

Perceptions of Parental Support for Physical Activity and Healthy Eating among School-age Children During COVID-19 pandemic

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Abstract

Family routines play a key role in promoting child health behaviors. This study 1) describes changes in children's perceptions of physical activity (PA) and healthy eating family routines across three time points: pre-pandemic (2017-2020), early pandemic (2020), and mid-pandemic (2021); and 2) explores how sex, age, and pandemic-related economic stressors relate to changes. Children's perceptions of family routines were assessed using four subscales adapted from the Comprehensive Home Environment Survey: PA-policies, Diet-policies, Diet-rules, and PA-Diet-role-model. Linear mixed models assessed changes in perceptions and associated factors (child age and sex; caregiver(s) job loss during pandemic). Children ($N=277$) were aged 9.3-15.5y at pandemic onset (March 2020), dichotomized by median age (12.1y) as younger and older. Children's perceptions of PA-policies (pre-pandemic mean=15.4) and Diet-policies (pre-pandemic mean=26.3) increased significantly from pre- to early ($b=1.2$ and 2.3 , respectively) and mid-pandemic ($b=1.0$ and 1.2 , respectively). Diet-rules (pre-pandemic mean=10.8) decreased significantly from pre- to early ($b=-1.1$) and mid-pandemic ($b=-2.0$), with no PA-Diet-role-model changes. Younger children had a greater increase in perceived PA-policies and Diet-policies across the pandemic. Females (59.9%) had a greater decrease in perceived Diet-rules across the pandemic and less increase in Diet-policies and PA-Diet-role-model from pre- to early pandemic. Children whose caregiver(s) lost employment (51.8%) perceived a greater increase in PA-policies. Overall, children reported increased parental policies to support PA and healthy eating and decreased parental rules for diet during the pandemic. Future research is needed to understand how changes in family routines relate to PA and healthy eating behaviors.

Keywords: Child, adolescents; COVID-19 pandemic policies; Health disparities; Family routines; Physical activity; Healthy eating; Perceptions

Dietary intake and physical activity (PA) are important for child health and development. Imbalance in these behaviors, characterized by low intake of fruits, vegetables, whole grains, nuts, legumes, fish, and yogurt and overconsumption of unhealthy calorie-dense snacks and sugar-sweetened beverages (Androutsos et al., 2021; Cipolla et al., 2021; Liberali et al., 2020; Maltoni et al., 2021; Valenzise et al., 2021), low levels of PA, and high screen time, negatively affect child physical health and wellbeing and promote childhood obesity (Nagata et al., 2023), with consequences into adulthood (Katzmarzyk et al., 2014; Ward et al., 2017; Yanovski, 2015). Few children meet diet and PA recommendations (Friel et al., 2020; Kuhn et al., 2021; Liu et al., 2020). Identifying levers to promote optimal dietary intake and PA can support healthy child growth.

Family routines related to diet and PA play a key role in promoting child health behaviors. Parents establish routines within the home by providing policies and rules as well as role modeling healthy behaviors that create structure, predictability, and consistent opportunities for children to engage in PA and healthy dietary behaviors (CDC, 2019a; Gustafson & Rhodes, 2006; Wansink, 2006). Policies are general patterns of behavior that define how the family operates (e.g., eats dinner with me, watches me play sports), while rules are specific statements about a behavior that parents expect (e.g., when I can have snacks) (CDC, 2019b). Supportive parental policies, such as encouraging children to eat fruits and vegetables and be physically active, preparing fruits and vegetables for children, and taking children to be physically active, are beneficial in helping children meet the PA and healthy diet recommendations (Lopez et al., 2022). Parental rules for dietary intake such as limits on fast food and sugar sweetened beverage consumption are related to healthy eating behaviors (Fleary & Ettienne, 2019; Shonkoff et al., 2017), but have also been associated with higher sugar sweetened beverage and junk food consumption in at least one study (Fleary & Ettienne, 2019). Parental role modeling of PA and healthy eating behaviors is associated with child PA (Matos et al., 2021) and improved diet quality (Linde et al., 2022; Vaughn et al., 2018) respectively. Conversely, parental role modeling of unhealthy eating behaviors (e.g., fast food intake) is associated with increased sugar sweetened beverage intake among children (Linde et al., 2022).

The onset of the COVID-19 pandemic in March 2020 resulted in widespread social distancing policies and unprecedented closures to schools, workplaces, and public spaces, disrupting daily life (Bayham & Fenichel, 2020; Cluver et al., 2020; Haug et al., 2020). These measures, while important for mitigating virus spread, were disruptive for families with children. Families had to establish new routines in a general context characterized by fear, economic uncertainty, and increased caregiver stress (Gassman-Pines et al., 2020). The Family Stress Model posits that environmental and economic stressors are distressing for parents, which disrupts parenting practices and has negative consequences for children's health and development (Masarik & Conger, 2017). During the

COVID-19 pandemic, many parents experienced disruptions to their socioeconomic status (SES) through employment instability and income insecurity, and these disruptions were associated with worse mental health, poor sleep, and disruptive child health behavior (Bates et al., 2021; Kalil et al., 2020; Prime et al., 2020; Zhang, 2022).

Little is known about how family routines to support PA and diet changed among school-age children during the COVID-19 pandemic. In a national cross-sectional survey of 300 US caregivers of children ages 6-18 during the first three months of the COVID-19 pandemic, caregivers reported engaging in significantly fewer family routines related to child health behaviors, particularly for their children's sleep and screen time (Bates et al., 2021). Although maintaining family routines was challenging, higher engagement in routines during the COVID-19 pandemic was beneficial to family wellbeing (Bates et al., 2021), as suggested by the Family Stress Model. Investigating children's perspectives about family routines and changes during the pandemic can be helpful in identifying the potential factors impacting changes in children's PA and diet.

Using longitudinal data collected prior to and during the pandemic, this study aims to 1) describe changes in children's perceptions of parental policies and rules and role modeling behaviors to support PA and healthy eating across three time points: pre-pandemic (2017-2020), early pandemic (2020; remote learning), and mid-pandemic (2021; return to hybrid school); and 2) explores how sex, age, and pandemic-related economic stressors relate to these changes.

Methods

Study population

Amid the onset of the COVID-19 school closures, participants from a prior statewide childhood obesity prevention trial, Wellness Champions for Change (WCC) (H. Lane et al., 2018) were invited to re-enroll in the COVID-19 Family Study, a longitudinal observational cohort study evaluating changes in child weight status and health behaviors following the onset of the pandemic and to understand mechanisms explaining the observed changes. In WCC, children and caregivers were enrolled over 3 academic years between 2017 to 2020 from eighteen elementary and fifteen middle schools serving low- and middle-income communities in 5 Maryland counties. Schools were eligible if >40% of the student body was eligible for free or reduced-price school meals. After the onset of the pandemic, the COVID-19 Family Study recruited and re-enrolled WCC participants who completed a pre-pandemic caregiver survey and continued to reside in Maryland. Overall, 369 of 835 eligible WCC families (44.2%) re-enrolled and were followed longitudinally. The University of Maryland School of Medicine Institutional Review Board approved the WCC Study and the COVID-19 Family Study, which was also approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Data collection

This study used data collected at three time points: pre-pandemic (10/2017 to 3/2020), early pandemic (5/2020 to 8/2020), and mid-pandemic (2021). Surveys were administered to children and their caregivers (97% were parents) electronically (via email) or by mail (via paper copies), based on caregiver preference. Caregivers provided consent for their participation and their child through an electronic informed consent process. WCC children who were invited to complete a child survey, also provided electronic assent. This analysis included child survey data on perceived parental support for family PA and healthy eating routines and caregiver survey data on SES and demographic characteristics that were collected at three time points.

