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Maternal feeding practices and children's food intake during an *ad libitum* buffet meal: Results from the GUSTO cohort

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This study was conceived and designed by MFFC, LRF, and CGF. Data were collected and videos were coded by MJC, JYT, ATG, IMA, MTT, and SC. Analyses were conducted and interpreted by MJC, LRF, QPL, and MFFC. Tables were prepared by MJC. The manuscript was drafted by LRF, MJC, and MFFC, with input from ISZ, QPL, AF, and CGF. YSC, KHT, FY, LPCS, MJM, BFPB, AR, YSL, KMG, and PDG were responsible for the conception of and recruitment for the GUSTO cohort. All authors reviewed and approved the final draft.

Conflicts of interest

LRF and ISZ are employees of Nestlé Research. LS, YSC, PDG, KMG and YSL have received reimbursement for speaking at conferences sponsored by companies selling nutritional products. They are part of an academic consortium that has received research funding from Abbott Nutrition, Nestle, and Danone. All other authors have nothing to disclose.

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Abstract

Parents' feeding practices have been shown to be associated with children's food intake and weight status, but little is known about feeding practices in Asian countries. This study used behavioral observation to explore the feeding practices of 201 mothers of 4.5 year-old children in Singapore during an *ad libitum* buffet lunch. Feeding practices were coded from videos, focusing on behaviors used to prompt the child to eat more food (autonomy-supportive and coercive-controlling prompts to eat, suggesting items from buffet), those to reduce intake (restriction, questioning food choice), and those related to eating rate (hurrying or slowing child eating). Child outcome measures included energy consumed, variety of food items selected, and BMI. Maternal restriction and trying to slow child eating rate were associated with higher energy consumed by the child (r=0.19 and 0.13, respectively; $p<0.05$). Maternal autonomy-supportive prompts and restriction were associated with a greater variety of items selected by children (r=0.19 and 0.15, respectively; $p<0.05$). The frequency of maternal feeding practice use differed across ethnic groups, with Malay mothers using the most prompts to eat ($p<0.05$), Chinese mothers most likely to question a child's food choice ($p<0.01$), and Indian mothers the last likely to tell the child to eat faster ($p<0.001$). There were no differences between ethnic groups for other feeding practices. No associations were found between feeding practices and child BMI. It is possible that feeding practices related to restriction and slowing child eating are adopted in response to children who consume larger portions, although longitudinal or intervention studies are needed to confirm the direction of this relationship and create local recommendations.

Keywords

Children; preschool; feeding practices; behavioral observation; Singapore; food intake

1 Introduction

Parents can influence their children's diet and eating habits through the foods they provide (the "what"), and the feeding practices they use when offering them (the "how"). Parents' feeding practices have been previously associated with both children's food intake [1] and weight status [2–4], suggesting that feeding practices could be modifiable behaviors that could contribute to child diet quality and health outcomes. Some of the most common categories of feeding practices described in the literature are "pressure to eat", which constitutes actions taken by the parent to encourage the child to eat more, and "restriction",

which includes behaviors associated with limiting a child's intake [2]. With respect to children's intake and diet, pressure to eat has generally been associated with lower intake of recommended food groups such as fruits and vegetables [5, 6], or decreased liking for these foods [7]. However, children who are prompted to eat during a meal also tend to consume more energy [8, 9], so the type of prompt used or the target food may play a role in the association between this category of feeding practice and child eating behavior. The use of restriction has shown mixed associations with diet quality [1]. Regarding weight, in cross-sectional studies, parents of heavier children tend to restrict intake more often and those of children perceived to be underweight use more pressure to eat; some longitudinal studies find longer-term consequences of these feeding practices on weight status, whereas others do not [2].

Some of these equivocal findings regarding these feeding practices may be attributable to the broad range of behaviors included within each category of feeding practices. For example, behaviors included within "pressure to eat" could include anything from physically feeding a child to a mild suggestion to take a bite of something [10–13]. Restriction can also include a range of behaviors, from physically taking a food away from a child or saying "no" to a child's request (forms of *overt* restriction), to simply not keeping certain foods in the house (*covert* restriction) [14]. Recently, a growing number of studies have started to explore these subtle differences in relation to children's food intake, such as different ways of prompting a child to eat a food [15], or different types of restriction [14]. One recent proposal of a way to cluster feeding practices focuses on whether the parent's behavior supports the autonomy of the child, or whether the practice is used as a way of controlling the child [16]. As in an earlier study [17], we used this classification system as a way of exploring whether different types of maternal prompts to eat were associated with children's food intake.

