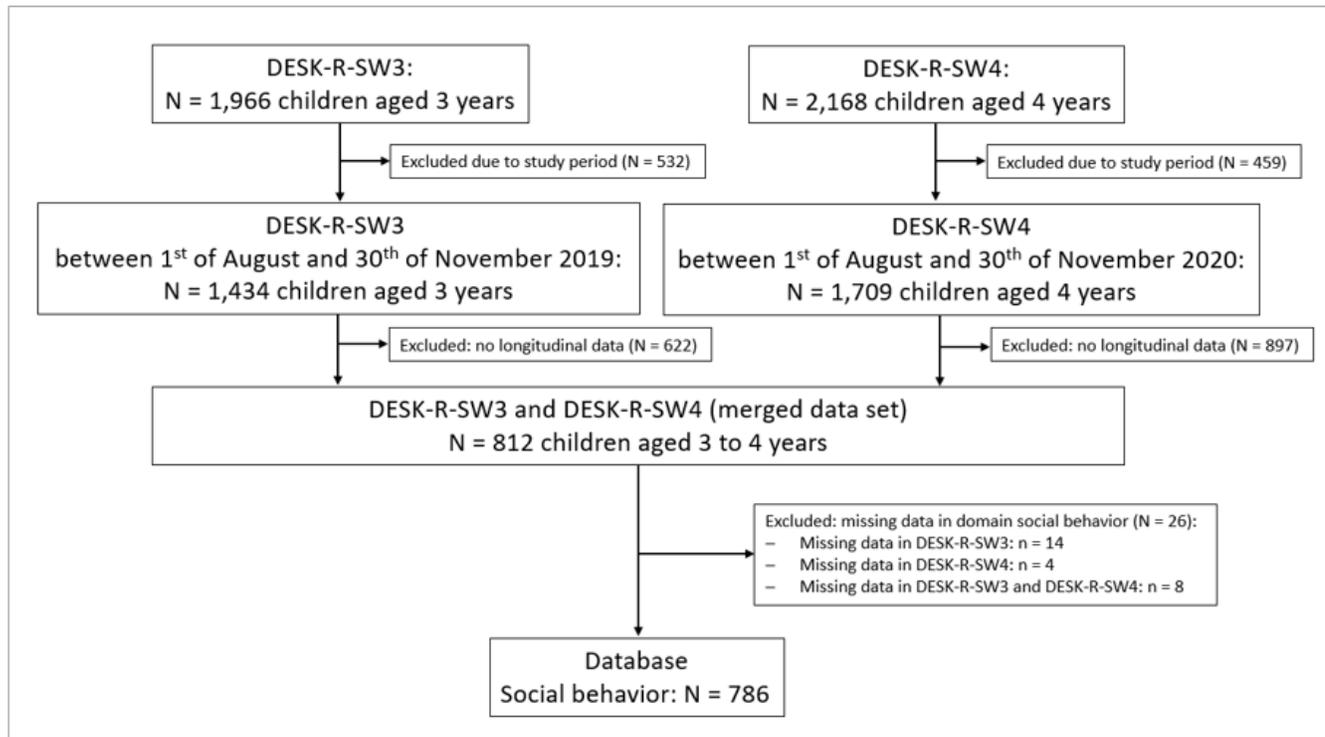
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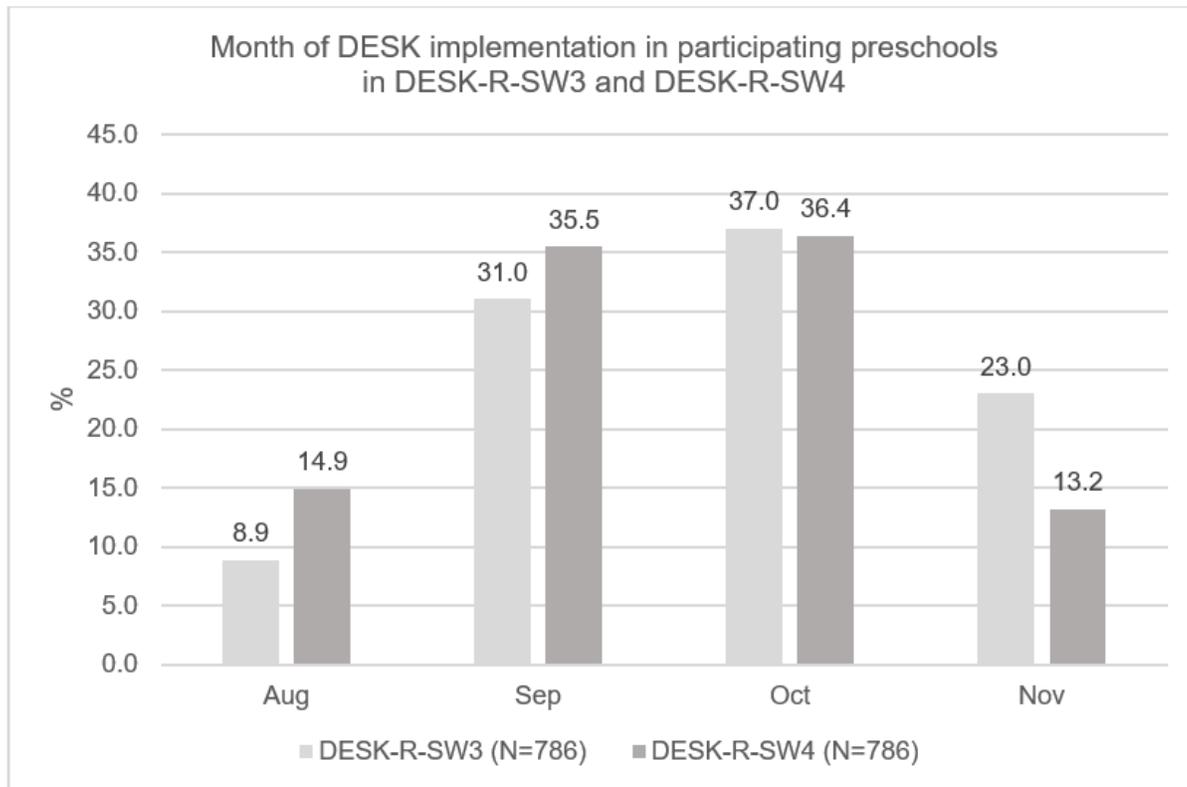
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## Figures



**Figure 1**

Consort diagram illustrating the data base for longitudinal data analysis of age-adjusted DESK scores in the domain social behavior



**Figure 2**

Month of cross-sectional DESK assessment in participating preschools in DESK-R-SW3 (conducted in 2019) for 3-year-olds and DESK-R-SW4 (conducted in 2020) for 4-year-olds

## Supplementary Files

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