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ORIGINAL CONTRIBUTION

Testing links between unfavorable living conditions, fast life-history strategy adoption, and overeating: a four-wave longitudinal study

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Abstract

Although overeating increases risk for chronic illness and premature mortality, evolutionary life-history theorists posit that such behaviors arise as a potential outcome of using fast life-history strategies to function in environments that are harsh or unpredictable. To test this premise, we examined links between harsh, unpredictable living conditions (HULC), the adoption of fast life-history (LH) strategies, and overeating among early adolescents using a four-wave longitudinal design. Participants were 2547 Chinese adolescents (1202 girls, 1345 boys) who completed baseline questionnaires assessing experiences of HULC, preferences for use of fast LH strategies, and overeating. Measures were re-administered in follow-ups 7, 13, and 20 months later. Analyses indicated HULC predicted increased use of fast LH strategies within each gender. However, fast LH strategy adoption contributed to increases in overeating only among girls. Findings supported specific tenets of life-history theory and underscored gender as an important consideration in understanding links between living conditions, the adoption of fast LH strategies, and risk for overeating. Interventions focused on reducing poverty and increasing stable, nurturing family, and community environments may aid in reducing overeating and obesity for adolescents.

Keywords Overeating · Life-history strategies · Environmental unpredictability · Adolescents · Gender difference

Introduction

Overeating is conceptualized as energy intake that is disproportionately greater than energy expenditures [40]. Short-term overeating may help to replenish body fat stores and increase the likelihood of survival in harsh and unpredictable environmental conditions. However, chronic overeating is related to overweight and obesity, problems that increase risk for metabolic diseases and premature mortality [4, 18, 28, 42]. Over 23% of the world's population has an overweight or obese weight status [15]. These trends are not limited to Western countries and extend to understudied rapidly developing countries such as China. For example, one recent study reported rates of overweight and obesity based on World Health Organization (WHO) criteria to be 14.6% and 7.4%, respectively, among Chinese adolescents between 2011 and 2015 [51]; significant increases during this interval were found for adolescents compared to children and urban adolescents compared to those in rural regions.

Various studies have found that living in harsh, unstable circumstances contributes to overeating and increased risk for obesity [19, 35, 41]. For example, children from less secure lower socioeconomic status backgrounds are more likely to engage in overeating later, during adulthood, despite the absence of hunger [19]. In this four-wave longitudinal study, we tested the evolutionary life-history premise that early adolescents who live in harsh, unstable living conditions are more likely to adopt faster life-history (LH) strategies that increase subsequent risk for overeating.

According to life-history theory [27], organisms face necessary trade-offs in dividing limited energy and resources toward long-term projects to develop the body and mind such as learning versus immediate payoffs such as eating for pleasure or in response to hunger [14]. How one negotiates these trade-offs reflects one's LH strategies. Prioritization of efforts to develop mind and body is viewed as slow LH

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strategies that reflect willingness to delay immediate gratification in exchange for long-term benefits. Preferences for immediate rewards or gratification despite future consequences reflect a preference for fast LH strategies. A crucial point of the theory is that people adopt slow or fast LH strategies that help them best adapt to their living conditions.

For example, harsh, unpredictable living conditions (HULC) are manifested in various ways including punitive or inconsistent caregiving, frequent residential changes, lower socioeconomic status (SES), inadequate resources to satisfy necessary needs, and social networks that include dangerous or unstable persons [41]. Such experiences cause children to perceive caregivers as unreliable and the world as dangerous or unpredictable. In response, children may develop fast life-history strategies—cognitive and behavioral tendencies that maximize current gratification despite potentially negative future consequences [14]. Related studies have used lower SES and poverty as proxies for environmental harshness and inconsistent neighbor or caregiver rearing to measure environmental unpredictability [36, 47, 48].

