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Exploring parental preferences for childhood obesity prevention program in China: a discrete choice experiment

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Abstract

Background Childhood obesity has emerged as one of the most critical public health challenges in China. Despite its urgency, the existing research on parental preference for tackling childhood obesity remains insufficient. This study aimed to determine the factors that parents prioritise most when commissioning hypothetical programs that target childhood obesity prevention in China.

Methods A discrete choice experiment (DCE) was conducted to assess parental preferences for a hypothetical childhood obesity prevention programme attributes. Recruitment occurred between 20th October 2022 and 30th December 2022, using snowball sampling facilitated through social media platforms. Eligibility criteria were limited to parents with at least one child aged between 5 and 17 years old. Relevant attributes of the childhood obesity prevention programme were identified through a literature review and expert consultation. The study encompassed six attributes, and the coefficient of these different attributes was analysed using multinomial logit models (MNL) and latent class models (LCM).

Results This study, involving 631 participants, demonstrates that in prioritizing attributes of childhood obesity prevention programs, parents place the greatest importance on additional costs (32.36%). This is followed by daily sleep duration (18.42%) and dietary choices (16.49%). A preference for a 9-hour sleep duration is evident (Odds Ratio [OR]: 1.291; 95% Confidence Interval [CI]: 1.186–1.406; $p < 0.05$, reference: 7 h), as well as a tendency towards high-protein diets over low-fat ones (OR: 1.114; 95% CI: 1.034-1.200; $p < 0.05$, reference: low-fat diet). School-based exercise is favoured over fitness centres (OR: 0.837; 95% CI: 0.785–0.893; $p < 0.001$, reference: school-based). A latent class model (LCM) identifies two distinct groups: one preferring school-based exercise, 8-hour sleep, and minimal additional expenses; the other favouring 9-hour sleep and willingness to invest an additional RMB200 for weight control. Both groups prefer high-protein diets and early eating schedules.

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Conclusions Understanding parental preferences and concerns is vital for crafting effective public health policies aligned with UN SDGs and the SDH framework. Key elements include promoting balanced diets, ensuring safe exercise spaces, and fostering parental engagement. Collaboration among policymakers, educators, and parents is essential to mitigate childhood obesity.

Keywords Childhood obesity, Discrete choice experiment, Parental preferences, Parental engagement, Culturally sensitive interventions, Health policies, Dietary choices, Sleep duration, Sustainable development goals, Obesity prevention programs

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Childhood obesity has evolved into a pressing global public health challenge, marked by escalating prevalence rates worldwide [1, 2]. China, in particular, has witnessed a pronounced surge in childhood obesity over recent decades. The National Health Commission (NHC) of the People's Republic of China (PRC) reports a dramatic increase in overweight or obesity among children aged 6–17, soaring from 6.6% to nearly 20% within the past two decades [3, 4]. This trend is deeply concerning for several reasons. Firstly, childhood obesity is closely linked to a spectrum of serious health implications. Children who are obese are at a significantly higher risk of developing chronic diseases such as type 2 diabetes, cardiovascular diseases, and certain types of cancer [5–9]. Furthermore, obesity in childhood often sets a trajectory for health issues in adulthood, increasing the likelihood of these conditions persisting or worsening over time [10, 11].

The rise in childhood obesity within China can be attributed to a complex interplay of contributing factors. Urbanization has instigated substantial alterations in dietary preferences, characterized by heightened consumption of energy-dense, processed foods, paralleled by diminished intake of traditional, healthful dietary choices. Simultaneously, the adoption of sedentary lifestyles, driven by technological advancements and evolving societal norms, has resulted in reduced physical activity levels among children [12–14]. Moreover, socioeconomic determinants, including parental education and income, exert notable influence over childhood obesity rates, with a higher socioeconomic status frequently associated with enhanced access to resources conducive to a health-conscious lifestyle [15].

Effectively addressing the issue of childhood obesity necessitates a comprehensive grasp of the multifaceted determinants contributing to its emergence, in conjunction with the development of targeted and evidence-based prevention strategies. Recognizing the pivotal role parents play in shaping their children's behaviours, encompassing dietary preferences [16–18] and physical activity levels [16, 17, 19], underscores the critical importance of parental involvement. However, empirical research exploring Chinese parents' preferences concerning initiatives aimed at addressing childhood overweight and obesity remains conspicuously deficient, potentially impeding the development of interventions that resonate with their unique needs and expectations. Therefore, this study aims to investigate parental preferences regarding interventions for preventing childhood obesity, with the aim of providing valuable insights for designing effective and culturally appropriate strategies that encompass various aspects of children's daily lives, spanning physical activities, dietary habits, sleep patterns, screen time management, and other relevant domains [20–22].

To gain insights into parental preferences in the context of healthcare decisions, a rigorous scientific methodology is warranted. One such approach is the Discrete Choice Experiment (DCE), a quantitative method widely used in health economics and health services research to elicit preferences and understand decision-making processes [23]. DCE involves presenting respondents with a set of hypothetical scenarios or choices, each comprising various attributes with differing levels, and asking them to select their preferred options. This method allows researchers to infer the relative importance of different attributes and the trade-offs participants are willing to make between them.

The strength of DCE lies in its ability to simulate real-world decision-making in a controlled environment, making it particularly suitable for understanding complex choices, such as those related to healthcare interventions or policies. It enables researchers to capture the nuances of preferences that might not be apparent through traditional survey methods. Furthermore, DCE can be tailored to address specific research questions by carefully designing choice sets that reflect relevant attributes and levels pertinent to the study population.

Methods

Between October and December 2022, we conducted a discrete choice experiment (DCE) to discern parental preferences for childhood obesity prevention. DCE, grounded in random utility theory [24], is a widely-used method to evaluate patient preferences for hypothetical

scenarios, particularly in obesity research [25–27]. Participants made choices involving attributes with multiple levels. Online consent was obtained, and the study was conducted according to the guidelines of the Declaration of Helsinki, and ethically approved by the Jinan University Medical Ethics Committee (JNUKY-2021-004) and City University of Hong Kong (HU-STA-00001075).