One general limitation of the literature on feeding practices is that it relies quite heavily on parent report, often to measure both feeding practices and child behavior or intake, which may not necessarily reflect parents' actual behaviors in practice [18, 19]. To address this, in the current study, we analyzed videos of mothers and children eating an *ad libitum* buffet lunch together and coded the use of various feeding practices during the meal. The outcome measures included child body mass index (BMI) and food intake, both measured objectively through weighing during the study visit. Food intake was measured in terms of grams consumed, as well as the number of different foods consumed from the buffet. To our knowledge, no prior studies have explored the association between feeding practices and variety of foods consumed in such an observational setting, especially one in which the child is in control of selecting which foods to eat. For this reason, this measure provided a novel opportunity to explore how both the quantity (energy) and the number of different foods selected by the child might be associated with maternal feeding practices.

It is important to note that the majority of the feeding practice literature has been conducted in the United States, Europe, and Australia [2, 4], and that little is known about parent-child mealtime interactions in other parts of the world. Furthermore, parenting-and feeding practices have been shown to vary across cultures [20, 21], including between families of Asian- or Indian ancestry and other ethnic groups in studies conducted outside of Asia [e.g., 22, 23]. There are limited studies on feeding practices conducted in Southeast Asia, with the

majority focusing on breastfeeding as a feeding practice [24]. Although the relationships between feeding practices and children's eating behaviors or weight status may differ between families of different ethnicities [21, 25], overall, the general patterns found from recent studies in Asian populations reflect those seen in European or American samples. For example, studies consistently find greater pressure to eat when the child has a lower weight status, and more restriction in children with higher weight status [24, 26]. A recent study of Singaporean parents has shown that parent-reported modeling healthy eating was associated with greater child intake of vegetables and whole grains, and less intake of sweet snacks and fast foods [27]. Also in line with the broader parenting literature, the majority of the studies conducted in Singapore use parent-report instruments to assess feeding practices. In addition to the usual limitations of questionnaire-based research on feeding practices, there is some debate as to whether such measures, which were designed for other populations, can adequately capture Asian parenting approaches [22, 28], and whether mothers of different ethnic groups would interpret the questions in the same way. Thus the current study provides an opportunity to examine these feeding practices in a more objective way, through behavioral observation.

Observing and analyzing feeding practices in the Growing Up in Singapore Towards healthy Outcomes (GUSTO) multi-ethnic Asian cohort provides the opportunity to describe these behaviors for the first time in Asia and compare their use across families from the three largest ethnic groups in Singapore: Chinese, Malay, and Indian. In the current study, we aimed to explore how mothers in Singapore interacted with their children during mealtimes, and how this related to children's food intake and body composition. There is a paucity of cross-cultural data on feeding practice in families in Asia, but there is substantial evidence that other types of parenting practices or overall parenting styles differ across ethnic groups [29–31]. Thus as a secondary objective, we conducted additional exploratory analyses to compare the use of feeding practices across the Chinese, Malay, and Indian ethnic groups.

We hypothesized that the mother's feeding practices would be associated with the child's food intake, both in terms of quantity and the variety (number) of different foods selected. The direction of some of the associations was difficult to predict, as feeding practices and eating behavior interact in a bidirectional manner, with parents influencing child behaviors and vice versa. Based on the literature, we expected to see that prompts to eat would be positively associated with energy intake [8, 9]. We expected to observe more maternal restriction in children who consumed larger amounts of food or selected a large number of items from the buffet, as mothers may react to the amount of food a child eats by using restriction. Further, we expected mothers' feeding practices to be associated with children's body mass index (BMI), with parents of heavier children using more restriction and those of children with lower BMI using more prompts to eat [32, 33]. We also expected to observe differences in the use of feeding practices across the ethnic groups, although these analyses were exploratory and we could not anticipate the direction of the results.

2 Materials and methods

2.1 Participants

The participants in this study were a subset of 320 mother-child dyads from the GUSTO mother-offspring cohort (N=1247) who took part in the video recorded *ad libitum* buffet lunch at 4.5 years of age (range: 54-56 mo). GUSTO is a prospective study started in 2009 that was designed to examine the health and wellbeing of pregnant mothers and their offspring. The participants are citizens or permanent residents of Singapore, and came from three majority local ethnic groups: Chinese, Malay, and Indian. Further details of the GUSTO cohort have been previously described [34]. From the available videos of the buffet lunch, 119 were excluded due to missing intake or anthropometric data (n=13), the presence of people other than the mother and child in the room (n=15), non-compliance with instructions (n=31), poor video quality (n=18), or families speaking languages other than English, Mandarin, or Malay (n=41). The remaining 201 videos of mother-child dyads were coded and analyzed in the final dataset. The children had a mean age of 54.5 months (SD 0.54) with mothers of an average age of 35.8 years (Table 1). The majority of the participants were of Chinese ethnicity (60%), followed by Malay (28%) and Indian (12%). The excluded participants did not differ from those included in the study in child age, sex, height, BMI, or energy intake; however, the excluded group had mothers that were slightly but significantly younger (mean of 34.5 vs. 35.8 years) and were more likely to be Indian or Malay, due to constraints in translating videos. The study was approved by the National Healthcare Group Domain Specific Review Board and Singhealth Centralized Institutional Review Board and is registered under the Clinical Trials as NCT01174875. All mothers gave written consent before participating in the study.

