BMJ Open

Diet structure and academic achievement of children from difficult families: a cross-sectional study of Chinese children

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To cite: Du B, Mu Y, Wang X. Diet structure and academic achievement of children from difficult families: a cross-sectional study of Chinese children. *BMJ Open* 2022;**12**:e055839. doi:10.1136/bmjopen-2021-055839

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2021-055839).

Received 26 July 2021
Accepted 01 March 2022

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ABSTRACT

Objectives Welfare policy focuses on vulnerable populations, such as children with difficult family backgrounds. Education is a crucial way to reduce poverty. This study explored the relationship between children's diet structure and academic achievement and compared these across different family backgrounds.

Design A cross-sectional study was conducted to survey the health status of children from difficult families based on a random sampling method in 2018. Survey data were collected from children and their guardians with a questionnaire. A multi-sample latent class model and an ordinal logistic model were applied for data analysis.

Setting This study was conducted in 31 provinces nationwide. Two provinces in the Central (Shandong and Jiangxi), Eastern (Hebei and Henan) and Western (Chongqing and Shanxi) regions and one province in the Northeast (Liaoning) were selected considering different stratum of economic development.

Participants A total of 2099 children with difficult family backgrounds and 666 children from ordinary families were surveyed.

Results The dietary structure of children from ordinary families was significantly better than that of children with difficult or unstable family backgrounds (χ^2 =9.178, p<0.01). Children from difficult families had an intake of dairy products and fruits below dietary standards. The difference in academic achievement between children in the balanced and deprived groups was statistically significant (OR=0.640, 95% CI 0.429 to 0.955). Other determinants of the academic achievement of children in difficult families were parents' education level (OR=1.331, 95% CI 1.162 to 1.525), family economic status (OR=0.835, 95% CI 0.748 to 0.932) and parents' academic concern (OR=0.373, 95% CI 0.252 to 0.553).

Conclusions To address the differences between children from difficult families and ordinary families, policymakers should develop support policies for difficult children, guide the formation of a reasonable dietary structure. Besides, enhancing family closeness and fostering family nurturing behaviours are the keys to promote the good academic development of children from difficult families.

Strengths and limitations of this study

- ► There is limited research about Chinese children from difficult families, a vulnerable group.
- ► This national study covers economically developed regions, general regions and undeveloped regions to increase representativeness.
- ► Dietary structure was classified through a multisample latent class model, which can compare different samples.
- ► A limitation is that we only can test the relationships among variables through a cross-sectional study.

INTRODUCTION

China's Ministry of Civil Affairs[1] issued 'Pilot Project of Building an Adequate and Inclusive Child Welfare System', which defines the concept of children from difficult families: children whose parents are severely disabled or ill; children whose one parent has died and the other parent is unable to fulfil their child-rearing obligations and guardianship duties due to other circumstances; children whose parents are serving long-term prison sentences or are under mandatory drug rehabilitation and children from low-income families. According to the sixth census, the Ministry of Civil Affairs estimates that millions of children in China are in difficult families.[2]

These families lack the financial and care support for healthy child development. Education is critical to reducing poor health.[3] Children's academic achievement was associated with further educational attainment and working performance in the labour market.[4] Thus, improving vulnerable children's academic performance and creating quality human capital can interrupt the intergenerational transmission of poverty and avoid poverty returning. In addition, the findings for this population can be extended to other vulnerable groups with a model effect.