Study design

Our study employed a questionnaire with four sections. Prior to participation, respondents were provided with a webpage presenting the study's background, objectives, and methodology. Following this, participants provided online consent (more details in Supplementary 1) and met inclusion criteria: parents aged 20 or older with at least one child aged 5 to 17 years. Recruitment was conducted in urban areas across several major cities in China.

Upon agreeing to participate, respondents completed the first section, providing demographic details including gender (father or mother), age, education, marital status, family income, and employment status. The second section collected information on the number and ages of their children, as well as the heights and weights of both parents and children. The third section consisted of a discrete choice experiment (DCE), wherein respondents were asked to select their preferred weight control plan from two hypothetical options (Fig. 1). This section was structured to include eight randomized choice tasks, designed to elicit preferences for various attributes of weight control plans. In addition to these randomized tasks, a fixed choice question was included for the purpose of data quality control. The fixed choice task served as a consistency check, ensuring that respondents were engaging with the survey material in a thoughtful and consistent manner. It involved presenting all respondents with the same set of options, where one option was clearly more favorable than the other based on predefined criteria. Respondents' choices in this fixed task

Information box: "Suppose there are two different prevention programs aimed at reducing the incidence of childhood obesity. Please choose the one you prefer from the following two hypothetical plans for preventing childhood obesity. ***Please note***: Some scenarios may not be realistic, but please choose the one that better aligns with your preferences based on the information provided. "

	Option 1	**Option 2**	**Neither**
Average Daily Exercise Time	1.5 hours	1 hour	
Major Exercise Location	Home	Outdoor	
Average Sleep Duration	8 hours	9 hours	
Major Diet Mode	Low-fat diet 	High-protein diet 	I do not like either of the two options
Early- /Late Eating Mode	Early-eating mode (Having meals around 9 AM, 1 PM, and 5 PM)	Early-eating mode (Having meals around 9 AM, 1 PM, and 5 PM)	
Willingness to Spend Extra Expenses on Program	RMB 500	RMB 100	
Choose which one?	Choose	Choose	Choose

Fig. 1 An example of a DCE scenario with two alternatives and an opt-out option

were used to assess the reliability of their responses to the randomized tasks.

Determination of attributes and levels

To establish the initial attributes and their respective levels for our study on childhood obesity, we embarked on a multi-faceted approach. Our primary step involved conducting a comprehensive literature review, focusing specifically on factors influencing childhood overweight and obesity. This review spanned several key research papers and reviews in the field [16–18, 28, 29], allowing us to identify recurrent themes and factors that have been previously studied and acknowledged as significant in the context of childhood obesity.

Building on the insights from the literature, we enhanced our understanding by consulting a diverse group of local public health professionals, including public health professors, research fellows specializing in childhood obesity, paediatricians, nutritionists, and school health coordinators. Using a purposive sampling approach, experts with a minimum of five years of experience in their respective fields were selected to ensure diverse representation and informed perspectives. These experts engaged in a structured consultation process, providing individual feedback to validate and refine the relevance of the attributes identified from the literature. This approach ensured that the selected attributes were comprehensive, aligned with current practices in childhood obesity prevention, and tailored to our study context, thereby enhancing the scientific rigor and practical relevance of our research.

Through this integrative process of literature review and expert consultation, we identified six primary attributes for our study on childhood obesity interventions. These included [1] average daily exercise time, which reflects the physical activity aspect of obesity management; [2] major exercise location, recognizing the importance of the environment in facilitating physical activity; [3] average sleep duration, considering the emerging evidence linking sleep patterns with obesity; [4] major diet mode, a critical aspect of any obesity intervention; [5] early-/late-eating mode, in response to research suggesting the timing of meals can influence weight management; and [6] willingness to spend extra expense on program, a practical consideration reflecting the economic aspects of obesity management programs.

Each of these attributes was then further broken down into specific levels, based on the range and variations found in the literature and as advised by the consulted experts. This detailed attribute and level determination was essential for the construction of realistic and relevant choice scenarios in the subsequent Discrete Choice Experiment (DCE). A detailed breakdown of each attribute and its corresponding levels can be found in Table 1.

Sampling

We utilized a snowball sampling approach for participant recruitment, leveraging various social media platforms as recruitment channels during the data collection period spanning from October to December 2022. To determine the minimum required sample size for our study, we applied the following equation:

$$N > 500c/(t \times a)$$

In this equation, Johnson and Orme [30, 31] have proposed a rule of thumb for establishing the necessary sample size to capture main effects, which is contingent upon the variables t (number of choice tasks), a (number of alternatives), and c (number of analysis cells). Following their guideline, when focusing solely on main effects, the value of c corresponds to the highest number of attribute levels. Conversely, when considering all two-way interactions, c is defined as the highest product of levels derived from any two attributes. Accordingly, our study's minimum sample size requirement was determined to be 167.

Statistical analysis

We conducted a descriptive analysis of participant demographics, including socioeconomic status, heights, weights, and BMI for parents and children, the sample size and percentage were calculated and presented. Children with overweight or obesity were identified using WHO growth standards [32]. Discrete choice tasks were analysed using a multinomial logit (MNL) model rooted in random utility theory [33] as follows:

$$maxU_{in} = v + \epsilon_{in} = \alpha + \beta X_{in} + \epsilon_{in}$$

Where v is the systematic components which generated by means of the attributes levels, and ϵ_{in} is the random component. This theory assumes that an individual's preference for a specific alternative was impacted by the utility of attribute levels that brings. However, if the individual not choosing the alternatives according to the utility, then it is due to the random components.