2.2 *Ad libitum* task meal

The *ad libitum* buffet meal was embedded within a battery of neurocognitive tests. The task was conducted in a testing room equipped with three high-resolution video cameras. The cameras were positioned in three corners of the room to be able to capture the entire room. The buffet consisted of nine commercially-available foods and three beverages. These foods were chosen because they are familiar and frequently consumed by local children in this age group, based on food diaries from the same cohort. The food items served were white bread (2.63 kcal/g; six slices; Gardenia), Honey Stars breakfast cereal (3.8kcal/g; 80 g; Nestlé), pancakes (3 kcal/g; 70 g; Aunt Jemima), chocolate cake (4.3 kcal/g; 80 g; Sara Lee), cheese (2.95 kcal/g; three slices; Cowhead), chicken cocktail sausages (2.95 kcal/g; 192 g; Fairprice), chicken nuggets (2.29 kcal/g; 216 g; CP), apple slices (0·44 kcal/g; 204 g), canned corn (0.81 kcal/g; 160 g; Hosen), apple juice (0.5 kcal/ml; six boxes; Marigold), full cream milk (0.65 kcal/ml; six boxes; Marigold), and water. Vegetarian children were served bean curd (0.73 kcal/g; 3 packets; Unicurd) and chickpeas (0.85 kcal/g; 240g; S&W) instead of the chicken sausages and nuggets. The buffet contained the same amount of food for all mother-child pairs.

The mother and child were asked not to eat for one hour before arriving at the study center, then there were two hours of other tests before lunch, meaning that by the time they arrived at the *ad libitum* buffet task, they had not eaten for at least three hours. Before the start of the

meal, mothers asked not to override the child's food choice or to share food with the child, but they were encouraged to otherwise interact freely with child, as they normally would during mealtimes at home. The mother and child then proceeded to the test room for their buffet meal, which lasted for 20 minutes. An additional 10 minutes were given, if the family required more time to finish eating.

2.3 Measures

2.3.1 Observational coding—An observational coding scheme was developed to measure mothers' feeding practices during the buffet meal. This type of behavioral coding through observation makes it possible to objectively quantify the frequency of mothers' feeding practices and make comparisons across families, without relying on subjective interpretations of questionnaire options such as "often". The coding scheme was designed to focus on three categories of feeding practices: 1) those used to increase children's food intake (prompts to eat a food, suggestions to take an additional item from the buffet, and physically feeding the child), 2) those related to limiting children's intake (telling them not to eat something, or questioning their buffet selection), and 3) those related to telling children to eat faster or slower. Mothers' positive, negative, and neutral comments about the food or eating were also recorded. The coding scheme was developed based on those previously used in the literature [8, 15, 17] and further adapted for the current study to account for the children's age and the particular structure of the buffet task. For example, even if mother-child pairs were instructed to have the children select their own food from the buffet, some mothers questioned their child's food choice (e.g., "Are you sure you want to eat that?"). Therefore, a code was added to reflect this feeding practice not previously observed in studies performed in the home environment in which parents typically selected and served the foods.

The behaviors included in this coding scheme are described in Supplementary Table 1. Briefly, they included the use of restriction (verbal or non-verbal), questioning the child's food choice, hurrying the child to eat faster, telling the child to eat slower, physically feeding the child, or talking about food. We further included two categories of prompts to eat [16, 17]. Autonomy-supportive prompts (ASP) are parental prompts to eat that allow the child some autonomy in deciding whether to eat the food. These included making a gentle suggestion to eat, offering a reason why the child should eat a food, or the mother modelling eating the food herself. Coercive and controlling prompts (CCP) are those in which the mother prompts the child to eat in a way that is more difficult for the child to refuse, due to coercive methods (e.g., use of rewards or threats) or use of parental authority. Feeding practices were coded each time mothers used the practice. In the event that mothers repeated the same behavior or sentence multiple times without a break (e.g., "Slow down, slow down"), this was counted as a single instance.

