



# Early Childhood Care Trends and Associations with Child Health Well-being in China: Evidence from the CHNS 1991 to 2011 Data

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## Abstract

It has become increasingly common for young children to be taken care of by multiple caregivers in China after the socio-economic reforms. Complex migration patterns and high female labour force participation have led to children receiving care from various individuals in different contexts. However, little is known about how childcare arrangements are associated with child health well-being. This study examines various early childhood caregivers and their influences on children's physical health in China. Using data from the China Health and Nutrition Survey (CHNS 1991–2011) with 3,470 children aged 2 to 6, we first identified different types of childcare arrangements in and outside of the household based on who provides the care, where they provide the care, and the intensity of the care. Then we examined the relationship between various childcare arrangements and health outcomes for children. Overall, household members undertook early childhood care tasks in China, with an increase in grandparents as primary caregivers between 1991 and 2011. The proportion of children receiving formal childcare fluctuated around 20% during this period. The findings suggest that: 1) primary caregiver in the household other than parents is not associated with undesirable physical health outcomes; 2) formal childcare outside the household is associated with higher height and lower BMI scores; 3) primary caregivers in the household, particular grandparents, moderate the association between childcare arrangements outside the household and children's health outcomes. It yields an implication that early childhood care policies incorporating multiple caregivers would benefit children's well-being in China.

**Keywords** Family · Childcare · Grandparent · Physical health · CHNS

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## Introduction

Quality of life is important to individuals across the life course. Though most studies focused on adults and adolescents, an increasing number of studies have recently begun to examine the developmental outcomes and well-being of young children (Lippman et al., 2011). Early childhood is a formative life stage and critical to people's future quality of life (Britto et al., 2017; Cunha & Heckman, 2010). Within the broad and multidimensional research on the quality of life, the initial and fundamental indicators of child development and well-being are health-related indicators (Britto et al., 2017; Lippman et al., 2011). Since caregivers play an essential role for children in the early life stage, different childcare arrangements would influence child health outcomes. However, relevant empirical studies are dominant in western contexts and have not reached a firm conclusion. Some of the child health development processes show similarities to other parts of the world, but environments and childcare arrangements are unique to the social contexts. In this article, we examined childcare arrangements and child physical health outcomes in China.

Physical health contributes to child development and well-being, in which the caregivers play a crucial role. Recent studies seeking to understand the mechanism of child health-related quality of life found that multiple family-related determinants contributed to child physical health, such as genetic factors, parent's knowledge and practice on the habituation of diet, family environment and household structure (Bramlett & Blumberg, 2007; Cislak et al., 2012; Monasta et al., 2010; Murrin et al., 2012; Sleddens et al., 2011; Ventura & Birch, 2008). While most previous studies focused on children in general or school-age children, physical health development in early childhood remains unexplored. Research in the field of childcare exclusively focused on primary caregivers or a particular childcare arrangement of interest while showing little about the complexity of childcare arrangements and their influences on children's health outcomes (Cunningham et al., 2019).

Childcare is the natural corollary of having children, particularly as a mother. Nevertheless, cooperative childrearing is common, flexible and beneficial for children in many societies (Sear & Coall, 2011; Sear, 2016). China has been experiencing mass working population migration, which has increased the phenomenon of left-behind children. According to China's 1% National Population Sample Survey in 2015, children without parents living together accounted for about 30% of children under 6, which was higher than older age groups (UNICEF, 2017). Additionally, high female labour force participation raises the need for childcare support from others, such as grandparents, nannies, and institution services provided by nurseries and kindergartens. Due to the limited leave policies and a lack of systematic formal early childhood care services in China, children are usually taken care of by more than one adult (Qi & Melhuish, 2017; Wu, 2018). So far, the knowledge about various types of childcare arrangements for preschool-age children is acquired in the context of the popularity of dual-breadwinner families, increasing involvement of grandparents, and childcare policies reforms in contemporary China.

Therefore, this study aimed to contribute to the field by identifying the patterns of mixed childcare arrangements in early childhood in Chinese families and examining

the associations between childcare arrangements and child physical health outcomes. We used data from the China Health and Nutrition Survey (CHNS, 1991–2011) and measured childcare arrangements from children's perspectives of their experiences with multiple caregivers. The term caregiver used in this article denoted the people or institutions which took care of young children, including parents, grandparents, other individuals or formal professional childcare.