Family plays a fundamental role in childhood development. Family socioeconomic status (SES) is one of the most important family factors influencing all aspects of child

development, including parents' education level, family income and parents' occupation.[5–7] In the family environment, the most influential direct variable on a child's academic performance is not parental SES, but parenting style and parental behaviour.[8]

Parenting patterns involve parental involvement, supervision and monitoring and autonomy.[9] Acceptant parental involvement and autonomy express recognition and emotional support for the child and imply more academic-related support at the level of specific behaviours.[10] Parental monitoring and behaviour control promote the development of self-management skills and more time spent on work, which contribute to good academic performance.[11] A series of studies provide empirical evidence for this, such as Bixinwen *et al*, who reported that parental acceptance involvement and supervision monitoring significantly and positively predicted adolescent academic performance.[12]

Other studies found that parental monitoring,[11] autonomy support[13] and engagement[14] significantly affect the academic performance of elementary and middle school students. Parents in difficult families have lower educational attainment, are under more pressure and work in low-paying service industries compared with families facing fewer struggles. Previous studies have confirmed that children from difficult families have significant differences in prosocial behaviour, mental health and physical health compared with children from ordinary families.[15] However, there is no research on whether the academic achievement of children from families in distress differs from that of other children. Based on previous research, this study proposed two hypotheses. Hypothesis 1: the difference in academic achievement between these two groups of children is significant. Hypothesis 2: the academic performance of children from difficult families is influenced by their dietary structure.

Neuroscience research suggests that vitamin E and iron deficiencies can lead to reduced mental concentration and cognitive performance,[16] and choline and lecithin deficiencies can affect children's memory capacity.[17] However, these studies only demonstrated the role of a single micronutrient or food. Single nutrients may have synergistic or antagonistic effects in different contexts, suggesting that studies on children's diets should investigate multiple dietary behaviours to assess overall diet quality better. Research has shown that a healthy dietary structure has a positive association with academic performance. Children with balanced diets have an advantage in dynamic learning behaviours and academic achievement over children with poor diets.[18] Studies involving Australian school-aged children found that a higher intake of sweets and sugary drinks was associated with lower English language achievement.[19] These studies concentrated on Western populations. Further research involving a Chinese population is needed to capture different food cultures. We propose a third hypothesis, hypothesis 3: academic performance of children from difficult families is influenced by their dietary structure.

Current Chinese research explores the relationship between single nutrients or foods and children's health or uses a composite index to evaluate the quality of school-age children's diets.[20–22] We conducted this study based on two objectives: to include more Chinese samples and include children from different family backgrounds. We adopt the family ecosystem theory, emphasising the family environmental factors of children from difficult families to research the relationship between dietary structure and academic achievement. Family ecosystem theory indicates that each family member is in a different position and interdependent from one another.[23] The theory means the better the family functions, the more balanced the family ecosystem is, and the healthier the family members are. Parents in families experiencing difficulties have problems performing their duties because of family economic status and other reasons (in prison or physical disability). Their adverse experience changes the family economic environment and parental subsystems, influences the child subsystem and affects the child's development. This study aimed to promote children's academic performance and considered dietary structure as a significant determinant of academic performance. We also suggested the inclusion of children from more stable families because family environment factors were another important determinant of academic achievement based on the family ecosystem theory.

METHODS

Participants

The research team surveyed seven provinces and randomly selected 300 children from difficult families, for 2099 children in total. Children from ordinary families were randomly selected from the same sampled districts, for 666 children in total.

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

Setting

The field survey was launched in August of 2018 and lasted for 1 month. Children from difficult families are those who meet any of the following criteria: (1) parents who are seriously disabled or ill; (2) parents who are serving long-term prison sentences or forced drug rehabilitation; (3) one parent dies and the other parent is unable to fulfil their child-rearing obligations and guardianship duties due to other circumstances or (4) poor families whose parents are unable to support them. These criteria are based on the official definition from the Chinese Ministry of Civil Affairs. In China, each child from the difficult family is registered with the Ministry of Civil Affairs in each district and county (which is kept up-to-date). During our field research, we worked with local officials to randomly choose children from difficult families whose data were recorded. The inclusion criteria

for ordinary families are that they do not meet the criteria of a difficult family.