To explore potential preference heterogeneity, we applied a latent class model (LCM) [34] and followed by subgroup analyses using MNL for preference analysis among father and mother respondents, as well as parents with and without children who have overweight or obesity. The LCM provides an approach to accommodating the heterogeneities in the models such as MNL. We calculated odds ratios (OR) with 95% confidence intervals (CI) to compare utility levels using the formula below [35], the 95% CI was then calculated using 1.96 times standard deviation (SD).

$$Odds\ ratio = \exp\left(current\ main\ effect - reference\ main\ effect\right)$$

Table 1 Attributes and levels in the discrete choice experiment

Attributes	Levels	Description
Average daily exercise time	30 min	Average daily exercise time is 30 min
	1 h	Average daily exercise time is one hour
	1.5 h	Average daily exercise time is one and half hour
	2 h	Average daily exercise time is two hours
Major Exercise Location	School	Major exercise place is at school
	Home	Major exercise place is at home
	Fitness Centre	Major exercise place is at fitness centre
	Outdoor	Major exercise place is outdoor
Average Sleep Duration	7 h	Average daily sleeping duration is 7 h
	8 h	Average daily sleeping duration is 8 h
	9 h	Average daily sleeping duration is 9 h
	10 h	Average daily sleeping duration is 10 h
	11 h	Average daily sleeping duration is 11 h
	12 h	Average daily sleeping duration is 12 h
Major Diet Mode	Low-fat diet	A low-fat diet is a dietary approach that restricts the intake of foods high in fat, particularly saturated and trans fats. It emphasizes the consumption of foods low in fat content, such as fruits, vegetables, whole grains, lean proteins, and low-fat dairy products.
	Low-carbohydrate diet	A low-carbohydrate diet is a dietary approach that restricts the consumption of carbohydrates, particularly refined carbohydrates and sugars. It focuses on reducing the intake of foods like bread, pasta, rice, cereals, sweets, and sugary beverages. Instead, it emphasizes foods rich in protein, healthy fats, and non-starchy vegetables.
	High-protein diet	A high-protein diet is a dietary approach that emphasizes the consumption of foods rich in protein while reducing the intake of carbohydrates and fats. It typically involves consuming foods such as lean meats, poultry, fish, eggs, dairy products, legumes, and certain plant-based protein sources.
	Mediterranean Diet	The Mediterranean diet is a dietary pattern inspired by the traditional eating habits of people in countries bordering the Mediterranean Sea, such as Greece, Italy, and Spain. It is characterized by the consumption of plant-based foods, such as fruits, vegetables, whole grains, legumes, nuts, and seeds. Olive oil is the primary source of fat, replacing butter and other saturated fats. The diet also includes moderate amounts of fish, poultry, and dairy products, while red meat is consumed sparingly.
	Ketogenic Diet	The ketogenic diet, often referred to as the keto diet, is a low-carbohydrate, high-fat diet that aims to induce a metabolic state called ketosis in the body. It involves drastically reducing carbohydrate intake and replacing it with an increased consumption of dietary fats and a moderate amount of protein.
Early-/Late-Eating Mode	Early-eating mode	Having meals around 9 AM, 1 PM, and 5 PM.
	Late-eating mode	Having meals around 1 PM, 5 PM, and 9 PM.
Willingness to Spend Extra Expenses on Program	RMB 0	Willing to pay nothing to the body weight control program
	RMB 100	Willing to pay 100 RMB to the body weight control program
	RMB 200	Willing to pay 200 RMB to the body weight control program
	RMB 300	Willing to pay 300 RMB to the body weight control program
	RMB 400	Willing to pay 400 RMB to the body weight control program
	RMB 500	Willing to pay 500 RMB to the body weight control program

The number of LCM groups was determined using Akaike information criteria (AIC) and Bayesian information criteria (BIC) [36]. Both MNL and LCM analyses were conducted using Lighthouse Studio (version 9.14.2, Sun Valley, Idaho, United States).

Results

Out of the initial 753 participants who completed the survey and met the inclusion criteria, 631 respondents remained eligible for subsequent analysis following data quality control procedures. Within this eligible group, 404 individuals (64.03%) identified as mothers, with approximately half falling into the 31–35 years age bracket. Furthermore, 42.32% of the respondents held

a bachelor's degree or higher educational qualification. Marital status indicated that the majority, specifically 577 respondents (91.45%), were married, and a substantial portion, 86.85%, were engaged in either full-time or part-time employment. Additionally, among these respondents, 398 (63.07%) had one child, and 51.35% of the children were classified as having overweight or obesity (Table 2).

Attribute importance and coefficient of levels

Overall, respondents placed the highest importance on the willingness to spend extra expenses on a program (32.36%) for weight control, followed by average sleep duration (18.42%), major diet mode (16.49%), early-/late-eating mode (13.67%), and major exercise location (12.21%). Average daily exercise time was considered the least influential attribute in respondents' decision-making process (6.85%) (Fig. 2). Data indicated that respondents favoured schools as their children's