## Childcare Arrangements and Child Physical Health

The impact of childcare arrangements on child developmental outcomes can be explained by ecological theory (Allen & Henderson, 2017; Bronfenbrenner, 1986; Shek, 2020; Shek & Siu, 2019). An ecological view of childcare arrangements recognizes the complexity of family relationships and broader human relationships between different actors and institutions. As the gatekeeper, the caregiver links to ensuring a child health-related quality of life and well-being. Less care than adequate or disrupted care may lead to insufficient nutrition, causing a higher risk of poor health, neglect, or abuse (Richter, 2004). In the UNICEF model of care, the caregiver is a crucial determinant of the environment for child development. It is the mediator between the social context, resources from the society and child development (Engle et al., 1997). In terms of early childhood nutrition and physical health, caregivers affect children's food availability and variety, eating habit, sleeping pattern, exercise and level of inactivity, which in turn related to child health outcomes (Bégin et al., 1999; Black et al., 2017; Cislak et al., 2012; He et al., 2018; Li et al., 2015; Liu et al., 2018; Pilarz & Hill, 2014; Tan et al., 2010). What caregivers do is conditioned by their characteristics, including age, health status, relation to the child, the situation of their own family, knowledge level, resources and supports (Sleddens et al., 2011). These factors are also associated with the caregiver-child relationships that influence child health-related quality of life.

The present study focused on different types of caregivers and their associations with young children's physical health. We distinguished the childcare arrangement in and outside a child's household. In the household, caregivers are mainly parents, other coresident family members or co-resident nannies. Caregivers outside the household include both informal caregivers and formal childcare institutions. The following sections review each type of caregiver and its relation to child physical health outcomes. We also considered interactions between different caregiver types. In a nutshell, three questions are raised: 1) In the household, are non-parental caregivers different from parents on child health outcomes? 2) Outside the household, is there an association between childcare arrangements and child physical health outcomes? 3) Does the caregiver in the household interact with childcare arrangements outside the household to influence the health outcomes of young children in China?

## In-home Childcare Arrangements and Child Physical Health

According to the ecological model, individuals are primarily surrounded by their near environment, including immediate family members (Bronfenbrenner, 1986). In early childhood, household and family members play a crucial role in a child's health-related quality of life.

Parents, particularly mothers, are the most critical and familiar caregivers for infants and young children in the household. Research in developed countries found that separation from parents in early childhood had adverse effects on child developmental outcomes (Härkönen et al., 2017; Navsaria et al., 2017; Yarrow, 1964). Also, maternal employment was found to be associated with childhood obesity. For example, working mothers spend less time with their children at home, and so children may suffer from inadequate care, unhealthier diets and sedentary behaviour (Gwozdz, 2016; Watanabe et al., 2011). Similar studies in China mainly focused on migrant parents and left-behind children over the last decades (Fellmeth et al., 2018). Many studies showed that the left-behind children were more likely to be stunted, underweight, wasted or at high risk of anaemia (Mo et al., 2016; Shi et al., 2020; Tian et al., 2017), while others found that left-behind child had a relatively high prevalence of obesity or performed similarly to those children living with a parent (Mu & de Brauw, 2015; Zhou et al., 2015). Some researchers also suggested that maternal migration was more detrimental than paternal migration on child nutrition, including dietary diversity and micronutrients (Guo et al., 2017; Yue et al., 2016). Despite these studies, most did not determine who was the primary caregiver for children when their parents were not available, which leaves the question over the potential influence of non-parental caregivers in the household.

The literature on the household structure provided some evidence about the relation between non-parental adults and child development (Bramlett & Blumberg, 2007; Han et al., 2020; Härkönen et al., 2017). Evolution theory suggested that alloparents may contribute to young children's survival and health by investing in their close kin (Sear, 2018). Co-resident family members, most often grandparents, are essential sources for childcare. Grandparents shape the home environment and the relationships between the child and other family members. They play a significant role in rearing grandchildren across different countries and cultures (Timonen & Arber, 2012). In China, 45% of the households with a child under six-year-old has a grandparent living together (Chen et al., 2011), which is much higher than in European countries and the United States (Glaser et al., 2018; J. Zhang et al., 2020). However, some studies found that having co-resident grandparents increased the risk of being obese in childhood (He et al., 2018; Jiang et al., 2007; Li et al., 2015). These grandparents were generally less educated than the parents and more likely to have a traditional preference for fat children and limited knowledge of childhood obesity (Li et al., 2015). Partially due to their own childhood experiences, such as farming and challenging life experiences (He et al., 2018), grandparents in contemporary China tended to prefer overweight children. They believed that being heavy was associated with proper nutrition. Previous studies also suggested considerable differences between generations in caregivers' nutritional knowledge, particularly concerning the micronutrient needs for young children (Tan et al., 2010).