Considering the differing economic development of different provinces and cities in China, we used a random sampling method to select two provinces each in the Central (Shandong and Jiangxi), Eastern (Hebei and Henan) and Western (Chongqing and Shanxi) regions and one province in the Northeast region (Liaoning) according to the criteria of the National Bureau of Statistics. Three districts and counties were randomly selected in each sample province as representatives for the survey study, for a total of 21 districts and counties. Each district and county surveyed 100 children in each of the four types of difficult families, ensuring that the number of children in each type of difficult situation was at least 25. The total sample size was 2100, with no less than 525 children in each category. Children answered their questions by themselves, while the guardians answered questions regarding family financial status and demographic background. The response rate was 99%.

We randomly selected 30 children from ordinary families as controls in the sampled districts (age, gender and other characteristics were as identical as possible to the children from difficult families). The sampled districts and sampling strategy for the non-difficult families are the same as those of the difficult families.

Procedure

We spent 4 months of preparatory work, such as designing the questionnaire and staff training. Four professional professors designed the questionnaire, and three public health and demography experts reviewed the reliability and validity of the questionnaire to ensure survey feasibility. We also checked the readability and clarity of the questionnaire to ensure that participants would be able to understand the questions. The staff in this field survey included 21 current master's and doctoral students in related fields who had been involved in questionnaire design from early in the project. Before the questionnaire survey, there were three unified training sessions (lasting half a month), and we also had staff listen to a recording of each questionnaire repeatedly for verification after the survey.

We took numerous measures to address possible systematic errors in the questionnaire. First, during the survey design stage, a presurvey method was used to understand the complexity of the survey respondents. Relevant experts were consulted to verify the rationality of the questionnaire design and the specificity of the sampling scheme. In addition, professional data processors conducted a statistical analysis and a description of the pilot questionnaire data to check for systematic errors. They reported interview time, non-response rate and outliers to the quality supervision and survey teams.

We also took error control measures at the data collation stage. We developed a sorting plan for data entry, which includes reviewing the original questionnaires one by one. We also unified the methods for collating, summarising, calculating and analysing the questionnaire data. We developed a unified coding scheme and used EpiData software to double-enter and compare the same questionnaire in two groups to minimise errors caused by individual investigators.

Variables

This study included one dependent variable, academic achievement; one independent variable, dietary structure and seven covariates, including the children's age and gender, guardian education level and health status, the family's economic status and living conditions and parents' academic concerns.

Measurements

Academic achievement was measured with the question 'How do you currently rank in your class?' There were three answers: 'good', 'fair', and 'poor'. 'Good' represents the top 25% of the class, 'fair' represents the 25%–75% tier and 'poor' the bottom 25% of the class. In China, each student is informed of his grade ranking in a class after taking an examination. In our field survey, the interviewer asked children about their overall class ranking in the last academic year (final examination). The main reason for this design is that exam subjects vary from grade to grade and the difficulty of exam questions varies, so judging children's learning status based only on a particular score in a subject may result in some bias. Grade ranking is different from subjective assessments and is based on objective results.

The dietary structure was measured with a scale based on the dietary recommendations for school-age children in 'Dietary Guidelines for Chinese Residents (2016 edition)'.[24] The scale included seven food intakes: puffed food, eggs, meat, milk, vegetables, fruit and water (see in table 1). The Cronbach coefficient of this scale was 0.736, indicating good reliability. We used factor analysis to examine the structural validity of this scale. The KMO (Kaiser-Meyer-Olkin) test aims to compare simple and biased correlation coefficients between variables. A KMO value over 0.5 suggest there is substantial correlation in the data. The KMOvalue in this study was 0.753, which indicated that the structural validity of this scale was good.

Covariates included the child subsystem and family subsystem. A child's age and gender were contained in the child subsystem. The family subsystem included the guardian's education level and health status, the family's economic status and living conditions and the parents' academic concerns (more details in table 2).