Table 2 Demographic information of respondents in the study

Demographic items	Overall *n* (%)	Normal (*n*, %)	Overweight/Obese (*n*, %)	*P* value
Parent				
Mother	404 (64.03%)	255 (67.11)	149 (59.36)	0.0474
Father	227 (35.97%)	125 (32.89)	102 (40.64)	
Age				
20–25 yr	8 (1.27%)	3 (0.79)	5 (1.99)	< 0.01
26–30 yr	92 (14.58%)	37 (9.74)	55 (21.91)	
31–35 yr	272 (43.11%)	160 (42.11)	112 (44.62)	
36–40 yr	163 (25.83)	108 (28.42)	55 (21.91)	
41–45 yr	68 (10.78%)	51 (13.42)	17 (6.77)	
46–50 yr	23 (3.65%)	17 (4.47)	6 (2.39)	
Over 50	5 (0.78%)	4 (1.05)	1 (0.40)	
Educational Level				
Primary and below	19 (3.01%)	9 (2.37)	10 (3.98)	0.068
Middle school education	71 (11.25%)	49 (12.89)	22 (8.76)	
High school education	107 (16.95%)	56 (14.74)	51 (20.32)	
Vocational education or equivalent level[1]	167 (26.47%)	109 (28.68)	58 (23.11)	
Bachelor's or equivalent level	222 (35.18%)	130 (34.21)	92 (36.65)	
Master's or equivalent level	36 (5.71%)	24 (6.32)	12 (4.78)	
Doctoral or equivalent level	9 (1.43%)	3 (0.79)	6 (2.39)	
Relationship Status				
Married	577 (91.45%)	350 (92.11)	227 (90.44)	0.057
Divorced	30 (4.75%)	18 (4.74)	12 (4.78)	
Single	5 (0.79%)	1 (0.26)	4 (1.59)	
Other	19(3.01%)	11 (2.89)	8 (3.19)	
Level of Family Income				
10,000 CNY and below	111(17.59%)	58 (15.26)	53 (21.12)	0.106
10,001–20,000 CNY	231(36.61%)	145 (38.16)	86 (34.26)	
20,001–30,000 CNY	123(19.49%)	73 (19.21)	50 (19.92)	
30,001–40,000 CNY	75(11.89%)	52 (13.68)	23 (9.16)	
40,001–50,000 CNY	34(5.39%)	23 (6.05)	11 (4.38)	
More than 50,000 CNY	57(9.03%)	29 (7.63)	28 (11.16)	
Employment Status				
Employed (full-time or part-time)	548(86.85%)	332 (87.37)	216 (86.06)	0.096
Unemployed and searching for a job	18(2.85%)	7 (1.84)	11 (4.38)	
Housewife or Househusband	60(9.51%)	40 (10.53)	20 (7.97)	
Retired	5(0.79%)	1 (0.26)	4 (1.59)	
Number of Child				
1	398(63.07%)	224 (58.95)	174 (69.32)	0.052
2	201(31.88%)	134 (35.26)	67 (26.69)	
>=3	32(5.07%)	22 (5.79)	10 (3.98)	

Note: 1. Vocational education or equivalent level: Refers to job-focused training programs, typically at a post-secondary or technical level, designed to equip individuals with practical skills for specific careers or trades