Home-based nannies and their impact on children have been relatively understudied in both Chinese and global literature. Studies suggested that most nannies had low educational attainment and usually had no childcare training (C. Zhang, 2015). There is little research on whether other household members would contribute the same to child physical health as their parents. Considering the characteristics of different caregivers in the household, grandparents and other caregivers may associate with different health outcomes for young children compared to parents. Thus, we expect those children primarily taken care of by parents to grow healthier than those under the care of grandparents or others (Hypothesis 1).

### **Informal and Formal Childcare Outside the Household and Child Physical Health**

There are many kinds of alternative childcare arrangements outside the household for families. The rise in maternal employment and the decline in household size in contemporary China require informal and formal childcare help outside the household. From there, the caregivers outside the household construct the mesosystems that create or restrict opportunities and resource for children, because these systems bridge the microsystem to the broader contexts of families, institutions, culture and society (Allen & Henderson, 2017). It is worth knowing to what extent alternate caregivers outside the household affect child health.

Informal caregivers involve relatives and non-relative caregivers. As yet, few studies distinguished relatives and non-relative informal caregivers from grandparental caregivers. Existing empirical research also revealed mixed results on the associations between these informal childcare types and child physical growth. A systematic review showed that most research did not consider the heterogeneity of informal childcare and suggested that informal care was associated with an increased risk of obesity than parental care (Black et al., 2017). One study on Canadian children found links between informal care and increased body mass index percentile for boys in general and girls from low-income households (McLaren et al., 2012). Other studies reported no associations between non-relative informal care and childhood weight status (Tanskanen, 2013; Zahir et al., 2013).

Formal childcare refers to childcare services provided in public or private institutions, including kindergartens, nurseries and pre-schools. Such services have unique characteristics compared to informal caregivers, such as more involvement of professionals and peers (Slot, 2018). Although most studies examined informal care or centre-based care compared with parental care, only a few studies compared formal childcare with informal care or other reference groups (Black et al., 2017). Moreover, available research on the health outcomes of formal childcare attendance mainly conducted in western societies, and the association between attending formal childcare institutions and childhood physical health outcomes varied regionally, with inconsistent findings (Black et al., 2017), depending on the quality of childcare and caregiver-child relationship (Richter, 2004). Few relevant Chinese studies about the health impact of attending childcare institutions were available for reference. This paper seeks to fill this void. We hypothesize that informal childcare is associated with worse health outcomes for young children, whereas formal childcare is associated with positive outcomes than not using childcare outside the household (Hypothesis 2).

## Multiple Childcare Arrangements and Child Physical Health

Despite the richness of the studies on childcare arrangements, their primary focus was a specific childcare arrangement. Few empirical studies aimed at evaluating the differences and interactions between various caregivers on child health outcomes. Previous evidence suggested that different types of caregivers involved in different amounts and patterns of interaction with children (Liu et al., 2018). From an ecological perspective, factors in and out of the individual's family system are related, and the interactions between these factors influence child well-being (Shek, 2020). Therefore, the investigation of multiple childcare arrangements is required for further examination. The multi-caregiver arrangement has the advantage of pooling together childcare resources, while it also has disadvantages. Changes in childcare arrangements might disrupt children's formerly attached relationships with caregivers and may destroy positive interactions with a particular caregiver (Pilarz & Hill, 2014). These, in turn, may impede the health and development of children.

Based on the discussions above, we speculate that different types of caregivers would be associated with varied outcomes for child physical health. Primary caregivers in the household could moderate the potential association between childcare outside the household and child physical health (Hypothesis 3). For example, while informal caregivers outside the household may be associated with less benefit for child health outcomes due to variation in quality, parents as primary caregivers could watch out for unhealthy diet and activity habits. On the contrary, non-parental caregivers in the household, who are considered inadequate to rearing children properly, may undermine the contributions to support healthy lifestyles from formal professional childcare institutions.

## Method

### Data Source and Sample

This study used data from the China Health and Nutrition Survey (CHNS), an ongoing open cohort project conducted jointly by the National Institute for Nutrition and Health at the Chinese Centre for Disease Control and Prevention and the Carolina Population Centre at the University of North Carolina at Chapel Hill. CHNS collected information from a sample of about 7,200 households with over 30,000 individuals in multiple provinces and cities in China, following a multistage, stratified, random cluster process, and aiming at examining how socio-economic transitions influencing population health in China (B. Zhang et al., 2014). A detailed description of the survey design can be found at <https://www.cpc.unc.edu/projects/china>.