Statistical analysis

First, we used multisample latent class modelling (MS-LCM) to analyse the potential categories of dietary structure and to explore the difference between the two groups (children from difficult families and children from ordinary families). MS-LCM is a simultaneous analysis of the responses of two or more groups of subjects on the same set of epistemic variables, allowing the researcher to compare whether the results of the potential category analysis differ across samples.[25] The MS-LCM model introduces factor

Table 1 The scale of dietary structure

Items	Value	
How many times did the child eat **puffed food** in the past 7 days?	1=zero	0=once and more
On average, how many **eggs**, such as eggs and duck eggs, including in the form of scrambled eggs and egg soup did you eat during the past 7 days?	1=once and more	0=zero
How many times did you eat **meat** in the last 7 days	1=4 times and more	0=3 times and less
How many times did you drink **milk** (including canned milk, milk powder or fresh milk from animals, yoghurt without kefir, dairy drinks such as Nutri-Fast, etc., at least 200 mL each time) in the past 7 days?	1=4 times and more	0=3 times and less
In the past 7 days, how many fresh **vegetables** have you eaten each day?	1=two types and more	0=one types per day or basically no food
How many times did you eat **fruit** (excluding canned fruit and dried fruit) in the past 7 days?	1=3 times and more	0=two times and less
How much plain **water** do you usually drink every day?	1=more than 800 mL	0=less than 800 mL

analysis and structural equation modelling based on the principle of probability distribution and log-linearity.[26]

Second, we performed an ordinal logistic model after determining the number of latent categories to compare the differences in academic achievement between the different groups of children. We incorporated the dietary structure (identified by MS-LCM) as the independent variable and children's family environment factors as covariates in the logistic model. Because the dependent variable, academic achievement, was ordinal, we chose an ordinal logistic regression model to analyse the relationship between dietary structure and academic achievement. The study used Mplus V.7.4 software to run the MS-LCM model. The subsequent logit model and parameter estimation were implemented by Stata V.16.0 software.

RESULTS

Participant characteristics

Children from non-difficult families had better academic performance than children from difficult families, and the difference was statistically significant (χ^2 = 9.178, p<0.01). The differences in food intake between the two groups were statistically significant, except for the difference in daily water intake, which was not. There were no significant differences between the two groups in terms of gender and age in other covariates. Therefore, the result was comparable. Children from difficult families had weaker family SES, guardianship status and family relationships than children from stable families (table 3).

Multisample latent class analysis of the dietary structure pattern

To estimate children's dietary structure patterns, latent class analysis was conducted for seven observable daily intakes: puffed food, eggs, meat, milk, vegetables, fruits and water. Table 4 reported the five fitted latent class models, M1–M5. The study proved that BIC (bayesian

Table 2 Basic information of covariates

Variables	Explanation
Child subsystem	
Age	A continuous variable.
Gender	The sex of children; 1=male;2=female.
Family subsystem	
Education level	Highest education level in guardians; 1=illiteracy, 2=elementary school, 3=middle school, 4=high school, 5=post-secondary and 6=bachelor.
Health condition	Guardian's self-rated health; 1=very healthy, 2=relatively healthy, 3=fair, 4=relatively unhealthy and 5=very unhealthy.
Family economic status	A continuous variable; household annual income per capita in the last year (China Yuan, CNY).
Living condition	The type of housing the children currently live in; 1=building, 2=brick and tile bungalow, 3=earth-built bungalow and 4=others.
Academic concerns	A dichotomous variable, indicating whether the guardian attaches importance to the children's studies. 1=yes; 2=no.