Child-perceived PA and healthy eating family routines

In this analysis, “family routines” includes constructs specific to children’s perceptions of parental policies to support PA (PA-policies) and healthy eating (Diet-policies), parental rules for healthy eating (Diet-rules), and parental role modeling of PA and healthy diet (PA-Diet-role-model), assessed pre-pandemic, early, and mid-pandemic. Perceived family routines were reported by children using subscales adapted from the Comprehensive Home Environment Survey (CHES) (Pinard et al., 2014).

The CHES was originally developed for caregivers to assess home food, PA, and media environment related to childhood obesity. It consisted of 18 subscales which were evaluated for reliability (internal consistency, test-retest reliability, inter-rater reliability) and predictive validity (in relation to behaviors) (Pinard et al., 2014). The WCC study, from which participants were recruited for this COVID-19 Family Study, included a focus on the home environment (H. Lane et al., 2018). Our team chose the CHES as a measure of the home environment and adapted the measure (1) for administration with children and (2) to reduce the items. In conjunction with the validation of other evaluation tools for WCC (H. G. Lane et al., 2018), our team also systematically adapted specific CHES subscales for use among children and evaluated the test-retest reliability of the new items and scales and internal consistency of the scales. This process is described in **Appendix 1**, which also includes the CHES items as administered to the WCC caregivers and children, and the items included in the COVID-19 Family Study.

Four subscales were included in this study: 1) PA-policies (6 items, max score 24), 2) Diet-policies (11 items, max score 44), 3) Diet-rules (8 items, max score 32), and 4) PA-Diet-role-model (6 items, max score 24). Children were asked about the frequency that their caregivers engaged in each item, ranging from: 0 “never”, 1 “once in a while”, 2 “sometimes”, 3 “most of the time”, and 4 “always.” One survey item in PA-Diet-role-model and six survey items in Diet-policies were reverse coded as: 0 “always”, 1 “most of the time”, 2 “sometimes”, 3 “once in a while”, and 4 “never”. Missing survey responses were excluded from the study. Items within each subscale that contain no missing responses were summed with higher scores indicating more positively perceived family PA and diet routines.

Household socioeconomic stressors experienced during pandemic

Household income, family size, and employment status were reported by caregivers at early and mid-pandemic. Household income as a percent of the federal level (% FPL) was calculated using 2019 and 2020 thresholds for early and mid-pandemic surveys, respectively (United States Census Bureau) and two categories were defined ($\leq 185\%$, and $> 185\%$) (Kowalski et al., 2021). A dichotomous variable was created as, “has household experienced poverty ($\leq 185\%$ FPL) at either early or mid-pandemic?”. A separate variable was created for caregiver(s) employment status, “have any caregivers experienced employment loss?” Households with caregivers reporting an affirmative response to this variable at either early or mid-pandemic were coded as “1”, and the remainder were coded as “0”.

Child demographics

Child sex and race and ethnicity were reported by caregivers at WCC enrollment (pre-pandemic). Children were assigned to one of three race and ethnicity categories for analysis: non-Hispanic Black or African American, non-Hispanic White, and Hispanic or non-Hispanic of any other race(s). Child age in March 2020, at the onset of wide-spread pandemic-related school closures in the location of the study, was calculated and dichotomized at the median to categorize children into two groups: younger (≤ 12.1 y) and older (> 12.1 y) children.

Statistical analysis

Of the 369 WCC caregivers re-enrolled in the COVID-19 Family Study, 287 WCC children were re-enrolled. Of these, 277 (96.5%) children who had pre-pandemic data for at least one family routine subscale at pre-pandemic and either early or mid-pandemic were included in the analysis. The children who re-enrolled with complete data ($n= 277$) were less likely to live in households that experienced pandemic-related poverty, compared to children in participating families that did not re-enroll ($n= 92$).

We calculated frequencies and proportions for sample characteristics and means and standard deviations for each family routine subscale at pre-, early, and mid-pandemic. Linear mixed models with random intercepts for school and child were used to explore the changes in each family routine subscale across the pandemic, adjusting for follow-up time. Follow-up time was calculated by subtracting child age at the last survey (at T1 or T2) to the child age at pre-pandemic survey. We added an interaction term between WCC intervention status of each re-enrolled children and time point (pre-, early, or mid-pandemic), and did not identify significant impacts of intervention status on family routine subscales; therefore, intervention status was not adjusted in the models (data not shown). Pre-pandemic household locale was not found as a significant predictor for family routine subscales, and it was not included in the model (data not shown). To identify whether the changes in family routines differed by household socioeconomic stressors experienced during pandemic (ever employment

loss and ever poverty), we included an interaction term between each socioeconomic stressor and time point in univariate models. Similar univariate models were run to identify child demographic (sex and age groups) factors associate with change in perceived routines. Significant variables from at least one univariate model (using a selection criterion of p-value = 0.1) of the 4 CHES subscales were included in multivariate models for parsimony. Multivariate models were adjusted for follow-up time and p-values < 0.05 were considered statistically significant. Analyses were performed using STATA/SE 17.0 (StataCorp).

Considering the possibility that a child may change their reporting of their “primary caregiver” during the pandemic, which follows the pre-pandemic CHES survey, and how this may interfere with children’s perceptions of family routines, we conducted a sensitivity analysis by

excluding children who experienced caregiver changes during the pandemic, as reported in the survey.

Results

Sample characteristics for the study of children and families are presented in Table 1. In March 2020, child age ranged from 9.3 to 15.5 y with a median age of 12.1 y. Over half of children (60%) were female; 44% identified as non-Hispanic Black or African American, 37% non-Hispanic White, 10% non-Hispanic and more than one race, 1% non-Hispanic and from another race, and 8% Hispanic of any race. Fifty-four percent of children lived in suburban households, 33% rural, and 13% urban. Most households (61%) were above 185% FPL during the pandemic. Around 39% experienced pandemic-related poverty and 52% experienced employment loss.