Maternal feeding practices were coded using ELAN 4.9.3 (Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands). Two coders, bilingual in English and Mandarin, were trained through telephone and video training sessions. All videos that were in English or Mandarin were coded by one of the trained video-coders. For videos in Malay (n=27), another research assistant, bilingual in Malay and English, translated and transcribed

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the videos before handing the translated transcripts to the first video-coder to code. Ten percent of all videos were then blind-validated by the second trained video-coder for inter-rater reliability. Inter-rater reliability, as measured by Cronbach's alpha, was above 0.80 for all behavioral codes.

2.3.2 Maternal and child characteristics—Data on maternal ethnicity, date of birth, and education level were collected at recruitment. Height was measured and self-reported pre-pregnancy weight was collected from the women at the first clinic visit at 11-14 weeks gestation. Height and weight were used to calculate maternal pre-pregnancy BMI (ppBMI) and mothers were categorized into the following weight categories based on recommended cutoff points for the Singaporean population: underweight (BMI<18.5 kg/m^2), normal weight (18.5-22.9), overweight (23-27.4), and obese (27.5 or higher), based on guidelines from the Singaporean Ministry of Health [35], which have been adapted from the Asia-specific WHO public health action points along the continuum of BMI.

The weight of the child at age 4.5 years was obtained using a calibrated digital scale (SECA model 813; SECA Corp.) to the nearest 10 g. Standing height was measured with the use of a stadiometer (SECA model 213). For reliability, all measurements were taken in duplicate. Based on the 2006 WHO Child Growth Standards, age- and sex-adjusted BMI z-scores were derived using WHO Anthro software (Version 3.2.2). Children were then classified into normal weight (BMI_z ≤1.04; n= 167[1]) and overweight groups (BMI_z >1.04; n= 34) [36].

2.3.3 Child's energy consumption and variety of food choice—Foods served at the *ad libitum* meal were weighed and recorded before and after the meal. The amount of food consumed by the child was calculated as the difference between the weight of food items before and after the meal. The amounts consumed were then converted to energy (kcal) by multiplying the weight consumed with the respective energy per gram, derived from Food Composition Table by the Health Promotion Board of Singapore [37]. The total number of foods served in the buffet was also recorded, as some children (23%) did not receive all 12 food items due to supply shortages, food allergies, or religious reasons. The percentage of food variety chosen by each child was calculated by dividing the number of foods chosen by the total number of foods provided.

2.4 Data transformation

As the duration of the meals varied between mother-child dyads, it was possible that differences in absolute counts of feeding practice use could be driven primarily by meal duration. Therefore, for all feeding practice analyses , the feeding practices were transformed into counts per 10 minutes of meal duration to provide a better representation of the feeding practice frequency, as has been done in similar feeding practice studies [15]. As previous studies in this cohort have shown that children with longer meal durations tend to consume more energy [38], again, the frequency of feeding practices per 10 minutes was also used to adjust for meal length in analyses with energy intake as an outcome.

[1]As there were only 8 underweight children in the sample, these were clustered with the normal weight children for analysis.

For prompts to eat, total counts for both autonomy-supportive prompts (ASP) and coercive-controlling prompts (CCP) were extracted from the coding. In addition, the proportion of total prompts of the ASP type (%ASP) was calculated using the formula: %ASP = (ASP*100)/(ASP+CCP).

2.5 Statistical analyses

Statistical analyses were conducted using SPSS Version 23.0 (IBM Corp, New York, USA). Analysis of variance (ANOVA) tests with Bonferroni corrections and post-hoc *t*-tests were used to compare the frequencies of feeding practice use between groups based on ethnicity, maternal pre-pregnancy weight status, child weight status, and child sex. Pearson correlations were conducted to examine the associations between mothers' feeding practices and children's food intake (energy intake and food variety selected) and BMI. Correlations were adjusted for maternal ethnicity, education, and child sex. Results were considered significant at $p < 0.05$. Multiple imputation was used to impute missing maternal ppBMI data (n=58) for statistical analysis.

3 Results

3.1 Meal duration

Meal duration for each subgroup is presented in Table 2. On average, the lunch meal lasted 24.0 minutes (SD 4.7). Although meal duration did not differ by child sex, nor child or maternal weight status, the meals of families of Chinese ethnicity (24.9 minutes) lasted significantly longer than those of Malay or Indian ethnicity (22.8 and 21.9 minutes, respectively; $p<0.01$). Meals were also significantly shorter in families with mothers with tertiary education (mean 23.4 minutes) than in those with less education (25.6 minutes; $p<0.01$). Therefore, all further analyses of feeding practices were adjusted for meal duration, with results presented per 10 minutes of video time.