Table 3 Variable distribution in two groups

Categorical variables	Difficult families		Ordinary families		χ^2/T	P value
	N	Per cent	N	Per cent		
Academic achievement					9.178	<0.01
Poor	124	6.77	28	4.93		
Medium	1328	72.53	391	68.84		
Excellent	379	20.70	149	26.23		
Dietary structure (past week)						
Never eaten puffed food	1065	50.74	198	29.73	89.931	0.000
Ate at least one egg per day on average	1444	68.79	503	75.53	10.995	0.000
Ate meat foods at least four times	402	19.15	401	60.21	413.588	0.000
Drank an average of 200 mL or more of milk per day	41	1.95	181	27.18	435.618	0.000
Ate at least two kinds of fresh vegetables on average per day	1334	63.55	563	84.53	103.33	0.000
Ate fruit at least three times	362	17.25	349	52.40	327.124	0.000
Drank at least 800 mL of plain water on average every day	1277	60.84	385	57.81	1.937	0.164
Gender					0.829	0.363
Male	955	52.16	311	54.75		
Female	876	47.84	257	45.25		
Education level of guardian					129.458	0.000
Illiteracy	107	5.84	26	4.58		
Elementary school	634	34.63	105	18.49		
Middle school	849	46.37	266	46.83		
High school	216	11.8	135	23.77		
Post-secondary	25	1.36	36	6.33		
Bachelor's degree or above	107	5.84	26	4.58		
Health condition of guardian					160.523	0.000
Very healthy	510	27.85	273	48.06		
Relatively healthy	573	31.29	212	37.32		
Fair	390	21.30	63	11.09		
Relatively unhealthy	276	15.07	19	3.35		
Very unhealthy	82	4.48	1	0.18		
Living condition					244.423	0.000
Building	177	9.67	193	33.98		
Brick and tile bungalow	1422	77.66	373	65.67		
Earth-built bungalow	212	11.58	1	0.18		
Others	20	1.09	1	0.18		
Academic concerns of guardian					22.729	0.000
Yes	1668	91.1	549	96.65		
No	163	8.9	19	3.35		
Continuous variables	Mean	SD	Mean	SD		
Age	9.88	2.70	9.81	2.61	0.533	0.703
Family economic status	8.45	1.05	9.30	1.03	–17.054	0.000
Total	1831		568			

We only reported the children meet the standard in the part of dietary structure. ** and *** indicated: p<0.01 and p<0.001, respectively.

information criterion) is the most effective indicator when the sample size is higher than 2000. BIC is a measure of relative fit, and a lower value indicates a better fit. The analysis results in table 4 showed that the M3 latent class model had the smallest BIC statistic, indicating that M3 was better than other models.

Figures 1 and 2 showed consistency in the classification trends between children from difficult families and

Table 4 Model fit indicators for different class

Class	AIC	BIC	ABIC	Degree of freedom	LMR LRT
M1	24 175.45	24 264.32	24 216.66	240	<0.000
M2	23 122.47	23 300.22	23 204.90	224	<0.000
M3	22 911.34	23 177.95	23 034.97	209	<0.000
M4	22 832.71	23 188.19	22 997.55	194	<0.001
M5	22 803.33	23 247.69	23 009.39	180	0.061

The AIC, BIC and ABIC predict relative goodness of fit; lower values represent better fitting models. The non-significant p-value of LMR-LRT indicates that the model with one less class is acceptable.
ABIC, Adjusted Bayesian Information Criterion; AIC, Akaike information criterion; BIC, Bayesian Information Criterion; LMR LR, Lo-Mendell-Rubin Likelihood Ratio Test.

children from non-difficult families, indicating that the two sample groups were similar in structure. Table 5 reported the predicted probabilities of the intake of the seven foods in the three different latent categories to categorise the latent variables. In latent variable one for difficult families, the prediction probabilities for all food categories were very low, and therefore named the "deprivation group." In latent variable 2, the vast majority of dietary intake is balanced (this group meet the balance dietary from Dietary Guidelines for Chinese Residents,[24] moderate intake of fish and meat and other high-quality protein and vegetables and fruits, less puffed food), and therefore named the "balanced group." In latent variable 3, meat, fruit, and puffed foods had the highest prediction rates, and the rest were deficient, so it was named the "unbalanced group". The single category prediction probability composition of each latent variable in the ordinary families was similar to that of the difficult families.

Table 6 reflected the composition of children's diet in the two family groups. Although most children were categorised in the "unbalanced group," the percentage of children in ordinary families who were categorised in the "balanced group" was significantly higher than that of children in difficult families. In comparison, the percentage of children from ordinary families categorised as the " deprivation group" was significantly lower than that of children in difficult families. This indicated that children in ordinary families had a better dietary structure than children in difficult families, and the difference was statistically significant.