Table 1. Characteristics of analytical sample (N= 277)

Sample characteristics		
	N	%
Sex		
Male	111	40.1
Female	166	59.9
Age group (median = 12.1 y)		
≤ 12.1 y (younger)	139	50.2
> 12.1 y (older)	138	49.8
Race and Ethnicity		
Black or African American Non-Hispanic	121	43.7
White Non-Hispanic	102	36.8
More than One Race Non-Hispanic	28	10.1
Hispanic of Any Race	23	8.3
Other Non-Hispanic	3	1.1
Locale (n= 265)		
Rural	87	32.8
Suburban	143	54.0
Urban	35	13.2
Employment loss during pandemic (n= 276)		
No	133	48.2
Yes	143	51.8
Poverty (≤ 185% federal poverty line) during pandemic (n= 236)		
No	144	61.0
Yes	92	39.0

Figure 1 and Table 2 present changes in mean scores for the four family routine subscales from pre-pandemic to early and mid-pandemic. The mean score for PA-policies increased from pre- to early pandemic (beta-coefficient = 1.2, p-value < 0.01) and from pre- to mid-pandemic (beta-coefficient = 1.0, p-value = 0.02). Significant changes in the mean score for Diet-policies were found from pre- to early pandemic (beta-coefficient = 2.3, p-value < 0.01),

from pre- to mid-pandemic (beta-coefficient = 1.2, p-value < 0.01), and from early to mid-pandemic (beta-coefficient = -1.1, p-value = 0.02). Diet-rules decreased significantly from pre- to early pandemic (beta-coefficient = -1.1, p-value = 0.05) and from pre- to mid-pandemic (beta-coefficient = -2.0, p-value < 0.01). No significant change was found for PA-Diet-role-model mean score across three time points.

Figure 1. Changes in PA-policies, Diet-policies, Diet-rules, and PA-Diet-role-model scores from pre-pandemic to early pandemic, and mid-pandemic

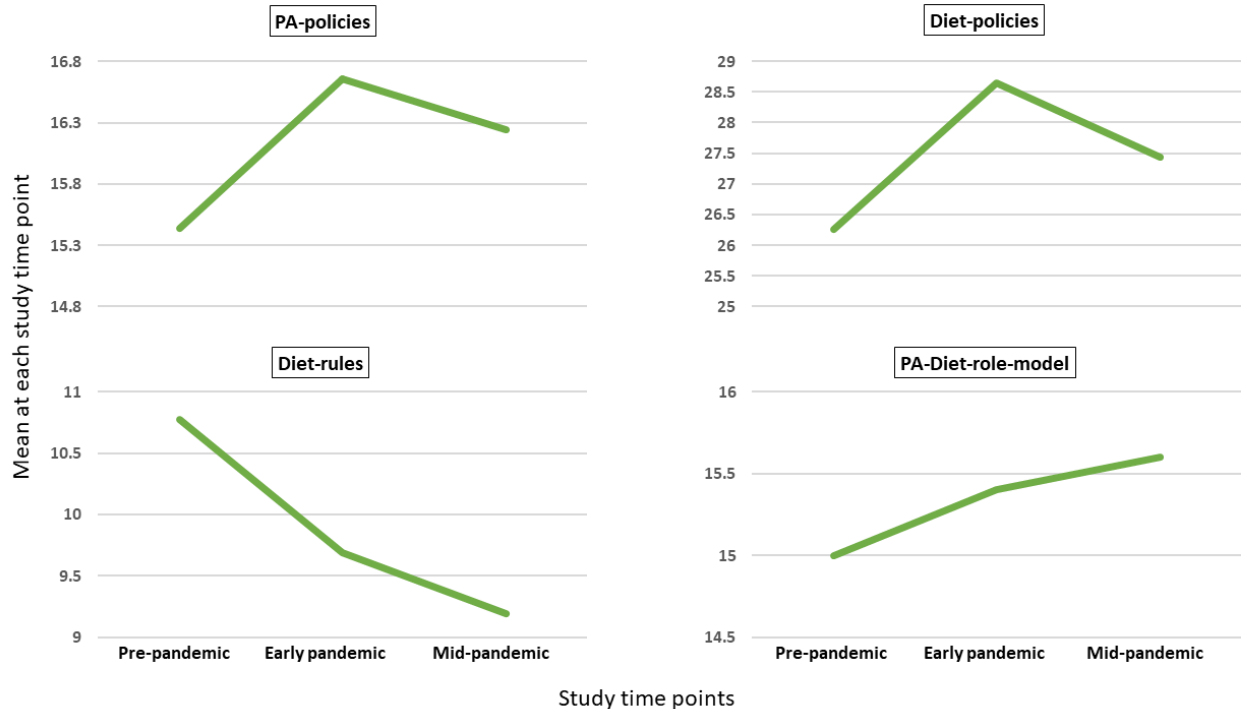


Table 2. Changes in PA-policies, Diet-policies, Diet-rules, and PA-Diet-role-model scores from pre-pandemic to early pandemic, and mid-pandemic¹

Family Routine Score	Pre-Pandemic Mean (SD)	Early Pandemic 2020 Mean (SD)	Difference in pre- and early pandemic beta-coefficient (p-value)	Mid-pandemic 2021 Mean (SD)	Difference in pre- and mid pandemic beta-coefficient (p-value)	Difference in early and mid-pandemic beta-coefficient (p-value)
<i>PA-policies</i> (N= 273)	15.4 (6.5)	16.7 (5.4)	1.2 (<0.01)	16.2 (5.8)	1.0 (0.02)	-0.3 (0.57)
<i>Diet-policies</i> (N= 266)	26.3 (5.3)	28.7 (5.4)	2.3 (<0.01)	27.4 (5.1)	1.2 (<0.01)	-1.1 (0.02)
<i>Diet-rules</i> (N= 267)	10.8 (7.6)	9.7 (6.8)	-1.1 (0.05)	9.2 (7.0)	-2.0 (<0.01)	-0.9 (0.13)
<i>PA-Diet-role-model</i> (N= 273)	15.0 (4.2)	15.4 (3.6)	0.4 (0.17)	15.6 (3.8)	0.5 (0.06)	0.2 (0.58)

¹ Linear mixed models accounting for repeated measures within each child and school cluster, and follow-up time were used to examine the beta-coefficient and p-values for the changes in mean scores of PA-policies, Diet-policies, Diet-rules, and PA-Diet-role-model from pre-pandemic to early pandemic, and mid-pandemic.

The unadjusted changes in four family routines subscales by household socioeconomic stressors experienced during pandemic (poverty and employment loss) and child demographic factors (sex and age) were included in Appendix 2. Overall, child sex, age, caregiver(s) employment loss, and household experience with pandemic-related poverty were each significantly associated with the changes in at least one of the family routine outcomes. Because 63% of households (148 out of 235) experienced both employment loss and pandemic-related poverty, and more caregivers reported employment status (n= 276) than pandemic-related poverty data (n= 236), we included caregiver(s) employment loss in the final adjusted model, in addition to child sex and age.

In the adjusted models (Table 3), child sex was associated with perceived changes in Diet-policies, Diet-rules, and PA-Diet-role model. In comparison to males, females exhibited a smaller perceived increase in Diet-policies from pre- to early pandemic (beta-coefficient = -1.8, p-value = 0.03), alongside a more pronounced decrease in Diet-rules from pre- to early pandemic (beta-coefficient = -2.1, p-value = 0.05) and pre- to mid-pandemic (beta-

coefficient = -2.6, p-value = 0.02). Perceived PA-Diet-role-modeling increased more in males compared to females from pre- to early pandemic (beta-coefficient = -1.2, p-value = 0.04). Regarding age groups, older children experienced a smaller increase in PA-policies and Diet-policies from pre- to early pandemic (beta-coefficient = -1.8 and -1.9, p-value = 0.02 and 0.02, respectively) and pre- to mid-pandemic (beta-coefficient = -2.0 and -1.7, p-value = 0.01 and 0.04, respectively) compared to the younger counterparts. Additionally, caregiver(s) employment loss was associated with a greater increase in perceived PA-policies from pre- to early pandemic (beta-coefficient = 1.7, p-value = 0.03).