Eight waves of CHNS data (1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011) were used in this study. Information from the 1989 dataset was excluded because the childcare information for children under six was not collected, and the questionnaire and sampling in this first-round survey were substantially different from those in subsequent waves. Besides, data for physical health indicators as introduced below were not publicly available in the dataset of 2015. We selected a sample of children

aged 2 to 6 at each interview time and stacked the data into a person-wave structure. Our working sample consisted of 3,470 children (4,292 person-wave records) after excluding missing values on variables included in the analyses. Those excluded children were a little bit older and lived in households with higher incomes.

## Measures

**Physical Health Outcomes** The physical health of children was the dependent variable of interest. CHNS recorded anthropometrical measurements, including height in centimetres and weight in kilograms. We calculated the body mass index (BMI,  $\text{kg}/\text{m}^2$ ) and standardized z-scores for weight, height and BMI across age and sex according to World Health Organization growth standards (2006) to allow for accurate comparisons among children (World Health Organization, 2006). Height-for-age z-scores (HAZ) reflected cumulative nutritional investments and illnesses over time. Weight-for-age z-scores (WAZ) and BMI z-score (BMIZ) were considered more sensitive to immediate diet changes. One should note that high energy diets may contribute to weight gain while reducing linear growth for children. Also, we distinguished two physical development problems based on BMI, namely obesity and underweight (Vidmar et al., 2013).

**Childcare Arrangements** The primary caregiver in the household and childcare arrangement outside the household were the two key independent variables of interest in this study.

We generated a variable for the primary caregiver in the household with three categories: parents, grandparents, and others. The CHNS asked all household members over six years old whether they spend time taking care of children aged six or younger who were living in the same household, and if so, how many hours in the last week. The detailed information on the relationship between the young child and each household member allowed us to examine every caregiver's childcare hours. It is, therefore, possible for us to compare the childcare time spent by parents with those by grandparents and others.

Childcare arrangements outside the household were derived from the multiple-choice questions in the 'care of children age six or younger' section in the household survey. The CHNS asked whether and where the young child had been taken care of by non-household members. The 11-item scale assessed informal childcare (provided by non-household members in the household, paternal grandparents' house, maternal grandparents' house, house of other relatives, and the neighbour's house) and the formal childcare institutions (including private care centre, public care centre, work unit care centre, pre-school, nursery school and other facilities). Because childcare can happen in multiple locations, the variable childcare arrangements outside the household had four categories: not using any childcare outside the household, only using informal care, only using formal care, and using mixed care.

**Control Variables** In addition to the above childcare variables, we controlled for a series of child characteristics and household characteristics in the analyses.

Demographic predictors included the child's age, gender, and whether he or she was an only child. The household structure was measured by household size and two dummy variables indicating the presence of parents and grandparents in the household. Household income per capita was constructed from all individual wage income, family agricultural and/or business income and welfare benefits, then adjusted to prices in 2011. The site (rural/urban) and wave dummies were incorporated as well.

## Analytical Strategy

First, we conducted descriptive analyses of the pooled sample to examine childcare patterns and trends from 1991 to 2011. Next, we investigated how various childcare arrangements were linked to the child physical health outcomes with random effect models, considering the longitudinal design of CHNS. Linear regression models were used for height, weight and BMI z-scores due to their continuous feature. Logistic regression models were used for the health problem diagnoses, namely obesity and underweight.

To alleviate the endogeneity, we controlled for covariates as mentioned above in the analytical models. The cluster option was used to account for the non-independence of children in the same county and to calculate the adjusted standard errors. It should be noted that many of the children in the sample reached seven which lie out of our restricted age range before the next wave due to the interval between waves. On average, a child was observed 1.3 times across waves. As a robustness check, the models using the sample as repeated cross-sectional data showed similar associations between childcare arrangements and child physical health outcomes as those presented in this article.