The effect of children's dietary structure on academic performance

To analyse the effects of differences in the dietary structure on children's academic achievement from the two family types, four ordinal logistic models were fitted (table 7). Models 1 and 3 only examined the effect of dietary structure on children's academic achievement in difficult and ordinary families. Covariates were added in

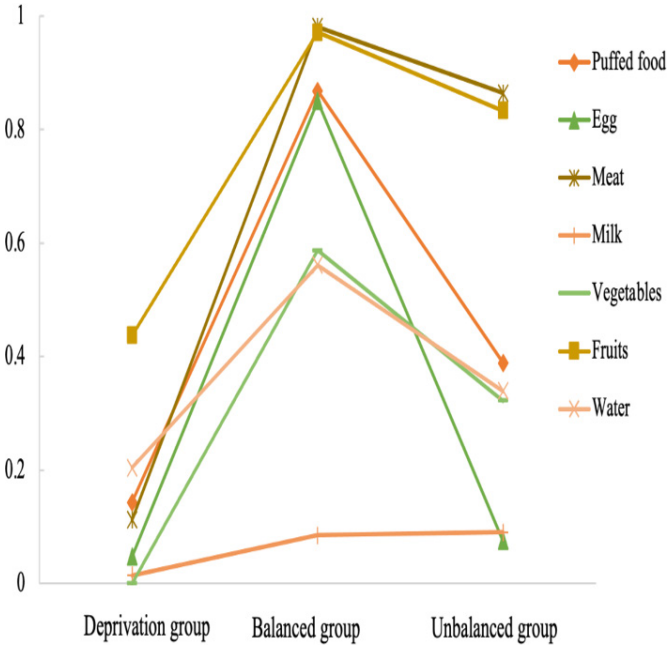

Figure 1 Trends in the classification of three potential categories of children from difficult families.

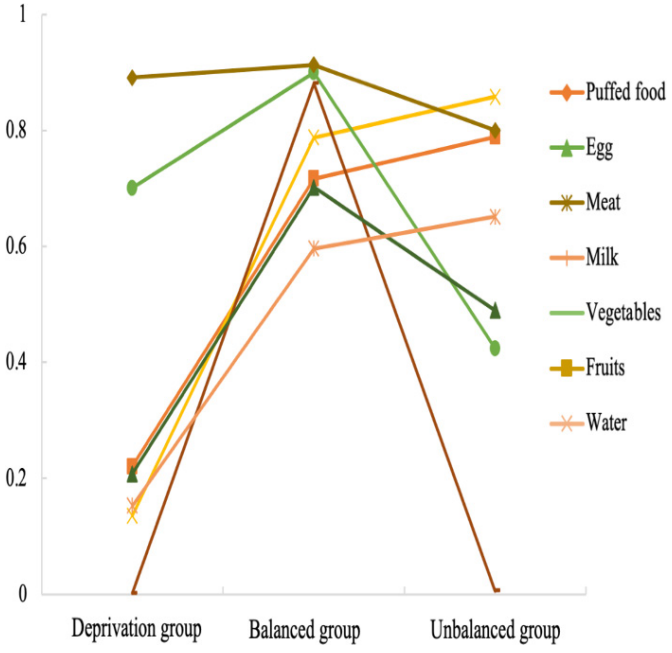

Figure 2 Trends in the classification of three potential categories of children from ordinary families.

Table 5 Predicted probabilities and latent class for each food group in a single category

	Difficult families			Ordinary families		
Food index	Latent class 1 (deprivation)	Latent class 2 (balanced)	Latent class 3 (unbalanced)	Latent class 1 (deprivation)	Latent class 2 (balanced)	Latent class 3 (unbalanced)
Puffed	0.143	0.868	0.389	0.221	0.717	0.789
Eggs	0.047	0.850	0.075	0.136	0.788	0.858
Meat	0.112	0.981	0.864	0.701	0.900	0.424
Milk	0.014	0.085	0.091	0.002	0.881	0.006
Vegetable	0.000	0.587	0.322	0.891	0.913	0.800
Fruit	0.437	0.971	0.833	0.208	0.702	0.490
Water	0.204	0.561	0.339	0.153	0.596	0.651

models 2 and 4 to examine the effect of family environment on children's academic achievement in both types of families.