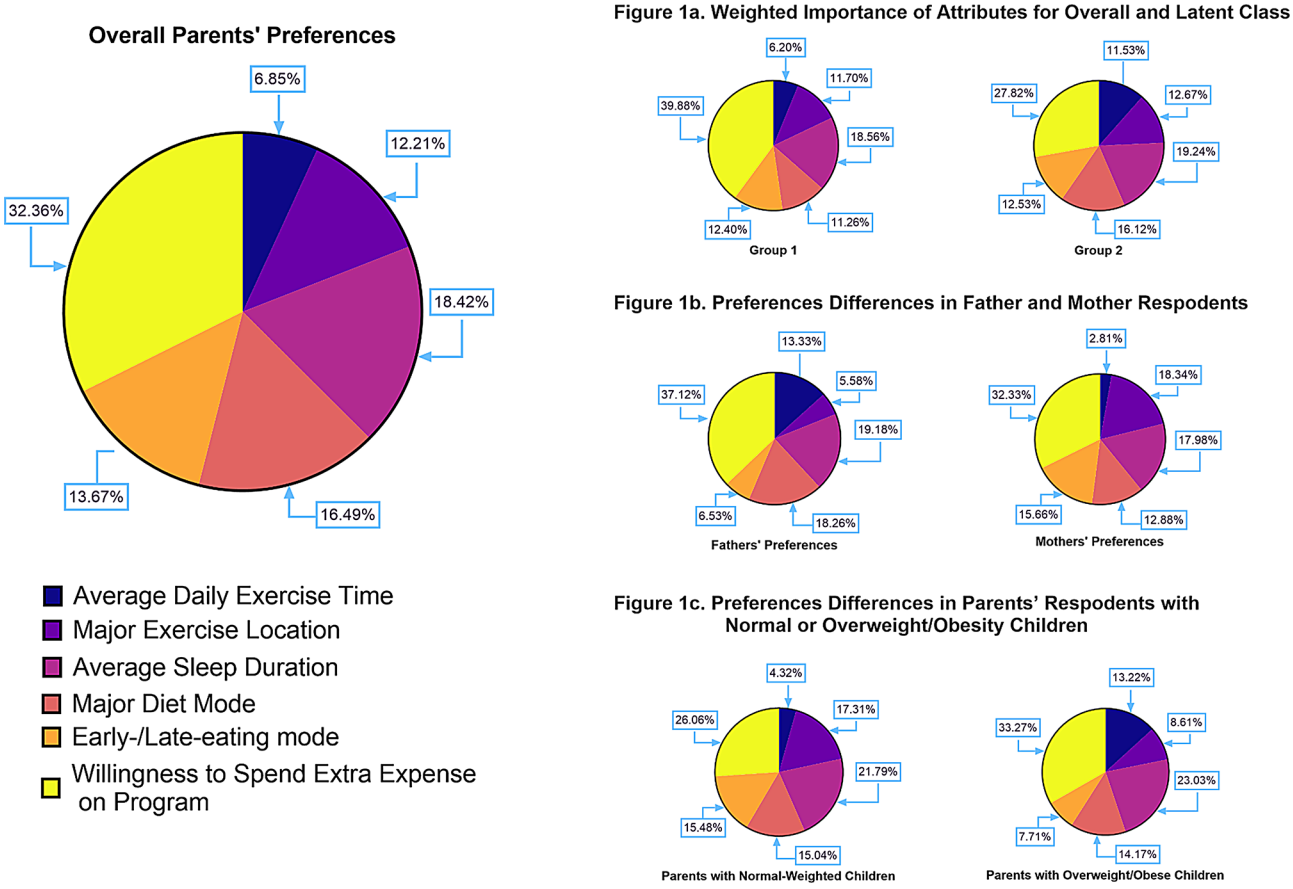

Fig. 2 Weighted importance of attributes for various segments

exercise location (reference level) over gyms (gym vs. school, OR = 0.837, 95% CI (0.785, 0.893), $p < 0.001$), homes (home vs. school, OR = 0.951, 95% CI (0.892, 1.014)), and outdoors (outdoor vs. school, OR = 0.980, 95% CI (0.920, 1.044)). Furthermore, respondents preferred a 9-hour average sleep duration for their children (9 h vs. 7 h, OR = 1.291, 95% CI (1.186, 1.406), $p = 0.001$), followed by 8 h (8 h vs. 7 h, OR = 1.265, 95% CI (1.163, 1.376), $p = 0.006$) over 7 h (reference level), 11 h, and 12 h. In addition, respondents exhibited a preference for providing a high-protein diet (high-protein diet vs. low-fat diet, OR = 1.114, 95% CI (1.034, 1.200), $p = 0.01$) and an early-eating daily meal (late eating mode vs. early eating mode, OR = 0.820, 95% CI (0.792, 0.846), $p < 0.001$). Notably, respondents expressed willingness to spend a modest sum, such as RMB 100, on their children's weight control program (RMB 100 vs. RMB 0, OR = 1.021, 95% CI (0.939, 1.110), $p < 0.001$). However, as the extra expense increased, respondents' utility decreased (e.g., RMB 500 vs. RMB 0, OR = 0.637, 95% CI (0.584, 0.695), $p < 0.001$) (Table 3).

Latent class analysis and subgroup analysis

A latent class analysis conducted on the entire sample revealed two distinct latent groups, as determined by both the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) (see Supplementary Information 1). The study identified two groups: Group 1 with 183 respondents (29%) and Group 2 with 448 respondents (71%). Both groups valued the cost aspect, 'willingness to spend extra expense on program', significantly, with Group 1 showing a 39.88% importance and Group 2, 27.82% (Fig. 2 and Table 4). While other attributes showed higher importance, Group 1 emphasized 'early-/late-eating mode' (12.40%), and Group 2 focused on 'major dietary mode' (16.12%). Across both groups, 'average daily exercise time' was considered the least important characteristic.

Group 1 parents favoured a two-hour daily exercise regimen for their children rather than 30 min (OR = 1.189, 95% CI (1.030–1.373)) (Table 4), with a preference for outdoor exercise locations over school-based settings (OR = 1.136, 95% CI (0.986–1.309), $p < 0.05$). In contrast, Group 2 parents preferred a 1.5-hour daily exercise regimen (OR = 1.152, 95% CI (1.071–1.238), $p < 0.05$) and a school-based exercise setting. Optimal sleep durations

Table 3 Attribute levels coefficient, OR and 95% CI

Variable	Coefficient	Std error	*P* value	OR	95% CI
Average Daily Exercise Time					
30 min	-0.051	0.033	0.119	Reference	
1 h	-0.016	0.033	0.613	1.035	(0.971–1.103)
1.5 h	0.049	0.032	0.131	1.105	(1.037–1.177)
2 h	0.019	0.033	0.57	1.072	(1.006–1.143)
Major Exercise Location					
School	0.062	0.033	0.058	Reference	
Home	0.012	0.033	0.72	0.951	(0.892–1.014)
Fitness Centre	-0.116***	0.033	< 0.001	0.837	(0.785–0.893)
Outdoor	0.042	0.032	0.194	0.98	(0.920–1.044)
Average Sleep Duration					
7 h	-0.116**	0.043	0.007	Reference	
8 h	0.119**	0.043	0.006	1.265	(1.163–1.376)
9 h	0.139**	0.043	0.001	1.291	(1.186–1.406)
10 h	0.068	0.043	0.113	1.203	(1.105–1.309)
11 h	-0.082	0.043	0.06	1.035	(0.951–1.127)
12 h	-0.129**	0.044	0.004	0.988	(0.906–1.077)
Major Diet Mode					
Low-fat diet	-0.009	0.039	0.809	Reference	
Low-carbohydrate diet	0.047	0.038	0.214	1.058	(0.982–1.140)
High-protein diet	0.098*	0.038	0.01	1.114	(1.034–1.200)
Mediterranean Diet	0.005	0.038	0.89	1.015	(0.941–1.094)
Ketogenic Diet	-0.142***	0.039	< 0.001	0.876	(0.812–0.945)
Early-/Late-Eating Mode					
Early-eating mode	0.099***	0.016	< 0.001	Reference	
Late-eating mode	-0.099***	0.016	< 0.001	0.82	(0.794–0.846)
Willingness to Spend Extra Expense on Program					
RMB 0	0.184***	0.042	< 0.001	Reference	
RMB 100	0.204***	0.043	< 0.001	1.021	(0.939–1.110)
RMB 200	0.135**	0.043	0.002	0.952	(0.876–1.035)
RMB 300	-0.037	0.043	0.396	0.802	(0.737–0.873)
RMB 400	-0.219***	0.044	< 0.001	0.669	(0.613–0.729)
RMB 500	-0.267***	0.044	< 0.001	0.637	(0.584–0.695)

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

for Group 1 and Group 2 were 8 and 9 h, respectively. Both groups favoured high-protein diets for their children over low-fat diets. Interestingly, Group 1 parents were unwilling to pay extra for a childhood obesity prevention program, whereas Group 2 parents were willing to pay an additional RMB 100 and 200 (e.g., in Group 1, RMB 100 vs. 0, OR = 0.754, 95% CI (0.632–0.901), $p < 0.05$; in Group 2, RMB 100 vs. 0, OR = 1.125, 95% CI (1.021–1.239), $p < 0.05$, and RMB 200 vs. 0, OR = 1.149, 95% CI (1.042–1.267), $p < 0.05$).