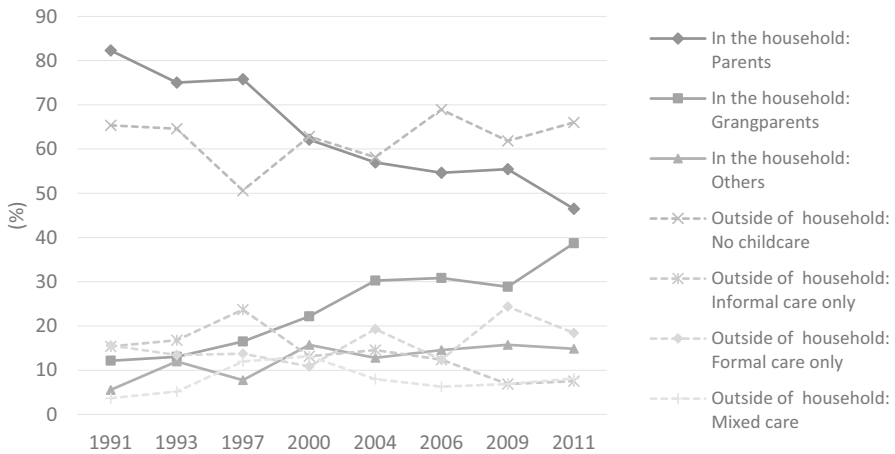
## Results

### Childcare Arrangement Patterns from 1991 to 2011 and Descriptive Statistics

Figure 1 presents the percentage of primary caregiver types in the household (solid lines) and the childcare arrangements outside the household (dotted lines) by years. On average, 63% of children were taken care of by household members only, 14% received informal care, 16% received formal childcare, and 7% received both informal and formal childcare. Concerning the primary caregiver in the household, the proportion of children who were taken care of by parents declined from over 80% in 1991 to below 50% in 2011. On the contrary, the proportion of children having grandparents as primary caregivers increased threefold from 12% in 1991. The proportion of children who were cared for by others increased slightly. Although there were fluctuations in each childcare arrangement outside the household across waves, the trend was unclear.

Table 1 shows detailed descriptive statistics on the pooled sample by the primary caregivers in the household. For children with parents as primary caregivers, the





**Fig. 1** The primary caregiver in the household and childcare arrangement outside the household for children ages 2–6, CHNS 1991–2011. *Source.* CHNS 1991–2011, authors’ calculations

proportions of those receiving care outside the household, both informal and formal childcare, were higher than those with non-parent primary caregivers. Regarding childcare time, household members’ average time was similar for children who were cared for by parents or grandparents, which was much higher than those cared for by others. However, for the children who were mainly taken care of by others in the household, the childcare time outside the household was the highest compared to those with parents or grandparents as primary caregivers.

For the characteristics of children and households, Table 1 revealed that when the primary caregivers were grandparents, children were more likely to be the only child in the family, in a better economic situation and with more household members living together. The mean age of children who were taken care of by others was older than those mainly taken care of by parents or grandparents. For the household structure, 60% of children with grandparents as primary caregivers lived with both parents, which was much lower than those taken care of by parents (92%) and others (81%). The rate of having coresident grandparents was 63% for the children who were taken care of by others, followed by 49% for those with parents as primary caregivers. All children with grandparents as primary caregivers were living with their grandparents.

**Association Between Childcare Arrangement and Child Physical Health**

Descriptive comparisons of physical health scores by various childcare arrangements (Table A1 Supplementary Material) showed that the average weight and height z-scores were lower for children with parents as primary caregivers in the household. Meanwhile, children who were mainly taken care of by parents had the lowest probability of obesity compared to children who were mainly taken care of by grandparents or others. Regarding the comparisons among childcare arrangements

**Table 1** Descriptive statistics of the sample's characteristics by primary caregivers in the household and correlations of variables

	Parents <i>N</i> = 2,821	Grandparents <i>N</i> = 971	Others <i>N</i> = 500	F / $\chi^2$ test
<b>Childcare outside the household</b>				
No childcare outside the household (%)	60.16	69.41	67.12	***
Informal care only (%)	15.85	8.55	11.80	
Formal care only (%)	16.31	15.86	14.00	
Mixed care (%)	7.69	6.18	6.60	
<b>Time spent on childcare (hours last week)</b>				
All household members on average ( <i>SD</i> )	20.37 (24.68)	21.75 (23.10)	5.56 (11.98)	***
Outside the household on average ( <i>SD</i> )	12.89 (22.07)	9.61 (20.00)	14.36 (29.82)	***
<b>Characteristics of children and household</b>				
Age in years ( <i>SD</i> )	4.17 (1.25)	4.08 (1.30)	4.98 (1.41)	
Boy (%)	54.06	52.83	52.00	
Only child (%)	36.65	62.31	36.00	
Urban area (%)	25.63	28.22	21.40	
Household size ( <i>SD</i> )	4.57 (1.47)	5.41 (1.56)	4.99 (1.78)	
Household income per capita ( <i>SD</i> )	23,587.63 (32,625.34)	35,994.32 (40,517.68)	27,869.08 (38,573.93)	
Both parents lived in the household (%)	92.34	59.76	81.02	
Grandparent(s) lived in the household (%)	48.78	100.00	63.00	