Model 1 showed that children in the diet-balanced group had 1.468 times higher academic achievement than those in the diet-deprivation group, without considering covariates. The difference in academic achievement between children in the dietary balance and deprivation groups remained statistically significant after considering covariates (model 2). Girls' academic performance was better than boys'. Guardians' education level and academic concern had a positive relationship with children's academic performance. However, there was a negative correlation between family economic status and children's academic performance.

In models 3 and 4, the result from ordinary families, the difference between the balanced, unbalanced diet groups, and the diet deprivation group was statistically significant without considering covariates (1.715 and 1.961 times higher, respectively). However, after including the covariates, the differences were statistically insignificant. Girls' academic performance was better than boys'. Guardians' education level was positively associated with academic performance.

DISCUSSION

Children from difficult families had significantly poorer dietary structure patterns than children from ordinary families. The proportion of children in difficult families who achieved a balanced diet was only about 10.0%, while this proportion in ordinary families was 26.3%. This may be related to the family's economic status and guardians' parenting knowledge. In addition, children in both groups had the highest probability of having an unbalanced diet. Previous research has found that Chinese children's snacks were dominated by processed foods.[27] This dietary pattern leads to high salt, energy and fat intake, which must be addressed. Besides, children in difficult families had a low intake of milk and fruits. Compared with ordinary families, difficult families are always at a disadvantage in economic status. Studies have reported the significant relationship between family economic income and Chinese children's milk drinking behaviour[28] and fruit consumption.[29]

Table 6 Composition of children's dietary subgroups in the two groups of families

Meal grouping	Difficult families	%	Ordinary families	%
Balanced	193	10.04	153	26.33
Dietary bias	1158	60.25	366	62.99
Deprivation	571	29.71	62	10.67
Total	1922	100.00	581	100.00

*150.155 P<0.001.

Before controlling for other family-related factors, children's dietary structure was associated with academic performance significantly in the two children's groups; however, after including covariates, only the academic differences between the deprivation and the balanced groups in difficult families remained statistically significant. Dietary deprivation may lead to a lack of adequate nutrients and develop malnutrition diseases such as anaemia. Thus, food shortage caused the reduction of children's responsiveness in heavy academic tasks.[30] Based on the results from predicted probability of different food intake, difficult children in deprived group faced serious food shortage problems. More attention should be paid to their diet and food supply in policy.

Previous studies have shown that an increase in family income provides a better physical environment for children and promotes their academic achievement.[31] However, the present study found that the economic status of difficult families had a negative relationship with children's academic achievement. Some studies have shown that the increase in family income mainly stems from the increase in parents' working hours.[32] Parents in difficult families usually struggle to earn more money than more stable parents, which leads them to sacrifice longer hours for relatively higher income and to spend less time with their children, often neglecting their children's schooling. The parental involvement positively impacts children's academic performance. The contradiction between the increase in work hours and parental

Table 7 Results of regression analysis of the effect of dietary structure and family environment on children's academic performance (OR values)