Regarding changes in child-reported primary caregiver during the pandemic, as reported in the survey preceding the CHES items, 85% reported the same primary caregiver from early to mid-pandemic. In excluding the children who noted changes in primary caregiver during the pandemic from the analysis, our study results remained robust, suggesting that COVID-19- associated changes in children's perceptions of family routines may not solely explained by alternative caregivers.

Table 3. Adjusted associations of child sex, age, and household member employment loss with changes in PA-policies, Diet-policies, Diet-rules, and PA-Diet-role scores from pre-pandemic to early pandemic, and mid-pandemic ¹

	PA-policies			Diet-policies			Diet-rules			PA-Diet-role-model		
	Pre- to early pandemic β (p)	Pre- to mid-pandemic β (p)	Early to mid-pandemic β (p)	Pre- to early pandemic β (p)	Pre- to mid-pandemic β (p)	Early to mid-pandemic β (p)	Pre- to early pandemic β (p)	Pre- to mid-pandemic β (p)	Early to mid-pandemic β (p)	Pre- to early pandemic β (p)	Pre- to mid-pandemic β (p)	Early to mid-pandemic β (p)
Sex												
Male (Reference)	-0.9	-0.3	0.7	-1.8	-1.0	0.8	-2.1	-2.6	-0.5	-1.2	-0.3	0.9
Female	(0.25)	(0.74)	(0.46)	(0.03)	(0.22)	(0.41)	(0.05)	(0.02)	(0.69)	(0.04)	(0.56)	(0.17)
Age group												
≤ 12.1 y (younger) (Reference)												
> 12.1 y (older)	-1.8	-2.0	-0.2	-1.9	-1.7	0.3	-0.5	-1.1	-0.6	-0.6	-0.3	0.3
	(0.02)	(0.01)	(0.84)	(0.02)	(0.04)	(0.77)	(0.63)	(0.30)	(0.60)	(0.25)	(0.56)	(0.62)
Employment loss												
No (reference)	1.7	1.3	-0.4	1.0	1.1	0.1	0.9	-0.3	-1.2	0.4	-0.4	-0.8
Yes	(0.03)	(0.12)	(0.61)	(0.20)	(0.19)	(0.96)	(0.42)	(0.77)	(0.31)	(0.48)	(0.51)	(0.21)

¹ All models accounted for repeated measures within each child and school cluster and adjusted for follow-up time across study timepoints. Significant level at 0.05.

Discussion

In this statewide sample of elementary and middle school-aged children, we found that children's perceptions of parental policies and rules related to PA and healthy eating routines changed from pre-pandemic to early and mid-pandemic. Perceptions of PA-policies and Diet-policies increased, and perceptions of Diet-rules decreased significantly from pre- to early and pre- to mid-pandemic, whereas perceptions of PA-Diet-role-model remained stable across the time. Children's perceptions of family PA and healthy eating policies during the pandemic differed by age and sex. Younger children perceived a greater increase in healthy eating and PA-promoting policies compared to older children. Females reporting a greater decrease in rules around healthy eating and a smaller increase in role modeling on PA and healthy eating compared to males. Moreover, children whose caregiver(s) experienced job loss perceived a great increase in PA-promoting policies. Prior evidence has shown that children's PA (Androutsos et al., 2021; Cipolla et al., 2021; Jia et al., 2021; Kim et al., 2021; Kuhn et al., 2021; Maltoni et al., 2021; Valenzise et al., 2021) and diet quality (Androutsos et al., 2021; Cipolla et al., 2021) declined during the pandemic, and screen time increased (Androutsos et al., 2021; Jia et al., 2021). This study, albeit exploratory, contributes to our understanding of potential mechanisms for observed changes in behaviors by describing children's perceptions of changes to their family's routines related to PA and healthy eating.

We observed upward trends in perceived parental policies supporting PA and healthy eating from pre- to early and pre- to mid-pandemic. One possible explanation for this finding may be greater parental attention on their children's PA and eating behaviors when children were confined to their homes with limited access to schools, recreation facilities, and outdoor activities. A recent qualitative study that focused on parental strategies for improving children's (ages 9-14) PA during the pandemic found that parents were concerned about low activity levels of their children and made modifications to their lives to support and encourage their children to be active, including taking them to places to be active and seeking activity opportunities (Ostermeier et al., 2022). Generally, elevated child-parent interactions regarding dietary intake and PA have been observed during the COVID-19 pandemic (Eyler et al., 2021; Luo et al., 2022; Szpunar et al., 2022), with some engagement positive (i.e.: making changes to encourage activity) and some negative (i.e.: use of food as a threat or reward). The current study findings endorse these interactions from children's viewpoints. Moreover, a decline in perceived parental support for healthy eating between the early and mid-pandemic (although above pre-pandemic levels) may reflect reduced parental engagement as community opportunities began to re-open in 2021. Further studies are needed to examine whether children perceived a return to pre-pandemic levels of parental engagement following the full re-opening of community opportunities.

Consistent with prior studies (Adams et al., 2020; Jansen et al., 2021; Loth et al., 2022; Wang et al., 2021),

the current study found a reduction in perceived parental rules for healthy eating during both the early and mid-pandemic. These findings can be predicted by the Family Stress Model in that pandemic-related disruptions, may increase parents' psychological distress, negatively impacting parent-child relationships and routines, potentially including family rules for healthy eating (Masarik & Conger, 2017; Prime et al., 2020). Parents experiencing such stress are less likely to monitor and regulate children's eating behaviors (Adams et al., 2020; Fulkeron et al., 2019; Loth et al., 2022). To protect children from hardships and negative emotional stress, parents may use or allow children to use food as a compensatory mechanism, indicated by elevated odds of emotional eating found among young children and adolescents during the pandemic (González et al., 2022; Jansen et al., 2021; Rodgers et al., 2020).

The change in perceived parental support for PA and healthy eating varied by child age, with a greater increase for younger children compared to older children with respect to PA and healthy eating from pre- to early pandemic. In addition to the impacts of the pandemic, certain aspects of family routine changes are also likely attributable to the natural progression of children's developmental milestones, which potentially influence their interactions and perceptions of caregivers (Gao & Cummings, 2019). For example, as children get older, they likely make more PA and diet decisions independently without involving their parents, and they may also provide more input into family routines (Azar et al., 2020). (Ziegler et al., 2021).