CHNS 1991–2011, authors' calculations

Standard deviation in parentheses. \*\*\*  $p < 0.001$ 

outside the household, there were statistically significant differences in weight, height, and BMI z-scores, but not in the proportion of obesity and underweight.

Table 2 presents the results from the regression models for each physical health measure, including all childcare arrangement variables. For the caregiver in the household, the estimations of grandparents and the others were positive for weight-for-age, height-for-age and BMI z-scores. However, the effect sizes were small. The differences compared to those children with parents as primary caregivers were not statistically significant. Hypothesis 1 suggested that parents would be associated with better physical health outcomes for young children. Our results indicated that was not the case. Other caregivers in the household were even associated with a lower risk of underweight compared to parents.

For childcare outside the household, we noticed that the estimates of only using informal care were not significantly different from that of not using any childcare outside the household for all physical health measures. Formal care was associated

**Table 2** Selected estimates from regression analyses using random effect models on children's physical health outcomes

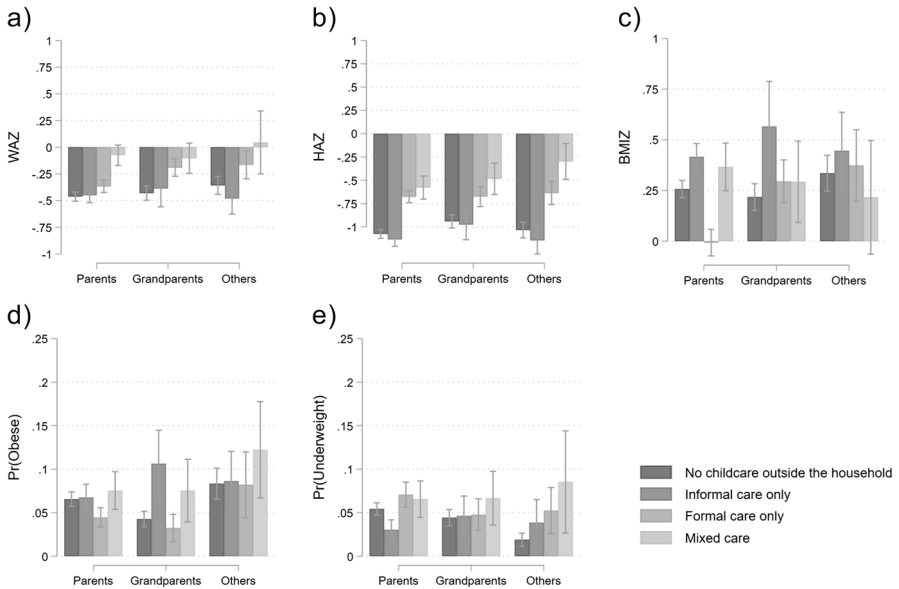
	Weight-for-age z-score	Height-for-age z-score	BMI z-score	Obese	Under-weight
Primary caregiver in the household					
Parents	Ref.	Ref.	Ref.	Ref.	Ref.
Grandparents	0.06 (1.03)	0.11 <sup>†</sup> (1.79)	0.03 (0.56)	-0.36 (1.25)	-0.23 (0.79)
Others	0.11 <sup>†</sup> (1.66)	0.05 (0.73)	0.11 (1.37)	0.46 (1.51)	-0.75* (2.01)
Childcare outside the household					
No care outside the household	Ref.	Ref.	Ref.	Ref.	Ref.
Informal care only	0.01 (0.16)	0.03 (0.46)	0.07 (1.12)	0.48 (1.61)	-0.22 (0.62)
Formal care only	-0.02 (0.43)	0.12* (2.07)	-0.14* (2.18)	-0.38 (1.22)	0.42 (1.58)
Mixed care	0.17* (2.04)	0.19 <sup>†</sup> (1.90)	0.08 (0.73)	0.41 (1.03)	0.67 <sup>†</sup> (1.79)