3.2 Frequency of use of feeding practices

For each feeding practice, the proportion of mothers that used the practice and the mean number of times they did so (per 10 minutes of video) are presented in Table 3. Almost all mothers suggested that the child take a food from the buffet (93.5%) and prompted the child to eat something (93%), including both autonomy-supportive-(ASP; 85.6%) and coercive-controlling prompts (CCP; 73.6%). On average, mothers made about seven prompts to eat during the meal, of which 61% were of the ASP type. Approximately half of the mothers restricted the child's intake of something and a quarter questioned their choice from the buffet. Regarding the child's rate of eating, 63% of mothers told their child to eat faster, and 40% told them to eat slower, with some mothers using a mix of both. The majority of mothers talked about the food, making an average of 9.5 comments over the course of the meal. These comments were mostly neutral in nature (mean 6.6), but there were also some positive (1.7) and negative comments (1.2). Very few mothers physically fed their child (6%), therefore this behavior was excluded from further analysis.

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3.3 Differences in the use of feeding practice by maternal and child demographics

The frequency of using the different feeding practices was compared across groups varying by ethnicity and maternal weight status. The frequency of use of feeding practices by ethnic group are presented in Table 3. Malay mothers used significantly more prompts to eat (3.8 per 10 minutes) than either Chinese or Indian mothers (2.9 and 2.2, respectively; $p<0.05$), and that this difference was largely driven by an increase in ASP. Chinese mothers were more likely to question a child's food choices than were Malay or Indian mothers (0.23 vs. 0.08 or 0.04, respectively; $p<0.01$). Indian mothers used the least instructions to eat faster, compared to Chinese and Malay mothers (0.19 vs 1.3 and 1.4, respectively; $p<0.001$). There were no differences between ethnic groups for other feeding practices.

When groups were compared based on pre-pregnancy maternal BMI (data not shown), mothers in the obese group used significantly more autonomy-supportive prompts to eat on average (2.8 per 10 minutes) than did mothers of normal weight (1.7, $p<0.05$). The other two BMI groups had similar rates of using this feeding practice as the normal weight group (underweight: 1.7; overweight: 1.6), but did not differ statistically from the other groups, likely due to the smaller sample sizes of these BMI categories. Mothers with less education (less than a tertiary degree) used more coercive-controlling prompts than did the more educated mothers (1.4 vs. 0.8 per 10 minutes, $p<0.01$; data not shown). There were no other significant differences in feeding practices by maternal characteristics.

Maternal use of feeding practices was also compared based on child sex (data not shown). Mothers told boys to eat more slowly significantly more often than they did girls (0.6 vs. 0.3 per 10 minutes, $p<0.05$). There were no other significant differences in feeding practices by child sex.

3.4 Associations between feeding practices and intake at *ad libitum* meal

On average, children consumed 292 kcal of food at the ad libitum lunch (SD: 150), selecting a mean of 4.5 food items. Pearson correlations (adjusted for ethnicity, child sex, and maternal education) between feeding practice frequency (per ten minutes) and energy intake revealed significant positive associations for restriction and slowing the child (Table 4). The use of ASP prompts and restriction were positively associated with the food variety selected by the child. When analyses were further adjusted for maternal BMI status, all associations remained significant, except for the one between slowing the child and energy intake (data not shown).

3.5 Associations between feeding practices and child weight status

Although energy intake and food variety both showed significant positive associations with child BMI_z (r=0.195 and 0.158, respectively), no individual feeding practice showed significant associations with BMI (Table 5). As mothers' use of feeding practices did not show a linear relationship with BMI when measured as a continuous variable, children were also categorized into normal weight and overweight groups to compare families with children of different categories of weight (Table 5). There were no significant differences between groups for mothers' use of feeding practices. This was also true when controlling

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for maternal BMI status (not shown). Analysis of covariance (ANCOVA), adjusted for maternal ethnicity, maternal education level, and child sex.

4 Discussion

Considering that the majority of the literature on feeding practices has been conducted in North America, Europe, or Australia, the novelty of the current study lies in addressing the use of maternal feeding practices and related child food intake and BMI in an Asian preschool population. Here we report that mothers in Singapore used a range of feeding practices during a buffet meal with their children. Among these, feeding practices that limit child intake, including restriction, and slowing the child's eating, were positively associated with energy intake. Mothers' use of autonomy-supportive prompts and restriction were positively associated with the variety of foods selected by children from the buffet. However, none of the feeding practices were correlated with child BMI. The frequency of some feeding practices, namely prompting children to eat more, hurrying children's eating, and questioning child food choices, varied across ethnic groups.