Empirically, longitudinal research has found that children who grow up in unpredictable environments characterized by parental absence and chaos at home report faster LH strategies focused on current rewards and immediate gratification 18 months later [31]. Similarly, retrospective recall of lower childhood SES and instability predict preferences for faster LH strategies over time [35]. Large-scale research on adolescents across nine countries including China, Italy, and Colombia found that 10-year-old children with HULC such as unsafe neighborhoods, traumatic life events, family chaos, and family income changes were more likely to endorse faster LH strategies directed at immediate rewards than peers who reported stable childhood environments [6].

Fast LH strategies can have profound effects on specific behaviors (e.g., current versus future reproduction efforts) that affect personal and species well-being [12, 32]. Food, especially highly palatable food, has immediate rewarding properties (e.g., good taste) that satisfy basic energy needs in addition to providing distraction from negative events. Researchers have even conceptualized food as having addictive properties that have the potential for abuse [49]. For example, food cues can activate the same reward-related brain circuits that alcohol and cigarettes do [49]. Against this backdrop, people who are prone to adopting faster LH strategies may be at risk for behaving impulsively in general but also during exposure to food [19]. Hence, this orientation may foster overeating in the presence of food or cues for food, presumably because future availability and access to food is uncertain or hindered. Therefore, continued eating in the absence of hunger may follow, while corresponding long-term health consequences of overeating are minimized [35].

Longitudinal research based on life-history theory has found that the use of fast LH strategies by less-privileged adolescents predicts later impulsive behaviors such as aggression and risk-taking as well as declines in academic performance [6, 31]. However, to date, prospective links between HULC, fast LH strategies, and overeating have not been assessed in early adolescents. Doing so may aid in identifying those at risk for negative long-term outcomes such as adult obesity and associated chronic illnesses.

Another limitation of studies based on life-history theory has been the relative neglect of gender as a possible moderating influence on associations between fast LH strategies and outcomes of interest. For example, while some research has found that overeating is more common among women than men [3], it is not clear whether this effect is a function of gender differences in the impact of HULC or preferences for fast LH strategies. However, based on evidence that (1) girls experience more life events and higher levels of stress and depression than boys do [26] and (2) girls use less effective coping strategies (e.g., rumination) to manage stressors [11], a plausible hypothesis in line with life-history theory is that associations between the adoption of fast LH strategies and overeating as a means of coping with negative emotion are more entrenched for early adolescent girls than early adolescent boys.

In sum, theory and associated research have found that increased exposure to HULC is related to the pursuit of faster LH strategies that tend to maximize current gratification, facilitate capacities for earlier reproduction, and foster outcomes reflecting increased impulsivity. To date, however, links of HULC and use of fast LH strategies with overeating have not been assessed over time among adolescents. Furthermore, possible moderating effects of gender on these associations have never been tested. In response, we conducted a four-wave longitudinal study to assess relations between current experiences of HULC, general preferences for fast LH strategies, and overeating as a particular outcome among 11–16-year-old adolescents during the course of 20 months. Early-to-middle adolescents were selected, because they are on the cusp of sexual maturity and because eating disorders characterized by overeating such as bulimia nervosa and binge-eating disorder often emerge during early-to-middle adolescence [8, 20]. From the preceding overview, we hypothesized that experiences of increased HULC would predict subsequent increases in fast LH strategies and promote overeating, particularly among girls, compared to the boys.

Methods

Participants

Participants were 2547 early adolescents (1202 girls, 1345 boys) from Wuhan, China. On average, they were 13.07 years of age (SD = 0.89 years, range 11–16 years) and of Han majority ethnicity (99.2%) rather than ethnic minority group members (0.80%). With respect to parental education, 23% reported fathers with post-secondary education, 38% with high school education, and 39% with middle school education or less; corresponding figures were 17%, 38%, and 45%, respectively, for mothers. Regarding monthly family income, 5% reported 4000 Chinese yuan (CHY) or less, 27% reported 4001–7000 CHY, 31% reported 7001–10,000 CHY, 21% reported 10,001–13,000 CHY, and 16% reported 13,001 CHY or more (1 CHY equals 0.155 US dollar approximately). At present, the average family income in China is 5880.67 CHY per month [37]. On average, the sample had a baseline mean body mass index standard deviation score (BMI-SDS) of 0.56 ± 1.37.