Subgroup analysis results

The study illustrates findings regarding potential variations in parental preferences, distinguishing between fathers and mothers, as well as parents whose children are (or are not) overweight or obese. Both fathers and mothers accorded the greatest importance to the willingness to allocate additional financial resources to the program, with weighted importance scores of 37.12% and 32.33%, respectively. Additionally, we observed statistically significant differences between fathers' and mothers' preferences for certain attributes. Fathers placed a notably higher emphasis on average sleep duration (19.18%), major dietary patterns (18.26%), and average daily exercise time (13.33%). In contrast, mothers assigned a significantly lower weight to average daily exercise time (2.81%).

Notably, parents with children who do not have excess weight attributed relatively lower importance to exercise time (4.32%) compared to parents with children who have excess weight (13.22%). Parents with children who have excess weight showed a strong preference for their children to engage in outdoor exercise for 1.5 to 2 h, while parents with children who do not have excess weight did not exhibit a specific inclination regarding exercise duration and considered schools as the most suitable venue for physical activity. Furthermore, parents with children who do not have excess weight tended to endorse high-protein, low-carbohydrate, and low-fat dietary patterns, whereas those with children who have excess weight exclusively prioritized high-protein diets. Lastly, parents with children who do not have excess weight favoured 8–10 h of sleep, while parents with children who have excess weight were more inclined toward 8–9 h of sleep (more details in Supplementary 1).

Discussion

Our study primarily focused on a sample of urban Chinese parents, which may restrict the generalizability of our findings to a wider range of socio-economic and geographical context within China. Nevertheless, parents in our sample demonstrated a willingness to allocate a portion of their income or savings towards weight control, childhood obesity prevention, and fostering healthy lifestyles for their children. According to our results, the majority of Chinese parents were willing to allocate between 400 RMB and 800 RMB per month (100–200 RMB per week) for obesity prevention efforts, an amount comparable to that of parents in developed countries such as the United Kingdom [37] and Australia [38]. In the past, obesity in China was perceived as a reflection of

Table 4 The coefficient of different levels in the latent class model

	Group 1 ($n=183$)					Group 2 ($n=448$)				
Variable	**Coefficient**	**Standard Error**	**P-value**	**OR**	**95% CI**	**Coefficient**	**Standard Error**	**P-value**	**OR**	**95% CI**
Average Daily Exercise Time										
30 min	-0.037	0.075	0.619	Reference		-0.055	0.037	0.141	Reference	
1 h	-0.009	0.074	0.904	1.029	(0.890–1.189)	-0.020	0.037	0.592	1.035	(0.963–1.114)
1.5 h	-0.090	0.075	0.232	0.949	(0.819–1.099)	0.087*	0.037	0.020	1.152	(1.071–1.238)
2 h	0.136	0.073	0.065	1.189	(1.030–1.373)	-0.012	0.037	0.747	1.044	(0.970–1.123)
Major Exercise Location										
School	0.056	0.074	0.455	Reference		0.063	0.037	0.091	Reference	
Home	0.005	0.074	0.951	0.950	(0.822–1.098)	0.017	0.037	0.649	0.955	(0.887–1.027)
Fitness Centre	-0.243**	0.078	0.002	0.742	(0.636–0.864)	-0.093*	0.037	0.012	0.855	(0.795–0.920)
Outdoor	0.183*	0.072	0.012	1.136	(0.986–1.309)	0.013	0.037	0.723	0.951	(0.885–1.022)
Average Sleep Duration										
7 h	-0.352***	0.105	< 0.001	Reference		-0.065	0.049	0.190	Reference	
8 h	0.325***	0.092	< 0.001	1.967	(1.641–2.358)	0.056	0.049	0.256	1.128	(1.024–1.243)
9 h	0.184	0.095	0.054	1.710	(1.419–2.060)	0.140**	0.050	0.006	1.227	(1.111–1.354)
10 h	0.254**	0.092	0.007	1.833	(1.529–2.198)	0.023	0.050	0.648	1.091	(0.990–1.204)
11 h	-0.168	0.100	0.096	1.202	(0.987–1.463)	-0.057	0.050	0.251	1.008	(0.914–1.111)
12 h	-0.244*	0.103	0.018	1.114	(0.911–1.362)	-0.096	0.051	0.057	0.969	(0.877–1.070)
Major Diet Mode										
Low-fat diet	0.050	0.086	0.563	Reference		-0.022	0.044	0.614	Reference	
Low-carbohydrate diet	0.075	0.085	0.375	1.026	(0.869–1.211)	0.046	0.044	0.291	1.071	(0.983–1.167)
high-protein diet	0.218*	0.084	0.011	1.183	(1.003–1.396)	0.064	0.043	0.141	1.090	(1.001–1.187)
Mediterranean Diet	-0.151	0.089	0.090	0.818	(0.688–0.973)	0.045	0.044	0.305	1.070	(0.981–1.167)
Ketogenic Diet	-0.192*	0.090	0.034	0.785	(0.658–0.936)	-0.133**	0.044	0.003	0.895	(0.821–0.976)
Early-/Late-Eating Mode										
Early-eating mode	0.226***	0.040	< 0.001	Reference		0.077***	0.018	< 0.001	Reference	
Late-eating mode	-0.226***	0.040	< 0.001	0.637	(0.588–0.689)	-0.077***	0.018	< 0.001	0.858	(0.828–0.888)
Willingness to Spend Extra Expense on Program										
RMB 0	0.799***	0.087	< 0.001	Reference		0.011	0.049	0.821	Reference	
RMB 100	0.517***	0.090	< 0.001	0.754	(0.632–0.901)	0.129**	0.049	0.009	1.125	(1.021–1.239)
RMB 200	0.184*	0.093	0.049	0.541	(0.451–0.649)	0.150**	0.050	0.003	1.149	(1.042–1.267)
RMB 300	-0.406***	0.106	< 0.001	0.300	(0.243–0.369)	0.067	0.050	0.177	1.058	(0.959–1.166)
RMB 400	-0.440***	0.108	< 0.001	0.289	(0.234–0.358)	-0.167***	0.050	< 0.001	0.837	(0.759–0.923)
RMB 500	-0.655***	0.115	< 0.001	0.234	(0.187–0.292)	-0.191***	0.050	< 0.001	0.817	(0.741–0.901)