Change in children's perceptions of caregivers' rules and policies for healthy eating differed significantly by sex during the pandemic, such that males perceived a greater increase in caregiver diet policies, compared to females, and females perceived a greater decrease in diet-related rules, compared to males. Caregivers may have different approaches for parenting regarding food for daughters compared to sons. There is evidence that disordered eating behaviors, for example, are closely linked among mother-daughter dyads (Rodgers & Chabrol, 2009). Moreover, disordered eating behaviors are more prevalent among females (Culbert et al., 2021), and there is emerging evidence of an increase in disordered eating behaviors during the COVID-19 pandemic (Schneider et al., 2023). Although the CHES subscales were intended to capture perceptions of family policies and rules around "healthy" eating behaviors, it could be that caregivers generally spoke less about food and eating/dietary behaviors following the onset of the pandemic with their daughters, compared to sons. Additional research is needed to further understand sex differences regarding how caregivers parented their children with respect to eating behaviors during the pandemic and the behavioral implications of their diet policies and rules.

Sex differences were also observed for perceived PA and healthy eating role modeling, with males showing a greater increase in perceived role modeling compared to females. This suggests that either parents of male children

engaged in more healthy eating and PA behaviors compared to parents of female children or, perhaps more likely, that male children became more aware of their parents' PA and healthy eating behaviors during the pandemic, supported by a pre-pandemic study that showed gender differences in awareness of parental health behaviors (Draxten et al., 2014). It should be noted that the role modeling subscale had a relatively low reliability, therefore, the findings related to role modeling should be interpreted with caution.

Caregiver(s) job loss was associated with greater increase in children's perception of parental policies to support PA, which may be explained by caregivers increased availability to engage in PA with their children while out of work (Eyler et al., 2021). The patterns of change in Diet-policies, Diet-rules, and PA-Diet-role-model did not differ by change in employment among household members. These findings are consistent with a recent study that found no association between pandemic-related income instability and common family routines (sleep, physical activity and inactivity (e.g., screen time), eating (e.g., mealtimes, snacking), and limiting snacking during the day) (Bates et al., 2021). Despite the known negative impacts of income instability on family health, it may not have impacted children's perception of family routines regarding PA and healthy eating during the pandemic or were overwhelmed by other pandemic-related disruptions.

Strengths and limitations

This study had several strengths, including the use of longitudinal data collected pre-pandemic and again in the early and mid-pandemic, during the two years after the onset of COVID-19 pandemic. Also, a novel aspect of this study is the inclusion of child perspectives on family routines, as children's perceptions of family routines are closely related to healthy eating and PA behaviors (Wang et al., 2019). The utilization of adapted survey items from CHES instruments allowed us to obtain comprehensive measures of both the physical and social home environment supporting children's PA and healthy diet simultaneously and aligns with the current prioritization of family or home environment in interventions for childhood obesity treatment and prevention.

This study also has multiple limitations. The generalizability of the study findings may be limited by the small sample size. Findings may also be biased because children excluded from current analysis were more likely to live in households experiencing pandemic-related poverty. Second, our model does not account for demographic or household socioeconomic factors, such as the utilization of federal assistance services and social support, that could potentially influence changes in family routines. Third, while our goal in reducing items from the validated CHES was to minimize participant burden, several adapted subscales (Diet-policies and PA-Diet-role-model) have lower internal consistency and thus our findings for these two subscales are preliminary should be interpreted with caution. An additional limitation is that the CHES items lacked a specific reference time period, which could

potentially lead to measurement errors; however, the larger survey of pandemic context frequently referenced the "past 2 weeks". To address survey limitations, future research to validate adapted, time-bound subscales is warranted. Finally, while not within the scope of our study, future prospective cohort studies involving young children and adolescents should also consider their emerging growth over time and incorporate how child development that plays pivotal roles in shaping family routines.

While not a limitation of our study design, it is worth noting that adaptation studies of the CHES and other family routine instruments should consider current nutrition and public health science. For example, the practice of using food as a reward or punishment or restricting sweets (as in Diet-policies and Diet-rules) may potentially undermine children's development of healthy eating habits by interfering with a child's natural ability to regulate their eating behaviors or increase the risks of disordered eating. The use of diet "rules" implies a more structured and enforced approach that may influence children's perception of dietary behaviors differently, while the term "habits" would better represent the dietary behaviors shaped by caregivers through encouragement and monitoring in a daily context.

Conclusion

This longitudinal cohort study examined changes in children's perceptions of healthy eating and PA-related family routines from pre-pandemic to mid-pandemic and revealed distinct patterns of change over time. Specifically, children reported an increase in their perceptions of parental policies to support PA and healthy eating, a decrease in parental rules for healthy eating, and no change in parent PA and healthy eating role modeling during the pandemic. These patterns of change differed by child age and sex such that younger children and males experienced greater increases in parental policies and rules to support healthy eating, respectively. The pattern of change differed by caregiver(s) job loss experienced during pandemic. Future studies should include qualitative research to further explore the role of family routines, and pandemic-related changes in family routines, on children's PA and healthy eating behaviors and explore age and gendered perceptions of said routines.

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Author contribution statement:

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The authors have no conflicts of interest.

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Appendix 1. Adaptations, uses, and internal validity of subscales derived from the Comprehensive Home Environment Survey (CHES)

Description of process for adapting survey items and examining item and scale reliability:

The CHES was originally developed to be an inclusive measure of home food, physical activity, and media environment related to childhood obesity. The survey includes 18 subscales which were evaluated for reliability (internal consistency, test-retest reliability, inter-rater reliability) and predictive validity (in relation to behaviors) (Pinard et al., 2014). The WCC study, from which participants were recruited for this COVID-19 Family Study, included a focus on the home environment. Our team chose the CHES as a measure of the home environment and adapted the measure (1) for administration with children and (2) to reduce the items.

To adapt the CHES, we first identified the subscales most relevant to the WCC study, including Parental Policies to Support Activity (7 items), Parental Policies to Support Healthy Eating (26 items), Diet Role Modeling (13 items), and Physical Activity Role Modeling (6 items). We modified the directions and question wording for use among children and evaluated item-by-item test-retest reliability and scale internal consistency in conjunction with a validation study with children that pilot-tested new measures for inclusion in WCC (detailed information on study design may be found elsewhere) (Lane, et al. 2018).

The language modification component included 2 stages. First, our team of pediatric behavior change experts reviewed the survey instructions and items intended for adults about their household and made minor changes to ask the question to children. For example, for the directions, “How often did you...” was changed to “How often does your caregiver do the following...” For the items, an example would be “Prepare meals with your child” was changed to “Lets me help make meals.” In addition, items not considered child-relevant (i.e., “how often do you not buy foods that you like because you do not want your child to have them”) were eliminated. Second, cognitive pre-testing was conducted with three groups of school-aged children (n=4 3rd graders, n=4 6th graders, and n=3 9th graders). Students took notes as they individually completed the child-adapted CHES, and items were reviewed in a moderated discussion. Minor modifications were made to the wording, including preferred Likert scales (CHES-caregivers: 0: never; 1: rarely;

2: sometimes; 3: frequently; 4: always; Revision-children: 0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always), changes to wording (i.e. change “food as a reward” to “sweets (like candy or dessert) as a reward”).