Due to the cross-sectional nature of the current data, it is not possible to infer a temporal relationship between feeding practices and energy intake, but we can speculate about possible explanations for these correlations. Although it is possible that the mothers' use of restrictive feeding practices could cause the child to eat more, perhaps by making the "forbidden fruit" more attractive [39–41], the pattern of associations could also suggest that mothers were trying to limit intake as a reaction to the amount of food that the children were eating. This latter hypothesis would be consistent with our finding that mothers made more attempts to slow children's eating when they were consuming more energy, as this "slowing" behavior has not previously been shown to increase children's intake. The idea that parents adopt feeding practices in reaction to their children's eating behaviors or weight status also has some support from longitudinal studies in the literature [26, 32, 33, 42]. Intervention studies or time-stamped behavioral observations that allow detailed analysis of the order of behaviors would be needed to confirm which behavior precedes the other and if there is a causal link.

Surprisingly, the use of both ASP and restriction were associated with children selecting a greater variety of food items from the buffet. These relationships are less expected and more difficult to explain. We hypothesized that suggestions to take additional items from the buffet would be associated with a wider variety of foods selected, but this was not the case. Instead, it was the ASP to eat foods that were already selected that were associated with greater variety. One could speculate that the prompts to eat may have encouraged children to try a wider range of foods, or that children who finished the first round of foods might have gone back to select additional items from the buffet. It is also possible that once children had already selected several items, mothers wanted them to consume what they had chosen, to avoid being wasteful. The restriction, again, in this case could be a response to the child having already selected a large variety (and potentially quantity) of foods from the buffet.

The mothers' use of feeding practices differed based on several maternal characteristics. The finding that less educated mothers used more coercive-controlling prompts to eat, is

consistent with some previous studies showing negative associations between maternal education and pressure/prompts to eat [e.g., 43], although other studies have failed to find significant associations between these variables [44]. We also found that obese mothers were more likely to use autonomy-supportive prompts to eat, consistent with some previous studies showing that heavier parents use more prompts to eat [12]. Several feeding practices showed ethnic differences in feeding practices. In particular, Malay mothers used the most prompts to eat, with the difference largely driven by an increase in ASP, a behavior that was associated with the child selecting a larger variety from the buffet. A previous study found that Malay mothers scored highly on "pressure to eat", which often encompasses a wide range of types of prompts to eat [45]. The emphasis on use of autonomy-supportive prompts is consistent with a previous study finding that Malay parents tend to endorse using "reasoning and rules" as an approach to guiding child behavior [31]. Chinese mothers questioned children's food choices most often, a practice found in children with greater energy intake. This is also consistent with the characterization of the Chinese mothers as being warm, while still providing discipline, guiding, and training their children [28, 29]. Indian mothers were the least likely to tell their child to eat faster, but this behavior was not found to be associated with intake during the ad libitum meal. These results are broadly consistent with previous studies finding ethnic differences in parents' feeding styles and practices [20, 21, 31, 46, 47]. It is important to be aware of cross-cultural differences in feeding practices, as it is possible that they could reflect underlying factors that affect both feeding practices and dietary intake. These relationships should be explored further in larger and more balanced samples.

In contrast to findings from some previous studies using questionnaires to assess feeding practices [2, 48, 49], we did not find any significant differences in mothers' feeding practices based on the child's weight status. However, this result was consistent with another study using behavioral observations of feeding practices from the UK, which also found no differences based on child weight [12]. It is possible that child weight status affects parents' report or perception of their feeding practices, more than their actual daily behavior. The lack of differences based on child weight may also be attributed, at least partially, to the fact that our sample of Singaporean children included few children who were overweight (17% by BMI), thus the study may not have been sufficiently powered to identify any existing differences in feeding practices based on weight status. Further, previous studies in this cohort and others have suggested that the parents of overweight children tend to underestimate their child's weight status [50, 51], thus it is possible that we did not see any differences by child weight status as the mothers of overweight children were not aware or concerned about their child's weight. Other studies [e.g., 21] have shown differences in the associations between feeding practices and weight, depending on the ethnicity of the family; thus it is also possible that there is not a strong association in Singaporean families, or that there may be different associations between the ethnic subgroups of our sample, but our sample was not sufficiently powered to test this. Previous studies in older children in Malaysia have shown that parents of children with higher BMI reported more food restriction and less use of pressure to eat [52, 53], but this literature is limited, and less is known about preschool aged children and children from the other ethnic groups.