Note: *** $p<0.001$, ** $p<0.01$, * $p<0.05$

a higher standard of living due to historical food scarcity [39]. The increased concern among Chinese parents can be attributed to factors related to rising family incomes, which are connected to the broader social and economic determinants of health.

Moreover, this study underscores the critical role of adequate sleep, with most parents acknowledging the need for 8–10 h nightly to support children's growth and prevent obesity, as supported by previous research [40–42]. However, sleep deprivation remains common among Chinese school-aged children, often sleeping less than recommended [43, 44]. Factors contributing to this include early school start times [45–47], parental sleep habits [48], and children's engagement in screen time [49] and homework [50–52]. Addressing this issue requires comprehensive strategies that align with the United Nations Sustainable Development Goals (UN SDGs) and the World Health Organization's Social Determinants of Health framework (WHO SDH), involving changes in school schedules, reduced screen time, and collaboration between schools and parents to encourage healthy sleep habits.

Additionally, the study reveals a strong parental preference for high-protein diets over low-fat diets, and a general aversion to ketogenic diets, likely influenced by traditional beliefs about protein and carbohydrate-rich Chinese dietary habits [53, 54]. While these preferences are important for designing effective interventions, the findings also suggest a need for education to guide parents towards more balanced dietary choices. Public health initiatives should thus balance aligning with parental preferences with educating about the benefits of diverse diets that meet al.l nutritional needs, addressing misconceptions and potential risks associated with

certain diets. This dual approach ensures interventions are both culturally sensitive and nutritionally sound, promoting healthier eating habits among Chinese children.

Regarding exercise, parents tend to prefer their children engaging in physical activities at school rather than fitness centres. This preference may be attributed to the expectation that schools bear greater responsibility in fulfilling children's daily exercise requirements and providing opportunities for physical activity after school to manage their weight [55]. This approach can facilitate the development of healthy exercise habits in children within a relatively safe environment while accommodating parents' childcare needs. Consequently, policymakers should consider this demand by ensuring that schools offer adequate sports and fitness facilities and provide a secure environment for children's exercise activities.

Latent class analysis in our study revealed that 29% of parents expressed heightened concerns regarding the costs involved in preventing overweight and obesity. This concern reflects the economic considerations in health-related decision-making among families. In response, it is important for policymakers to tailor obesity prevention strategies to be both affordable and effective, particularly for families with limited financial resources. Additionally, the study observed a strong parental preference for incorporating regular physical exercise into their children's routines as a key component of obesity prevention. These findings suggest the need for interventions that not only are cost-sensitive but also emphasize and facilitate physical activity for children.

The subgroup analysis conducted in this study revealed that parents' focus on preventing childhood obesity varies significantly, particularly in terms of exercise time and location. Fathers are more inclined than mothers to increase their children's daily exercise time as a preventive measure against obesity. Interestingly, one of the most unexpected findings was the relatively low priority placed on average daily exercise time by parents, especially mothers (2.8%). This may be influenced by cultural factors, such as the strong emphasis on academic achievement and structured extracurricular activities in China, which often results in less attention to physical exercise. Given the high prioritization of educational success, awareness of the importance of daily exercise as part of a healthy lifestyle may be lower. Addressing this issue is crucial, as it highlights an opportunity for targeted interventions and public health campaigns to promote physical activity among children, particularly in urban areas where sedentary lifestyles are more common.

This disparity may also stem from mothers' heightened concerns about their children's safety during exercise, as indicated by their preference for sports activities supervised by the school. In contrast, fathers did not demonstrate a specific preference regarding exercise locations. Therefore, policymakers should consider mothers' preferences when formulating policies to ensure a safe exercise environment for children.

Additionally, the study found differences in parents' willingness to incur additional expenditures for obesity prevention. As costs increase, mothers' willingness to spend declines, whereas fathers are most comfortable with an additional expenditure of around RMB 200. Within this acceptable range, fathers are generally more willing to spend than mothers. These insights suggest that tailored approaches, accounting for gender-specific financial considerations, may be needed when designing obesity prevention programs that involve costs for families.

Moreover, a subgroup analysis conducted in this study examined parents of children with and without weight issues. The findings revealed distinct preferences and priorities within these two groups. Parents of children without weight issues placed greater emphasis on their children's eating time. This suggests that they may prioritize establishing regular and structured eating routines to maintain their children's current healthy weight status. However, it's notable that parents of children without weight issues did not exhibit clear preferences regarding their children's exercise habits. This could indicate a potential gap in their awareness regarding the importance of a holistic approach to weight control, encompassing dietary intake, exercise, and sufficient rest.

Conversely, parents of children with weight issues had higher expectations for their children to engage in physical exercise. This emphasis on exercise likely stems from their recognition of the need to address weight-related concerns. These parents are likely more aware of the multifaceted nature of childhood obesity and the role that physical activity plays in weight management.

This divergence in preferences highlights the importance of tailoring obesity and overweight prevention programs to meet the specific needs of different groups of parents. For parents of children without weight issues, there is an opportunity for education and awareness campaigns to emphasize the importance of a balanced combination of dietary intake, exercise, and adequate rest for overall health and well-being, rather than focusing solely on weight control.