Procedure

The Human Research Ethics committee at the Southwest University approved the study (Project title: The association between environmental unpredictability, LH strategies and overeating, and IRB protocol SWUPSY17092006). Principals and class advisors of three Wuhan public middle schools were contacted and permitted the study. Each study phase took about 20 min to complete. Eligible students were those who were willing to undertake the study and who had obtained parental consents for the entire study. Those who met these criteria completed an informed consent outlining the study purpose (to investigate how living environments are related to other behaviors including eating), participant rights (e.g., right to withdraw at any time without penalty), and the time commitment as well as the measures described below. Student numbers were solicited to allow matching of Time 1 (T1) to Time 4 (T4) surveys of each participant while preserving anonymity in the data file. Although students were not compensated individually, after completing each assessment phase, participating schools received 2,000 CHY to support student learning.

Back-translated Mandarin language versions of the fast LH strategy and overeating scales were based on past peer-reviewed studies of Chinese samples [9, 31, 33], though select items from the former scale were deemed to be unsuitable or irrelevant for early adolescents and excluded; remaining items were reassessed via confirmatory factor analyses (CFA). The measure of HULC was adapted from previous studies [36, 43] and formally translated into Mandarin and back-translated into English by two fluent bilingual Mandarin–English speakers. The first author and translators discussed discrepancies between translations and resolved these differences based on consensus. This back-translation was then translated into an English version by a third bilingual translator. All translators independently indicated that derived item meanings were consistent with meanings from the original items.

Respondents completed the T1 assessment in September, 2017. There was modest attrition at the 7-month follow-up (T2) in April 2018 ($n = 2470$), though a substantial number of students did not complete follow-ups at 13 months (T3) in October 2018 ($n = 1549$) or 20 months (T4) in May 2019 ($n = 1513$) due to graduation from middle school in June 2018. Multiple imputation is an acceptable approach to managing missing data when attrition is 50% or lower [45] and was used to manage missing values, though results based on case-wise deletion were similar to results based on the entire sample following imputation.

Measures

Harsh, unpredictable living conditions (HULC)

To measure harshness and unpredictability in one's living environment, six items adapted from the Family Unpredictability Scale [43], three unpredictability items and four subjective SES items (reverse-scored) [36] were used. Sample items included, "My parent often fails to keep her/his promises", "Things are often chaotic in my house", and "My family usually has enough money for material possessions". Items were rated from *1* (*strongly disagree*) to *5* (*strongly agree*), with higher scores reflecting perceptions of living in a less economically secure, more unpredictable environment. Because these items have not been combined or used within Chinese samples, we performed confirmatory factor analyses (CFA) to assess whether a 13-item single factor model was appropriate. Uniformly adequate fits supported the model, RMSEA = 0.018, χ^2 (54) = 1.14, CFI = 0.992, TLI = 0.989, SRMR = 0.031. In the current study, internal consistencies for adolescent girls were $\alpha = 0.73$ (T1), $\alpha = 0.82$ (T2), $\alpha = 0.77$ (T3), and $\alpha = 0.78$ (T4); internal consistencies for adolescent boys were $\alpha = 0.68$ (T1), $\alpha = 0.78$ (T2), $\alpha = 0.75$ (T3), and $\alpha = 0.77$ (T4).

Fast life-history strategies

Sixteen items from the 20-item mini-K questionnaire [16] were used to measure fast LH strategies. Items (e.g., "I can often tell how things will turn out") were rated on a 5-point

scale from *1* (*strongly disagree*) to *5* (*strongly agree*) and reverse-scored, so that higher scores reflected more use of fast LH strategies. Although the 20-item version has been used in a Chinese college student sample [7], four items reflecting future perceptions of one's own children and lovers were not applicable to current experiences of early adolescents and were excluded from analyses. CFA performed on a modified 16-item single factor model of the measure generated uniformly adequate fits, RMSEA = 0.027, χ^2 (87) = 1.30, CFI = 0.987, TLI = 0.983, SRMR = 0.042. In the current study, internal consistencies for girls were $\alpha = 0.82$ (T1), $\alpha = 0.87$ (T2), $\alpha = 0.84$ (T3), and $\alpha = 0.89$ (T4); internal consistencies for adolescent boys were $\alpha = 0.81$ (T1), $\alpha = 0.87$ (T2), $\alpha = 0.86$ (T3), and $\alpha = 0.90$ (T4).