CHNS 1991–2011, authors' calculations

Unstandardized regression coefficients ( $b$ ) of childcare arrangement variables and standard errors ( $SE$ ) in parentheses are reported. All the models include covariates described in the Method section. 'Ref.' stands for the reference group. <sup>†</sup>  $p < 0.10$ , \*  $p < 0.05$

with higher height-for-age z-scores ( $b = 0.12$ ,  $SE = 2.07$ ,  $p < 0.05$ ) and lower BMI z-scores ( $b = -0.14$ ,  $SE = 2.18$ ,  $p < 0.05$ ). Also, the positive association with mixed care was evident in weight-for-age z-score ( $b = 0.17$ ,  $SE = 2.04$ ,  $p < 0.05$ ). Concerning the health problem measures, only using formal care was significantly associated with less likelihood of being obese than only using informal care. However, childcare outside the household was not related to underweight. These results, therefore, supported Hypothesis 2.

Next, we included the interaction terms for childcare arrangement in and outside the household to examine whether the associations with child health outcomes depend on each other (Table A2 in Supplementary Material). Figure 2 presents the predicted values for each health measure by childcare outside the household within each category of the primary caregiver in the household. For height and weight outcomes, there was no statistically significant interaction term. Figure 2a and 2b illustrated that formal childcare was associated with higher weight-for-age z-scores and height-for-age z-scores regardless of the primary caregiver in the household. However, Fig. 2c revealed that children who had parents as primary caregivers in the household and received formal childcare outside the household obtained the lowest BMI z-scores. For children with grandparents as primary caregivers in the household, informal care outside the household associated with higher BMI z-scores than not receiving childcare outside the household. We also noticed that when the primary caregivers were grandparents, the association between informal care and obesity was more substantial compared to not receiving any childcare outside the



**Fig. 2** Interactions between primary caregivers in the household and childcare arrangements outside the household: predicted margins for each physical health outcome with 95% confidence intervals. *Source.* CHNS 1991–2011, authors' calculations. *Note.* WAZ, weight-for-age z-score; HAZ, height-for-age z-score; BMIZ, BMI z-score

household and only using formal childcare (Fig. 2d). For underweight (Fig. 2e), when children were mainly cared for by parents, informal care outside the household was associated with a lower likelihood of underweight compared to children without childcare outside the household or children receiving formal care only. Overall, these results suggested that the primary caregiver in the household moderated the association between childcare outside the household and child physical health outcomes when measured by BMI z-score, obesity and underweight, which partially supported our Hypothesis 3.

## Discussion and Implications

The health-related quality of life for preschool-age children in China has improved in the past decades (Zong et al., 2019). Though research has indicated the importance of caregivers in the early life stage for child development and well-being, family studies are relatively under-researched in China (Leung & Shek, 2019; Shek, 2006, 2014). There is still a lack of knowledge about how families arrange childcare across multiple caregivers and how mixed caregivers are associated with child physical health. The analyses above contribute to this field of study by revealing China's childcare patterns and trends since the 1990s. The findings also provided information about the health consequences of non-parental childcare arrangements, which has increasingly become common.

Our results showed that the proportion of grandparents as primary caregivers had increased between 1991 to 2011, a period in which child health and nutrition also improved substantially (Zong et al., 2019). However, we should be mindful of the trends of different childcare arrangements and the association with child physical health in the early life stage. First, are primary caregivers in the household other than parents associated with less desirable health outcomes in early childhood? The multivariate analyses suggest that grandparental care is not associated with better or worse health compared to parental care. Notwithstanding, children may be at higher risk of gaining weight and less likely to being underweight when the primary caregiver is in the 'others' category. Second, considering the childcare arrangement outside the household, our results indicate that attending formal childcare is associated with gaining height, having a lower BMI, and thus reducing obesity. On the contrary, any informal childcare experience outside the household is associated with higher weight, BMI z-scores and the risk of obesity compared to only receiving formal childcare.

The findings also add to evidence that primary caregivers in the household may moderate the association between childcare arrangements outside the household and child health outcomes, such as BMI z-scores and obesity. It is insightful for understanding the ecological model for family and social contexts about childcare, most notably the interactions with grandparental childcare. For example, when the grandparents are the primary caregivers in the household, the positive health effect of formal childcare outside the household would be cancelled out. In contrast, grandparental care in the household combined with informal childcare outside the household would increase the risk of gaining weight for children. So while grandparents themselves may not be necessarily different from parents as primary caregivers, they do influence child quality of life simultaneously with other childcare arrangements outside the household. This is especially important for families in China where grandparents increasingly step in as primary caregivers, and other childcare arrangements outside the household are also used to meet the needs of both caregiver grandparents and working parents (C. Zhang, 2015).