The strengths of this study lie in the objective behavioral observation of a large sample of mother-child dyads interacting in a mealtime environment and the quantitative measurement of the child's food intake at the meal. As the majority of the literature on feeding behaviors relies on parent-report to assess both feeding practices and often child food intake, there is a risk of bias from both measures individually, as well as from having a single respondent providing both measures. In the current study, behaviors were coded by trained researchers and food intake was measured through weighing, providing a more objective and independent assessment of both variables.

The study had a few limitations that must be considered in interpreting the results, including that the results are based on a single laboratory-based *ad libitum* meal, which may not be representative of the feeding practices that mothers would use in a more natural environment. As the original goal of the task was to explore children's energy intake, mothers were asked not to interfere with children's food choice or the amount consumed, which may also have altered their behavior at mealtime. However, despite the instructions, the majority of mothers (over 93%) *did* tell the child to select or eat particular foods. This could suggest that the mothers were unsuccessful in inhibiting this habitual behavior. It is also possible that the mothers were aware that their children were being observed and therefore were using feeding practices to ensure that the children would demonstrate "healthy" eating behaviors [54]. Mothers may use different feeding practices in the home environment where they have more control over the foods purchased and offered to the child than were observed in the laboratory setting where the buffet foods were pre-selected by the experimenters. Although the current study allowed us to explore a few different ways for mothers to prompt children to select or eat certain foods, future studies set in more naturalistic environments could provide more granularity regarding mothers' use of different types of restriction (e.g., covert restriction), as well as feeding practices used by other caregivers such as fathers, nannies, or grandparents, who may also have substantial roles in feeding children [55–58]. As many of the analyses were exploratory in nature and there were many correlations conducted, we acknowledge the possibility of spurious findings that would need to be replicated in future studies. Finally, the current findings may not be generalizable to the full Singapore population, especially to groups that do not speak English or Mandarin in the home, as these were underrepresented in the sample, due to limited availability of multilingual video coders.

Mothers of preschoolers in Singapore use a variety of feeding practices during mealtimes, including prompts to eat more food and restriction of intake. In particular, mothers seem to react to children's larger food intake by telling them to eat less or more slowly. Further research is needed to understand whether the feeding practices currently used by parents are effective in managing children's food intake, and to explore with greater granularity which particular feeding practices are optimal to adopt in these situations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Participant characteristics (n=201)

Maternal age in years *(mean, SD)*	35.8 (5.2)
Ethnic group *(n, %)*	
Chinese	121 (60.2)
Malay	56 (27.9)
Indian	24 (11.9)
Pre-pregnancy BMI in kg/m2 * *(n, %)*	
< 18.5	24 (11.9)
18.5 – 22.9	113 (56.2)
23 – 27.4	38 (18.9)
≥ 27.5	26 (12.9)
Maternal level of education	
Tertiary degree	51 (25.4)
Below tertiary degree	150 (74.6)
Child age in months *(mean, SD)*	54.5 (0.54)
Child sex *(%)*	
Male	99 (49.3)
Female	102 (50.7)
Child weight in kg (Mean, SD)	17.5 (3.47)
Child BMIz categories *(n, %)*	
Normal	167 (83.1)
Overweight	34 (16.9)

* ppBMI: Pre-pregnancy BMI, self-reported

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Table 2

Meal duration (minutes) by ethnicity, child sex, maternal ppBMI and child BMI category

	Mean	S.D.	*p*
Ethnicity			0.001
Chinese	24.9[a]	4.82	
Malay	22.8[b]	3.41	
Indian	21.9[b]	5.32	
Maternal ppBMI category			0.939
Underweight (< 18.5)	23.8	5.55	
Normal Weight (18.5 – 22.9)	24.2	4.68	
Overweight (23 – 27.4)	23.6	4.11	
Obese (≥27.5)	23.9	4.75	
Maternal education			0.004
Tertiary degree	23.4	4.54	
Below tertiary degree	25.6	4.73	
Child sex			0.189
Boy	23.5	4.69	
Girl	24.4	4.64	
Child BMI category			0.417
Normal weight	23.9	4.64	
Overweight	24.6	4.83	

ANOVA with Bonferroni correction
BMI = Body Mass Index; ppBMI = pre-pregnancy Body Mass Index
Items with same superscript (a, b) are not significantly different (p>0.05)