Overeating

The nine-item uncontrolled eating subscale of the Three Factor Eating Questionnaire [2] assessed overeating. Items (e.g., "Sometimes when I start eating, I just can't seem to stop") were rated from *1* (*strongly disagree*) to *4* (*strongly agree*). The scale's nine-item univariate structure has been replicated in a Chinese adolescent sample [9]. In this study, internal consistencies for girls (T1: $\alpha = 0.87$, T2: $\alpha = 0.91$, T3: $\alpha = 0.86$, T4: $\alpha = 0.88$) and boys (T1: $\alpha = 0.86$, T2: $\alpha = 0.88$, T3: $\alpha = 0.88$, T4: $\alpha = 0.89$) were acceptable.

Demographic variables

Age, gender, height, and weight were assessed. In addition, education level of each parent and family income were assessed as objective SES indicators. BMI was calculated from the self-reported weight (kilograms)/self-reported height (meters^2).

Design and analysis

Data analyses were performed using SPSS Version 20 and Mplus 7.0. Preliminary analyses included missing data evaluation. Next, gender difference on baseline demographic variables (age, BMI, parental education, and family monthly income) were assessed using *t* tests. Analyses of covariance (ANCOVAs) were run to examine gender differences on the main study variables, controlling for significant demographic covariates.

Subsequently, within gender bivariate correlations were calculated between the research variables for girls and boys, respectively. Finally, following recommendations of Little [30], structural equation modeling (SEM) tested the mediation hypothesis for girls and boys, separately, controlling for age and BMI. Mediation was tested by examining (1) whether the path from T1 experiences of harsh, unpredictable living conditions (HULC) to T4 overeating was significant and (2) three indirect paths from T1 HULC to T4 overeating: i. T1 HULC to T2 HULC to T3 fast LH (LH) orientation to T4 overeating, ii. T1 HULC to T2 fast LH – T3 fast LH orientation to T4 overeating, and iii. T1 HULC – T2 fast LH orientation to T3 overeating to T4 overeating. If any of the three indirect path was significant, the overall mediation model was interpreted as significant [10].

Results

Preliminary analyses

In relation to missing values assessment, none of the Little's MCAR test values for research measures (HULC, fast life-history strategies, overeating) was significant (p's > 0.072), so multiple imputation via fully conditional specification (FCS) based on ten complete data sets was used to generate values to address missing data.

Differences between completers and non-completers of the research were assessed, because substantial percentage (40.6%) of the initial sample graduated from middle school in June 2018 and was not available to complete T3 and T4 follow-ups. Completers were younger [$M_{\text{completers}} = 12.69$, SD = 0.70, $M_{\text{noncompleters}} = 13.62$, SD = 0.85, t (1, 2545) = 920.77, $p < 0.001$, $d = 1.19$], had a lower mean BMI [$M_{\text{completers}} = 18.51$, SD = 2.92, $M_{\text{noncompleters}} = 19.21$, SD = 3.21, t (1, 2545) = 32.08, $p < 0.001$, $d = 0.23$], and reported lower baseline overeating scores than did non-completers [$M_{\text{completers}} = 17.24$, SD = 5.73, $M_{\text{noncompleters}} = 18.06$, SD = 5.94, t (1, 2545) = 12.33, $p < 0.001$, $d = 0.14$]. Furthermore, more girls than boys completed these follow-ups, $\chi^2 = 24.29$, $p < 0.001$.