After modifying the language, we recruited a separate cohort of ~60 students (~20 students/grade in grades 3, 6, and 9) to pilot-test several WCC evaluation tools, including the adapted CHES (more information on recruitment, etc. may be found elsewhere) (Lane, Driessen, et al., 2018). The survey was administered online, with repeat administration one week later (Time 1-Time 2). Of the 61 children who participated in the Time 1 survey, 58 also completed the survey at Time 2. Individual item-by-item Spearman’s correlations and % agreements were calculated for test-retest reliability. After reducing items with poor test-retest reliability, Cronbach’s alpha values and scale test-retest reliabilities (Spearman correlations) were calculated for newly formed subscales. Our goal was to identify reliable scales with a minimum number of items that were theoretically sound.

This process resulted in 4 subscales (31 items) from the 3 original CHES subscales (52 items; see below for item-by-item changes). The original CHES Parental Policies to Support Activity became “PA-Policies,” retaining 6 out of 7 items (alpha=0.87, scale test-retest=0.79). The Parental Policies to Support Healthy Eating (26 items) included 12 policy items which were reduced to 11, “Diet-Policies” (alpha=0.67, scale test-retest=0.79), and 11 questions about rules which were reduced to 9, “Diet-Rules” (alpha=0.75, scale test-retest=0.77). Finally, the item-by-item test-retest reliability for the adapted items from the CHES Diet Role Modeling (13 items) and Physical Activity Role Modeling (6 items) and the scale test-retest reliability and internal consistency values were low. Given the importance of parental role-modeling, we chose to keep 4 items across the 2 subscales, plus a newly developed item on water consumption, for a total of 5 items, to represent diet and PA role modeling subscale “PA-Diet-role-model” for inclusion in the survey and future scale exploration.

The tables below include the CHES items as administered to the WCC caregivers and children, in addition to the items included in the COVID-19 family study. The Cronbach’s alpha values for each subscale, for each study, are included.

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PA Policies

Original CHES (CHES pilot- caregivers)	Adapted survey items (WCC- caregivers)	Adapted survey items (WCC- children)	Adapted survey items (COVID-19 Family Study- children)
Parental Policies to Support Activity (7 items)	PA Policies (6 items)		
<u>Instructions:</u> In the past 30 days, think about the types of things you did in your leisure time and you parenting related to physical activity.	<u>Instructions:</u> Think about your parenting regarding physical activity over the past 30 days.	<u>Instructions:</u> The questions will ask you about eating and being active when you are at home. Please pick the answer that is closest to how you feel. These questions will ask you about the person who takes care of you most of the time. If you have more than one person who takes care of you most of the time, choose one to think about when answering these questions. Who are you thinking about? (multiple choice)	<u>Instructions:</u> This survey asks about what you eat and drink, life at home, and the coronavirus (COVID-19). These questions will ask you about the person who takes care of you most of the time. If you have more than one person who takes care of you most of the time, choose one to think about when you answer these questions. Who takes care of you most of the time? (multiple choice)
<i>Root: How often...</i>	<i>Root: How often did the following things happen?</i>	<i>Root: How often does this person do the following things?</i>	<i>Root: How often does this person do the following things?</i>
0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always	0: never; 1: rarely; 2: sometimes; 3: frequently; 4: always	0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always	0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always
1. Did you verbally encourage your child to be physically active or play sports?	1. I encouraged my child to be physically active or play sports	1. Encourages me to be physically active or play sports	1. Encourages me to be physically active or play sports
2. Did you transport your child to a place where he/she can be physically active or play sports?	2. I took my child to places where he/she could be physically active or play sports (like to sports practice or park)	2. Takes me to places to be physically active or play sports (like to sports practice or to a gym, park or playground)	2. Takes me to places where I can be physically active or play sports (sports practice or to a gym, park or playground)
3. Did you send your child outside to play when the weather was nice?	--	--	--

4. Did you give your child options to new physical activities to try?	3. I encouraged my child to try new physical activities, like a new sport or game	3. Encourages me to try new physical activities, like a new sport or game	3. Encourages me to try new physical activities, like a new sport or game
5. Did you praise your child when they were physically active?	4. I praised my child when he or she was physically active	4. Praises me or tells me that I did a good job for being physically active	4. Praises me or tells me that I did a good job for being physically active
6. Did you watch your child practice for sports?	5. I watched my child practice for sports	5. Watches me practice for sports	5. Watches me practice for sports
7. Did you watch your child play sports?	6. I watched my child play sports	6. Watches me play sports	6. Watches me play sports
Cronbach's alpha = 0.81 CHES pilot (n=150)	Cronbach's alpha = 0.87 Wellness Champions for Change Caregivers (n=521)	Cronbach's alpha = 0.87 Wellness Champions for Change Children (n=926)	Cronbach's alpha = Pre-pandemic: 0.87; Early pandemic: 0.84; Mid-pandemic: 0.87 COVID-19 Family Study Children (n=277)

**Reverse Coded*

Diet Policies & Diet Rules

Original CHES (CHES pilot caregivers)	Original CHES (WCC caregivers)	Adapted survey items (WCC children)	Adapted survey items (COVID-19 Family Study children)	Original CHES (WCC caregivers)	Adapted survey items (WCC children)	Adapted survey items (COVID-19 Family Study children)
Parental Policies to Support Healthy Eating (26 items)	Diet-Policies (11 items)			Diet-Rules (8 items)		
<u>Instructions:</u> Based on the past 30 days , thinking about your food and meal behaviors, please circle the appropriate response for each statement						
<i>Root: How often did you...</i>						
<i>0: never; 1: rarely; 2: sometimes; 3: frequently; 4: always</i>						
1. Avoid going to cafes or restaurants with your children which sell unhealthy foods?						
2. Avoid buying sweets and chips or salty snacks (change to fatty snacks?)						

and bringing them into the house						
3. Not buy foods that you would like because you do not want your children to have them?						
Instructions: Based on the last 30 days , thinking about your parenting regarding food, please circle your answers.	Instructions: Think about your parenting regarding food over the last 30 days.	Instructions: The next questions will ask you about eating when you are at home. Please pick the answer that is closest to how you feel. These questions will ask you about the person who takes care of you most of the time. If you have more than one person who takes care of you most of the time, remember to think about the same person you were thinking about before!	Instructions: These questions ask about eating at home. Remember to think about the person who you said takes care of you most of the time.			
<i>Root: How often did you (#4-3)...</i>	<i>Root: How often did you do the following things?</i>	<i>Root: How often does this person do the following things?</i>	<i>Root: How often does this caregiver do the following things?</i>			
<i>0: never; 1: rarely; 2: sometimes; 3: frequently; 4: always</i>	<i>0: never; 1: rarely; 2: sometimes; 3: frequently; 4: always</i>	<i>0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always</i>	<i>0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always</i>			
4. Use food as a reward for your child?	1. I used food as a reward for my child	1. Gives me sweets (like candy or dessert) as a reward for when I am well behaved or do something good*	1. Gives me sweets (like candy or dessert) as a reward for when I am well behaved or do something good *			
5. Use food as a punishment for your child?	2. I used food as a punishment for my child	2. Tells me that I can't eat sweets (like candy or dessert) when I misbehave or do something bad*	2. Tells me that I can't eat sweets (like candy or dessert) when I misbehave or do something bad*			
6. Prepare meals with your child?	3. I prepared meals with my child	3. Lets me help make meals	3. Lets me help make meals			
7. Plan meals/menus with your child?	4. I planned meals/menus with my child	4. Lets me help plan what my family eats	4. Lets me help plan what my family eats			