Incorporating parental preferences into the development of research and public health interventions is increasingly recognized as an essential strategy for addressing complex health issues, such as childhood obesity [56–58]. Engaging parents through co-design processes not only enhances the effectiveness of interventions but also increases their cultural relevance. Parents provide crucial insights into their children's health-related behaviours [59], which allow researchers and public health practitioners to tailor interventions

to address specific community needs. This collaborative approach enhances the adaptability of programs and improves their sustainability by fostering stronger community engagement.

Evidence from previous studies underscores the value of involving parents as co-designers or peer leaders in interventions. For instance, research on initiatives such as Head Start has demonstrated that parental involvement in shaping intervention strategies can significantly align program content with real-world challenges, including the promotion of healthy eating and physical activity [60]. Moreover, parental engagement has been associated with improved long-term sustainability of interventions, as it ensures that the programs remain relevant to the target population.

Culturally tailored co-design programs, particularly those developed for Indigenous Māori and Pacific Islander communities in Australia, further illustrate the efficacy of this approach [61]. These programs, which integrate community values and actively involve parents in shaping program objectives, have led to significant improvements in both children's and parents' health behaviours, such as reductions in the consumption of sugar-sweetened beverages and increases in vegetable intake. By ensuring that interventions are culturally sensitive and aligned with community values, these initiatives have contributed to addressing health inequities and enhancing the acceptability of health interventions across diverse populations.

We conducted a large-scale cross-sectional study using discrete choice experiments (DCE) in China, which, to our best knowledge, is the first study to investigate and quantify parents' preferences regarding the prevention of childhood overweight or obesity in China. Incorporating the United Nations Sustainable Development Goals (UN SDGs), particularly Goal 3: "Ensure healthy lives and promote well-being for all at all ages," and the World Health Organization's Social Determinants of Health framework (WHO SDH), the study underscores the necessity for tailored public health policies and educational initiatives that resonate with families and support healthy lifestyles among Chinese children. To achieve this, policymakers should consider the following suggestions.

First and foremost, policymakers should develop targeted education campaigns that emphasize the benefits of balanced and diverse diets, meeting children's nutritional needs while addressing concerns about the potential risks associated with certain weight loss diets. Also, collaborating with schools to prioritize offering adequate sports and fitness facilities, providing a secure environment for children's exercise activities, and adjusting school schedules to promote healthier sleep patterns. Furthermore, implementing cost-effective and practical obesity prevention strategies that consider the financial constraints of families while maximizing health outcomes for children. Also, encouraging active parental involvement in children's eating behaviours, emphasizing the importance of combining appropriate exercise time with customized nutrition intake to promote a more comprehensive approach to addressing childhood obesity. Last, acknowledging and addressing the heterogeneity in parental focus on exercise time and location, considering the distinct preferences and concerns of mothers and fathers when devising policies and interventions.

By emphasizing the importance of combining appropriate exercise time with customized nutrition intake and active parental involvement, the study contributes to a comprehensive approach to addressing childhood obesity, aligning with global health goals and the pursuit of health equity. This research not only has implications for the Chinese context but also provides valuable theoretical insights that can inform the development of effective obesity prevention strategies in other countries facing similar public health challenges. Ultimately, fostering a collaborative effort among policymakers, educators, and parents is crucial to promoting healthy lifestyles and mitigating the childhood obesity epidemic.

Limitation

While insightful, this study has limitations. This study's focus on urban Chinese parents limits its generalizability across varied socio-economic and geographical settings in China. Additionally, the use of Discrete Choice Experiments and snowball sampling may not fully capture the nuances of real-life decisions and could introduce sample bias. Moreover, self-reported data by parents on children's weight and height may be prone to inaccuracies, potentially introducing measurement bias. Despite these limitations, this study offers important insights that can inform future research and interventions in childhood obesity prevention strategies in China. Future research should broaden its demographic scope, including rural populations and children's viewpoints, and employ more representative sampling methods to enhance the study's applicability and understanding of obesity prevention strategies.

Conclusion

Effective childhood obesity prevention requires a collaborative approach involving policymakers, educators, and parents to address this multifaceted issue comprehensively. This study underscores the importance of integrating parental preferences into health policies aligned with the UN SDGs and the SDH framework. Emphasizing culturally sensitive interventions, balanced dietary education, secure exercise environments, and active parental involvement is crucial for developing sustainable and impactful solutions. By incorporating these elements,

policymakers can create effective strategies that address childhood obesity holistically, contributing to healthier lifestyles and long-term health equity for children in China.

Abbreviations

AIC	Akaike information criteria
BIC	Bayesian information criteria
CI	Confidence Interval
DCE	Discrete Choice Experiment
LCM	Latent Class Model
MNL	Multinomial Logit Model
NHC	National Health Commission
OR	Odds Ratio
PRC	People's Republic of China
UN	SDGs United Nations Sustainable Development Goals
WHO	SDH World Health Organization's Social Determinants of Health framework

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions
WKM: Conceptualization, Methodology, Resources, review, and editing, Supervision; XM, TL, JY and YG: Conceptualization, Methodology, Resources, Investigation, Formal analysis, Writing– Original draft preparation, review, and editing; CL, SL, BOA, XL, JH and CJPZ: Writing– Review and editing; All authors reviewed and approved the final manuscript.

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Data availability
The data supporting the findings of this study are accessible upon request, contingent on a reasonable basis, via electronic mail at wkming2@cityu.edu.hk.

Declarations

Ethics approve and consent to participate
All methods were carried out in accordance with relevant guidelines and regulations. Ethical approval was granted by the Jinan University Medical Ethics Committee (JNUKY-2021-004) and City University of Hong Kong Ethics Committee (HU-STA-00001075). Online informed consent was obtained from all participants, conforming to established ethical standards.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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