However, completers and non-completers did not differ on parental education [$M_{\text{completers}} = 2.23$, SD = 0.67, $M_{\text{noncompleters}} = 2.20$, SD = 0.67, t (1, 2545) = 0.78, $p = 0.378$, $d = 0.05$], monthly family income [$M_{\text{completers}} = 4.40$, SD = 1.60, $M_{\text{noncompleters}} = 4.30$, SD = 1.45, t (1, 2545) = 2.81, $p = 0.094$, $d = 0.07$], T1 HULC scores [$M_{\text{completers}} = 32.15$, SD = 7.38, $M_{\text{noncompleters}} = 31.79$, SD = 7.55, t (1, 2545) = 1.46, $p = 0.227$, $d = 0.05$], or T1 use of fast LH strategies [$M_{\text{completers}} = 38.52$, SD = 9.55, $M_{\text{noncompleters}} = 39.28$, SD = 10.86, t (1, 2545) = 3.41, $p = 0.065$, $d = 0.07$].

The evaluation of gender differences on demographics (age, BMI, father's education, mother's education, and family income) indicated that girls ($M = 12.97$, SD = 0.89) were younger than boys ($M = 13.15$, SD = 0.89), t (1, 2545) = 26.17, $p < 0.001$, $d = 0.20$) and had lower BMI ($M_{\text{girls}} = 18.54$, SD = 2.66) than did boys ($M_{\text{boys}} = 19.02$, SD = 3.36), t (1, 2545) = 15.27, $p < 0.001$, $d = 0.16$. There were no gender differences in parent education [$M_{\text{girls}} = 2.20$, SD = 0.67, $M_{\text{boys}} = 2.23$, SD = 0.67, t (1, 2545) = 2.41, $p = 0.121$, $d = 0.04$], but a statistical trend was found for

monthly family household income [$M_{girls} = 4.30$, SD = 1.53, $M_{boys} = 4.42$, SD = 1.54, t (1, 2545) = 3.73, $p = 0.054$, $d = 0.08$].

Gender differences on the main research measures

After controlling for effects of gender on age, BMI-SDS, and monthly family income as covariates in analyses, girls reported significantly more HULC and more overeating than boys did across all assessments (see Table 1). Girls also reported higher fast LH (LH) strategy scores across T1–T4, though this difference was no longer significant at T4.

Within gender correlations between the main research measures

Patterns of correlation between the main research measures were similar for girls and boys (Table 2). HULC was positively associated with fast LH strategies and overeating at each assessment for both genders. Results were robust and extended over 20 months.

Table 1 Gender comparison in main research variables

Measures	Adolescent girls ($n = 1202$)	Adolescent boys ($n = 1345$)	F (1, 2542)	p	Partial η^2
T1 HULC	32.31 ± 7.50	31.73 ± 7.40	3.99	0.046	0.002
T2 HULC	34.37 ± 8.97	33.63 ± 8.68	4.88	0.027	0.002
T3 HULC	35.31 ± 7.88	34.24 ± 7.65	12.34	< 0.001	0.005
T4 HULC	33.13 ± 7.66	32.34 ± 7.66	6.12	0.013	0.002
T1 fast life-history strategies	39.28 ± 9.64	38.42 ± 10.49	4.93	0.026	0.002
T2 fast life-history strategies	40.64 ± 10.29	39.15 ± 12.62	9.78	0.002	0.004
T3 fast life-history strategies	39.52 ± 8.70	38.26 ± 9.87	11.76	0.001	0.005
T4 fast life-history strategies	40.41 ± 10.05	40.29 ± 10.79	0.07	0.797	0.000
T1 overeating	18.23 ± 5.69	16.98 ± 5.89	34.70	< 0.001	0.013
T2 overeating	17.75 ± 6.23	16.61 ± 6.41	21.67	< 0.001	0.008
T3 overeating	18.34 ± 4.66	17.64 ± 4.60	14.99	< 0.001	0.006
T4 overeating	19.16 ± 5.33	18.13 ± 6.13	20.95	< 0.001	0.008

HULC harsh and unpredictable living conditions; F values are based on analyses of covariance, controlling for age, BMI-SDS, and monthly family income