We also tested the cumulative influence of the number of caregivers. Although not shown here, we found that increases in the number of informal childcare arrangements outside the household were associated with a higher risk of obesity in children, but the associations faded after controlling for the primary caregiver in the household. At the same time, parents' absence from the household was associated with lower weight, shorter height and risk of underweight, which is consistent with previous findings on the influence of parent-child separation. Interestingly, we notice that grandparental coresidence was also associated with a higher likelihood of underweight when the parental presence and childcare arrangements were considered. This finding contradicts a previous study that found grandparental coresidence increased the risk of obesity for Chinese children aged 2–13 using the same dataset and row weight as measurement (He et al., 2018). As the previous study showed, the prevalence of obesity was higher for school-aged children than younger children (N. Zhang & Ma, 2018). This apparent paradox might be due to a larger population which included school-age children. We only focused on the population aged 2–6 years old in this study. Another possible explanation could be that they

restricted the sample to children with both parents in the household; therefore, the influence of grandparental coresidence can be considered as an additional contribution of caregivers.

This study also has several limitations. Though we have established associations between the various childcare arrangement and the physical health well-being of young children in China, there is still a high degree of unobserved heterogeneity between the children in this study. A wide range of structural factors such as cultural changes and socio-economic transitions require investigations in the future. We noticed that the wave variables were still statistically significant in the full models after controlling childcare arrangements. It implies that the changes in the childcare arrangements during the study period were hardly attributable to the changes in the child health outcomes between 1991 to 2011. Although we have included a range of covariates of child physical health outcomes in the RE models, other factors might contribute to child health development, which could not be examined due to data limitations. For example, we cannot obtain parents' socio-economic characteristics if they did not live with the children. Also, it is hard to distinguish within-child differences and between-child differences for our findings from the RE models.

Furthermore, we acknowledge that childcare arrangements do not take place randomly. The choices of caregivers could be affected by coresidence, maternal employment, need of multiple generations in the family, and availability of and affordability for the formal childcare services (Chen et al., 2011; Du & Dong, 2013; Falkingham et al., 2020). Caregivers influence children by shaping their environment, but caregiving is also a reaction to family circumstances and child characteristics (Ventura & Birch, 2008). We cannot rule out the possibility, for example, that the children in better health were selected to be taken care of by other people or sent to centre-based institutions. In contrast, parents may spend more time taking care of underdeveloped children, particularly in early childhood. Hence, child physical health conditions could be a determinant for a family's childcare arrangement decisions. Future studies can include more specific time points during early childhood, if available, to obtain a trend of child physical growth to examine the mechanism of childcare arrangements on the critical time for healthy growth and better well-being of children.

Despite such limitations, this study is one of few attempts to examine child health-related quality of life with childcare complexity in China. Similar research on the quality of life for children in Chinese societies in this journal's recent special issue is mainly in Hong Kong (Leung & Fung, 2021). Empirical studies on mainland China are inadequate. Using a national representative longitudinal household survey in mainland China, this study complements the literature about quality of life in children in non-western societies. Practically, our findings illustrate that the different caregivers seem to be associated with different dimensions of child physical health and may contribute to child development through different pathways. Counter to the common fear that children raised by grandparents may be suffering low-quality care, the substantial involvement of grandparents compared to that of parents might at least be not harmful to physical health outcomes of children in early childhood in China. This should be accounted for when evaluating the consequence of the ageing population and increasing involvement of grandparents (Gong et al., 2016; Han

et al., 2020). Moreover, interventions aimed at increasing early childhood care and education enrolment may be linked to better physical growth and protect young children from overweight. Crucially however, policies aiming to promote formal childcare should consider the potential influence of the primary caregiver in the household and other childcare arrangements that a child is experiencing to ensure optimal outcomes for child health and well-being.

Policymakers concerned with childcare arrangements and child development often focus on nurturing the child, particularly improving early childhood education in China (Hu & Peng, 2012). The findings that multiple caregivers are associated with early childhood physical health is also a concern. Therefore, policymakers and educators should consider incorporating caregivers in the household and informal and formal childcare outside the household in a broader definition of early childhood education and care.

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## Declarations

**Conflict of Interest** The authors have no conflict of interest to declare.

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