Table 3
Descriptive of feeding practices for full sample and by ethnicity

Maternal feeding practices	Number of mothers using practice (%)	Frequency of feeding practices per 10 minutes Mean (S.D)				p-value
		Total N=201	Chinese n=121	Malay n=56	Indian n=24	
Suggestion	188 (93.5)	3.28 (3.11)	3.02 (3.07)	3.44 (2.57)	4.21 (4.24)	0.208
Prompts	187 (93.0)	3.07 (2.94)	2.91 (2.92)	3.81 (3.08)	2.18 (2.41)	0.048
ASP	172 (85.6)	1.80 (1.81)	1.67 (1.57)[a]	2.38 (2.30)[b]	1.12 (1.25)[a]	0.007
CCP	148 (73.6)	1.27 (1.87)	1.24 (2.10)	1.43 (1.49)	1.06 (1.46)	0.701
% ASP	-	24.3 (15.2)	23.3 (14.3)	27.1 (15.3)	23.3 (18.9)	0.284
Restriction	102 (50.7)	0.49 (0.71)	0.55 (0.74)	0.40 (0.57)	0.36 (0.82)	0.274
Questioning child's choice	51 (25.4)	0.17 (0.33)	0.23 (0.38)[a]	0.08 (0.19)[b]	0.04 (0.12)[b]	0.002
Talking about food/ child's eating	195 (97.0)	3.99 (2.93)	4.21 (3.14)	3.89 (2.50)	3.10 (2.63)	0.228
Negative comments	112 (55.7)	0.54 (0.84)	0.63 (0.91)	0.37 (0.55)	0.49 (0.96)	0.155
Neutral comments	191 (95.0)	2.74 (2.30)	2.89 (2.47)	2.71 (2.01)	2.08 (1.98)	0.288
Positive comments	126 (62.7)	0.71 (0.91)	0.69 (0.89)	0.81 (1.00)	0.53 (0.76)	0.429
Hurrying	127 (63.2)	1.20 (2.09)	1.30 (2.34)[ab]	1.44 (1.83)[a]	0.19 (0.42)[b]	0.035
Slowing	80 (39.8)	0.47 (0.84)	0.46 (0.87)	0.42 (0.71)	0.58 (0.94)	0.742
Physically feeding child*	12 (6.0)	0.05 (0.24)	0.03 (0.17)	0.06 (0.25)	0.15 (0.45)	0.087

Note: "Physically feeding child" was removed from further analysis as incidence was too low. Items with same superscript (a, b) are not significantly different (p>0.05). Abbreviations: ASP: autonomy-supportive prompt to eat; CCP: coercive-controlling prompt to eat. % ASP represents the percentage of total prompts to eat that were of the ASP type.

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Table 4

Pearson correlations between maternal feeding practice use and child outcomes

Feeding practice (Frequency per 10 min)	Energy intake (kcal)	Food Variety (%)	Child BMIz
Suggestion	-0.05	-0.04	0.00
Total Prompts	0.08	0.14	0.02
ASP	0.12	0.19*	0.03
CCP	0.01	0.02	-0.01
% ASP	-0.06	0.01	0.05
Restriction	0.19*	0.15*	0.02
Questioning	0.12	0.05	-0.03
Talking about food/ child's eating	0.01	0.03	-0.02
Negative	-0.04	-0.05	0.06
Neutral	0.02	0.09	-0.05
Positive	0.01	-0.08	0.01
Hurrying	0.09	0.11	0.03
Slowing	0.13*	0.09	-0.01

* $p<0.05$. Analyses adjusted for maternal ethnicity, maternal education level and child gender.

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Table 5

Differences in mean feeding practice use (per 10 minutes) by child weight category

	Normal Weight Mean (SE) n=167	Overweight Mean (SE) n=34	F	p-value
Suggestion	3.19 (0.24)	3.72 (0.54)	0.814	0.368
Total Prompts	3.10 (0.23)	2.93 (0.51)	0.098	0.755
ASP	1.80 (0.14)	1.78 (0.32)	0.004	0.947
CCP	1.30 (0.15)	1.14 (0.33)	0.182	0.670
% ASP	24.4 (1.19)	24.0 (2.67)	0.020	0.889
Restriction	0.47 (0.72)	0.58 (0.72)	0.580	0.447
Questioning	0.17 (0.03)	0.13 (0.06)	0.539	0.464
Talking about food/ child's eating	4.01 (0.23)	3.88 (0.51)	0.055	0.814
Negative	0.51 (0.07)	0.66 (0.15)	0.812	0.369
Neutral	2.79 (0.18)	2.51 (0.40)	0.396	0.530
Positive	0.71 (0.07)	0.71 (0.16)	0.000	0.994
Hurrying	1.24 (0.16)	1.03 (0.36)	0.275	0.601
Slowing	0.48 (0.65)	0.42 (0.15)	0.125	0.724

Analysis of covariance (ANCOVA), adjusted for maternal ethnicity, maternal education level, and child sex.