Table 2 Correlations between main study measures among boys and girls (boys = 1345, girls = 1202)

Measures	1	2	3	4	5	6	7	8	9	10	11	12
1 T1 HULC	–	0.37***	0.24***	0.61***	0.31***	0.22***	0.56***	0.26***	0.21***	0.60***	0.26***	0.13***
2 T1 fast LH	0.27***	–	0.34***	0.29***	0.51***	0.24***	0.27***	0.42***	0.28***	0.24***	0.47***	0.23***
3 T1 overeating	0.28***	0.09**	–	0.17***	0.18***	0.39***	0.15***	0.18***	0.37***	0.17***	0.19***	0.26***
4 T2 HULC	0.50***	0.21***	0.24***	–	0.34***	0.24***	0.68***	0.26***	0.24***	0.67***	0.28***	0.17***
5 T2 fast LH	0.20***	0.35***	0.12***	0.24***	–	0.42***	0.29***	0.49***	0.41***	0.30***	0.53***	0.26***
6 T2 overeating	0.12***	−0.01	0.45***	0.22***	0.02	–	0.21***	0.25***	0.43***	0.23***	0.23***	0.38***
7 T3 HULC	0.46***	0.19***	0.19***	0.59***	0.16***	0.17***	–	0.30***	0.25***	0.71***	0.31***	0.19***
8 T3 fast LH	0.21***	0.41***	0.13***	0.26***	0.53***	0.06*	0.23***	–	0.31***	0.28***	0.56***	0.27***
9 T3 overeating	0.05	0.04	0.23***	0.08**	0.04	0.30***	0.09**	0.07**	–	0.24***	0.28***	0.51***
10 T4 HULC	0.48***	0.19***	0.21***	0.56***	0.21***	0.16***	0.61***	0.26***	0.08**	–	0.33***	0.17***
11 T4 fast LH	0.21***	0.39***	0.09**	0.20***	0.38***	0.06*	0.21***	0.50***	0.02	0.26***	–	0.28***
12 T4 overeating	0.10***	0.01	0.25***	0.13***	0.04	0.37***	0.13***	0.04	0.25***	0.17***	0.03	–

HULC harsh and unpredictable living conditions, *Fast LH* fast life-history strategies; values above the diagonal are correlation coefficients for girls, and values below the diagonal are correlation coefficients for boys

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

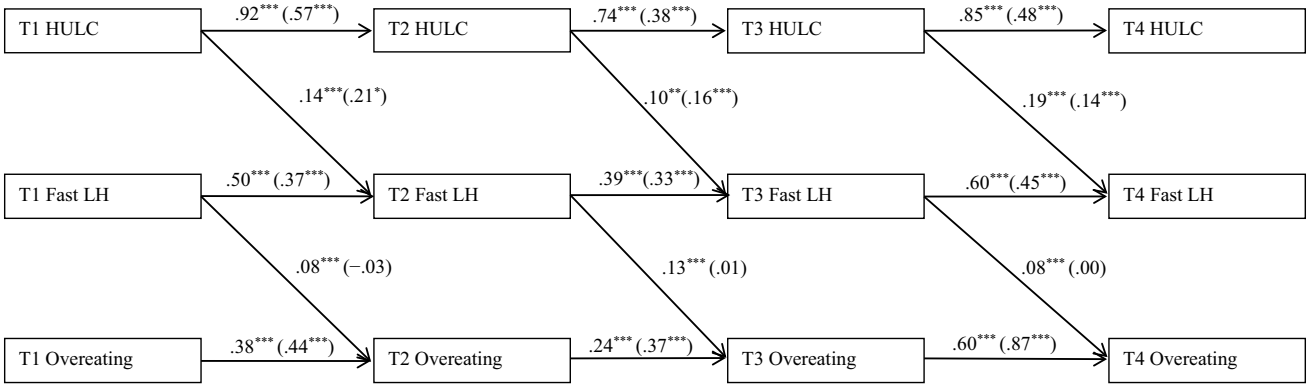

Fig. 1 The $*p<0.05$, $**p<0.01$,$***p<0.001$. Path analyses of longitudinal relations; values for girls ($n=1202$) are prior to brackets, values for boys ($n=1345$) are inside brackets; *HULC* harsh and unpredictable living conditions, *Fast LH* fast life-history strategies; the coefficients were standardized coefficients