8. Offer healthy snacks when your child was hungry?	5. I offered healthy snacks when my child was hungry	5. Gives me healthy snacks to eat when I am hungry	5. Gives me healthy snacks to eat when I am hungry			
9. Eat breakfast with your child?	6. I ate breakfast with my child	6. Eats breakfast with me	6. Eats breakfast with me			
10. Eat dinner with your child?	7. I ate dinner with my child	7. Eats dinner with me	7. Eats dinner with me			
11. Have regularly scheduled meals and snacks with your family?	--	--	--			
12. Allow your child to eat snacks or sweets without permission?	8. I allowed my child to eat snacks or sweets without permission	8. Lets me eat snacks or sweets any time I want*	8. Lets me eat snacks or sweets any time I want*			
13. Allow your child to take soft drinks whenever he/she wants	9. I allowed my child to take sugary drinks or non-diet soda without permission	9. Lets me drink sugar drink or non-diet soda any time I want*	9. Lets me drink sugar drink or non-diet soda any time I want*			
14. Give my child soft drinks or snacks if (s)he asks	10. I gave my child sugary drinks or non-diet soda if he/she asked	10. Lets me drink sugar drink or non-diet soda when I ask for them*	10. Lets me drink sugar drink or non-diet soda when I ask for them*			
15. Give your child something else if they did not like what was prepared	11. I made a different meal for my child if he/she did not like what was made for everyone else	11. Makes me a different meal if don't like what was made for everyone else*	11. Makes me a different meal if don't like what was made for everyone else*			
<u>Instructions:</u> Do you have the following food rules in your home?				<u>Instructions:</u> Think about your parenting regarding food over the last 30 days .	<u>Instructions:</u> Now we are going to ask you about rules that the person who takes care of you most has about the foods you eat when you are not at school. If you have more than one person who takes care of you most of the time, remember to think about the same person you were thinking about before!	<u>Instructions:</u> These questions ask about rules at home. Remember to think about the person who you said takes care of you most of the time.
<i>Root: How often did you...</i>				<i>Root: How often did you have the following rules?</i>	<i>Root: How often do you have the following rules in your home?</i>	<i>Root: How often do you have the following rules in your home?</i>

<i>0: no; 1: yes</i>				<i>0: never; 1: rarely; 2: sometimes; 3: frequently; 4: always</i>	<i>0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always</i>	<i>0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always</i>
16. How many servings of fruit and vegetables your child should eat				1. I had rules about how many servings of fruits and vegetables my child should eat every day	1. Has rules about how many fruits and vegetables I should eat every day	1. Has rules about how many fruits and vegetables I should eat every day
17. How many snacks is your child allowed to eat				2. I had rules about how many snacks my child was allowed to eat every day	2. Has rules about how many snacks I can eat every day	2. Has rules about how many snacks I can eat every day
18. When to snack				3. I had rules about when my child could have snacks	3. Has rules about when I can have snacks	3. Has rules about when I can have snacks
19. Which snacks to eat				4. I had rules about which snacks my child was allowed to eat	4. Has rules about what snacks I am allowed to eat	4. Has rules about what snacks I am allowed to eat
20. No second helpings at meals				5. I had a rule about not having second helpings at meals	5. Has rules about how much food I can eat during meals	5. Has rules about how much food I can eat during meals
21. Limited portion sizes at meals				6. I had a rule about how much food my child could eat during meals	6. Has rules about not having second helpings at meals	6. Has rules about not having second helpings at meals
22. No dessert except fruit				7. I had a rule that my child could not eat dessert except for fruit	7. Has a rule that I cannot have dessert except for fruit	7. Has a rule that I cannot have dessert except for fruit
23. No sweet snacks				8. I had a rule that my child could not have sweet snacks, treats or desserts	8. Has a rule that I cannot have sweet snacks, treats, or desserts	8. Has a rule that I cannot have sweet snacks, treats, or desserts
24. No fried snacks at home (such as potato chips)				--	--	--
25. Avoid going to cafes or restaurants with your children which sell unhealthy foods?				--	--	--
26. Avoid buying sweets and crisps (change to fatty snacks?) and bringing them into the house				9. I had a rule that my child could not have salty snacks (like chips, pretzels or Cheez-its)	9. Has a rule that I cannot have salty snacks, like chips, pretzels, or Cheez-Its	9. Has a rule that I cannot have salty snacks, like chips, pretzels, or Cheez-Its

<i>Cronbach's alpha = 0.85</i> <i>CHES pilot (n=150)</i>	<i>Cronbach's alpha = 0.67</i> <i>Wellness Champions for Change Caregivers (n=533)</i>	<i>Cronbach's alpha = 0.28</i> <i>Wellness Champions for Change Children (n=922)</i>	<i>Cronbach's alpha =</i> <i>Pre-pandemic: 0.34;</i> <i>Early pandemic: 0.53;</i> <i>Mid-pandemic: 0.43</i> <i>COVID-19 Family Study Children (n=277)</i>	<i>Cronbach's alpha = 0.85</i> <i>Wellness Champions for Change Caregivers (n=523)</i> <i>[excluding #2: alpha=0.83]</i>	<i>Cronbach's alpha = 0.87</i> <i>Wellness Champions for Change Children (n=830)</i> <i>[excluding #2: alpha=0.85]</i>	<i>Cronbach's alpha (*8 items)=</i> <i>Pre-pandemic: 0.84;</i> <i>Early pandemic: 0.84;</i> <i>Mid-pandemic: 0.86</i> <i>COVID-19 Family Study Children (n=277)</i>
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*Reverse Coded

PA-Diet-role-model

Original CHES (caregiver) Diet Role Modeling	Original CHES (caregiver) PA Role Modeling	Adapted CHES (WCC caregivers)	Adapted survey items (WCC children)	Adapted survey items (COVID-19 Family Study children)
Diet Role Modeling (13 items)	PA Role Modeling (6 items)	Diet & PA Role Modeling (6 items)		
Instructions: Based on the past 30 days, thinking about your food and meal behaviors, please circle the appropriate response for each statement	Instructions: In the past 30 days, think about the types of things you did in your leisure time and you parenting related to physical activity. Please check the appropriate box for each question	Instructions: Think about your parenting regarding food and physical activity over the last 30 days.	Instructions: This next section will ask you some more questions about the person who takes care of you the most. These questions will ask you about things this person does. If you have more than one person who takes care of you most of the time, remember to think about the same person you were thinking about before!	Instructions: This survey asks about what you eat and drink, life at home, and the coronavirus (COVID-19). These questions will ask you about the person who takes care of you most of the time. If you have more than one person who takes care of you most of the time, choose one to think about when you answer these questions.
Root: How often did you...	Root: How often did your child see you...	Root: How often did you do the following?	Root: how often does this caregiver do the following things?	Root: how often does this caregiver do the following things?
0: never; 1: rarely; 2: sometimes; 3: frequently 4: always	0: never; 1: rarely; 2: sometimes; 3: frequently 4: always	0: never; 1: rarely; 2: sometimes; 3: frequently 4: always	0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always	0: never; 1: once in a while; 2: sometimes; 3: most of the time; 4: always
1. Eat healthy meals or snacks while your child was around? ("healthy" defined as fruits, vegetables, low-fat foods, lean meats, whole grains etc.)		1. I ate healthy meals and snacks when my child was around	1. Eats healthy meals or snacks	1. Eats healthy meals or snacks
2. Eat meals in the living room or TV room?		--	--	--
3. Take a second helping during meals?		--	--	--
4. Eat unhealthy snacks around your children?		--	--	--
5. Drink sugared drinks or non-diet soda around your children?		2. I drank sugary drinks or non-diet soda when my child was around	2. Drinks sugary drinks or non-diet soda*	2. Drinks sugary drinks or non-diet soda*
6. Eat while standing?		--	--	--