	Difficult families				Ordinary families			
	Model 1		Model 2		Model 3		Model 4	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Dietary groups (reference : balanced group)								
Unbalanced	0.965 (0.169)	(0.685 to 1.359)	0.909 (0.166)	(0.636 to 1.301)	0.583* (0.119)	(0.391 to 0.869)	0.847 (0.187)	(0.550 to 1.305)
Deprivation	0.681* (0.129)	(0.469 to 0.988)	0.640* (0.131)	(0.429 to 0.955)	0.510* (0.170)	(0.265 to 0.981)	0.794 (0.286)	(0.391 to 1.610)
Gender (reference : male)			1.405** (0.148)	(1.143 to 1.726)			1.974* (0.375)	(1.360 to 2.864)
Age			0.977 (0.020)	(0.939 to 1.017)			0.996 (0.036)	(0.928 to 1.069)
Education level of guardian			1.331*** (0.092)	(1.162 to 1.525)			1.422** (0.155)	(1.149 to 1.760)
Health condition			0.975 (0.049)	(0.884 to 1.076)			0.790 (0.105)	(0.609 to 1.024)
Family economic status			0.835** (0.047)	(0.748 to 0.932)			1.007 (0.103)	(0.824 to 1.231)
Living condition			0.871 (0.092)	(0.707 to 1.072)			0.830 (0.170)	(0.556 to 1.239)
Academic concern of guardian			0.373*** (0.075)	(0.252 to 0.553)			0.648 (0.379)	(0.206 to 2.039)
/cut1	−2.769 (0.181)	(−3.124 to −2.413)	−4.178 (0.685)	(−5.521 to −2.835)	−3.397 (0.252)	(−3.891 to −2.904)	−2.574 (1.091)	(−4.713 to −0.435)
/cut2	1.216 (0.163)	(0.896 to 1.536)	−0.020 (0.673)	(−1.339 to 1.299)	0.637 (0.168)	(0.308 to 0.966)	1.679 (1.081)	(−0.441 to 3.798)
Samples	1831		1831		568		567	
Pseudo R^2	0.004		0.033		0.009		0.046	
χ^2test	9.41 (0.009)		89.15 (0.000)		7.95 (0.019)		39.22 (0.000)	

*,** and *** indicated: p<0.05, p<0.01 and p<0.001, respectively.

involvement explains the inconsistent between this study and previous results. In other family-related factors, this study found that academic concern and parents' education level were also associated with academic achievement. However, it is interesting that the significant relationship between academic concern and academic achievement was only found in children from difficult families. We presumed that children from difficult families are more sensitive and vulnerable, and parental attention and academic concern can boost children's confidence in school.

Implications for practice

Our findings have implications for school and welfare policy practice in China and other countries that focus on vulnerable children. This study may inform educators and school administrators about the importance of diet. Some children from difficult families have lunch and dinner in school. Our findings suggest that school administrators should pay more attention to canteen management. Education and welfare departments need to set the school standards. Parent academic concern plays an essential role in children's academic performance. Thus, parents should be involved in children's schooling and improve parent–child interaction quality, not just provide simple companionship. Community social workers can teach these skills to parents and provide care when the parents are busy. Policy guidelines should be amended as such.

Limitations

Although we incorporated relevant foods into a dietary structure based on the Dietary Guidelines for Chinese Residents (2016) recommendations for school-age children, a mature international framework for children has not yet been developed. As a result, the rationality of the dietary structure in this paper is open to question. The cross-sectional data cannot infer the causal effect of children's dietary structure and academic achievement, which requires further study.

CONCLUSIONS

This study innovatively distinguished children from different family backgrounds and analysed the relationship between diet structure and academic achievement

of children from difficult families. The difference of academic achievement between two groups of children was significant. Children from difficult families with poor diet structure, higher family economic status, lower parent' education level and academic concerns were significantly associated with lower academic achievement. For children from ordinary families, higher parent's education level was significantly associated with higher academic achievement. We recommended that joint force from public health department, school and community should be taken to provide healthy diet for children from difficult families.

Contributors BD as the first author has undertaken data curation and methodology, YM and XW have performed the formal analysis and YM finished the final editing. All authors have read and approved the manuscript. BD is the guarantor.

Funding This paper was sponsored by the National Social Science Key Project [grant number 21AZD073] and National Natural Science Foundation of China [grant number 71974194].

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Consent obtained directly from patient(s)

Ethics approval This study involves human participants and informed consent was obtained from all participants or their legal guardian (if participants are under 18), before the survey. All methods were carried out in accordance with relevant guidelines and regulations. The protocol was approved by the Ethics Committee of School of Sociology and Population Studies, Renmin University of China. (Project identification code:17JJD840001). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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