7. Eat straight from the pot/pan/bowl?		--	--	--
8. Eat while watching television, reading, or working?		--	--	--
9. Eat when you were bored?		--	--	--
10. Eat when you were angry or in a bad or sad mood?		--	--	--
11. Eat late in the evening or at night?		--	--	--
12. Eat while driving		--	--	--
13. How often do you take your child with you grocery shopping?		3. I took my child to the grocery store with me	3. I go to the grocery store with this person	3. I go to the grocery store with this person
--		4. I drank water with meals when my child was around	4. Drinks water with meals	4. Drinks water with meals
	1. Doing something that was physically active (e.g., walking, biking, playing sports)?	--	--	--
	2. Doing moderately active housework or yardwork?	--	--	--
	3. Use physical activity for relaxation or stress relief?	--	--	--
	4. Did your child hear you talk about participating in a sport or being physical active?	--	--	--
	5. Did your child hear you say that you were too tired to do something active?	--	--	--
	6. Were you physically active with your child <u>or</u> did you play sports with him/her?	5. My child saw me doing something that is physically active, like walking, biking, exercising or playing sports	5. This person does physical activities, like walking, biking, exercising or playing sports	5. This person does physical activities, like walking, biking, exercising or playing sports
		6. Was physically active or played sports with my child	6. This person plays sports or does something physically active with me	6. This person plays sports or does something physically active with me
<i>Cronbach's alpha = 0.81</i> <i>CHES pilot (n=150)</i>	<i>Cronbach's alpha = 0.80</i> <i>CHES pilot (n=150)</i>	<i>Cronbach's alpha = 0.61</i> <i>Wellness Champions for Change Caregivers (n=535)</i>	<i>Cronbach's alpha = 0.59</i> <i>Wellness Champions for Change Children (n=918)</i>	<i>Cronbach's alpha = Pre-pandemic: 0.58; Early pandemic: 0.57; Mid-pandemic: 0.61</i> <i>COVID-19 Family Study Children (n=277)</i>

**Reverse Coded*

Appendix 2: Independent associations of child sex, age, and household SES stressors with changes in PA-policies, Diet-policies, Diet-rules, and PA-Diet-role scores from pre-pandemic to early pandemic, and mid-pandemic^{1, 2}

	PA-policies			Diet-policies			Diet-rules			PA-Diet-role-model		
	Pre-Pandemic Mean (SD)	Early Pandemic 2020 Mean (SD)	Mid-Pandemic 2021 Mean (SD)	Pre-Pandemic Mean (SD)	Early Pandemic 2020 Mean (SD)	Mid-Pandemic 2021 Mean (SD)	Pre-Pandemic Mean (SD)	Early Pandemic 2020 Mean (SD)	Mid-Pandemic 2021 Mean (SD)	Pre-Pandemic Mean (SD)	Early Pandemic 2020 Mean (SD)	Mid-Pandemic 2021 Mean (SD)
Sex												
Male (reference)	15.2 (6.1)	17.3 (4.8)	16.1 (5.6)	25.0 (5.0)	28.7 (5.8)	26.9 (5.0)	9.7 (6.4)	10.0 (7.0)	9.5 (7.2)	13.9 (4.2)	15.3 (3.5)	14.7 (3.6)
Female	15.6 (6.8)	16.3 (5.7)*	16.3 (6.0)	27.1 (5.3)	28.6 (5.2)*	27.8 (5.2)	11.5 (8.2)	9.5 (6.7)*	9.0 (6.8)§	15.7 (4.2)	15.5 (3.7)*	16.1 (3.8)
Age group												
≤ 12.1 y (younger) (reference)	14.7 (6.7)	16.7 (5.2)	16.8 (5.6)	25.9 (5.3)	29.5 (5.4)	28.0 (5.4)	11.2 (7.8)	10.5 (7.0)	10.3 (6.3)	14.8 (4.4)	15.7 (3.6)	15.6 (3.4)
> 12.1 y (older)	16.1 (6.2)	16.6 (5.6)*	15.7 (6.1)§	26.6 (5.3)	27.9 (5.3)*	26.9 (4.8)§	10.3 (7.3)	9.0 (6.6)	8.1 (7.5)	15.1 (4.1)	15.1 (3.6)	15.5 (4.1)
Employment loss												
No (reference)	16.0 (6.6)	16.4 (5.6)	16.1 (6.1)	26.6 (5.3)	28.4 (5.6)	27.1 (5.5)	10.5 (7.5)	8.9 (7.0)	9.0 (7.0)	15.1 (4.6)	15.3 (3.9)	15.7 (4.1)
Yes	14.9 (6.5)	16.9 (5.2)*	16.4 (5.6)	26.0 (5.3)	28.9 (5.3)	27.7 (4.7)	11.0 (7.7)	10.3 (6.6)	9.4 (7.1)	14.9 (3.9)	15.5 (3.3)	15.4 (3.5)
Pandemic-related poverty (≤ 185% FPL)												
No (reference)	15.4 (6.2)	16.2 (5.5)	16.3 (5.3)	26.6 (5.3)	28.9 (5.6)	27.6 (5.0)	11.0 (7.4)	9.8 (6.8)	8.8 (6.8)	15.0 (4.0)	15.4 (3.9)	15.8 (3.3)
Yes	14.5 (7.2)	17.0 (5.4)*	16.2 (6.7)	25.2 (5.1)	28.1 (5.4)	27.5 (5.4)	10.8 (8.3)	10.1 (7.1)	10.0 (7.3)	14.8 (4.8)	15.5 (3.2)	15.5 (4.4)

¹ Compared to the referent groups, * next to early pandemic mean (SD) indicates the significant change from pre-pandemic to early pandemic, the § next to mid-pandemic mean (SD) indicates the significant change from pre-pandemic to mid-pandemic, and the † next to the mid-pandemic indicates the significant change from early pandemic to mid-pandemic. Significance level at P-value = 0.1.

² All models accounted for repeated measures within each child and school cluster and adjusted for follow-up time across study timepoints.