Structural equation model of associations between unfavorable environments, fast life-history strategy adoption, and overeating within each gender

SEM were run separately for boys and girls controlling for age and BMI-SDS (see Fig. 1). Separate indirect models for girls and boys yielded acceptable fits. For girls [CFI = 0.950, TLI = 0.906, RMSEA = 0.073, χ^2 (43) = 7.37, SRMR = 0.049], all relevant paths between HULC scores, use of fast LH strategies, and overeating were statistically significant and supported the hypothesized mediation model (Fig. 1). For boys [CFI = 0.935, TLI = 0.878, RMSEA = 0.070, χ^2 (43) = 7.60, SRMR = 0.056], more HULC were also related to higher fast LH strategy scores. However, mediation was not supported in light of non-significant paths from T1 use of fast LH strategies to T2 overeating, T2 use of fast LH strategies to T3 overeating, and T3 use of fast LH strategies to T4 overeating.

To examine hypothesized mediation models further, SEM were generated using Mplus version 7.0. Bootstrap analyses examined indirect effects based on 95% bias-corrected confidence intervals of effects from 2000 resamples of the data. When 95% confidence intervals (CI) did not include "0", mediating effects were significant at $\alpha = 0.05$. These indirect effects analyses suggested that fast LH strategies fully mediated the association between HULC and overeating for girls but not boys (see Fig. 1, Table 3).

Discussion

Life-history theory has generated considerable research to explain how harsh, unpredictable environments influence various behaviors including overeating. However, associated empirical studies have relied heavily on cross-sectional designs and adults' retrospective recall of earlier life experiences in addition to neglecting gender as having a potential moderating influence on these associations. In this study, structural equation modeling (SEM) indicated that increased use of fast LH strategies helped to explain why baseline elevations in experiences of HULC predicted subsequent increases in overeating over the course of 20 months among early-to-middle adolescent girls and not boys. Aside from within gender differences in associations between these experiences, girls reported consistently more HULC, fast

Table 3 Bootstrap analysis of indirect effect for boys and girls

Indirect effect from T1 HULC to T4 Overeating	Indirect effect size		Bootstrapped 95% Confidence Intervals	
	Boys	Girls	Boys	Girls
T1 HULC – T2 Fast LH – T3 Overeating – T4 Overeating	0.002 ($p=0.224$)	**0.009 ($p=0.001$)**	[0.000, 0.006]	[0.004, 0.013]
T1 HULC – T2 Fast LH – T3 Fast LH – T4 Overeating	0.000 ($p=0.755$)	**0.004 ($p=0.001$)**	[−0.002, 0.001]	[0.002, 0.006]
T1 HULC – T2 HULC – T3 Fast LH – T4 Overeating	0.000 ($p=0.794$)	**0.006 ($p=0.050$)**	[−0.004, 0.001]	[0.002, 0.013]

The bold values are noted for significant indirect effects. The significance (*p*-values) has been reported in the table

HULC harsh and unpredictable living conditions, *Fast LH* fast life-history strategies; the indirect effect of T1 HULC to T4 overeating is significant for girls but not for boy

LH strategy use, and overeating than did boys at baseline and follow-ups. Possible implications are elaborated below.

In line with our main hypothesis, gender was an important moderator of the strength and nature of associations between the main research measures. As predicted, the SEM for girls indicated that those who experienced T1 elevations in HULC (i.e., lower SES, unstable parenting, and residential changes) tended to report subsequent increases in overeating 20 months later, independent of T1 levels of overeating. Critically, increased use of fast LH strategies focused on short-term pursuits linked to immediate gratification fully mediated the association of initial HULC with later elevations in overeating among girls.

This pattern aligns with life-history theory tenets that children who experience HULC are prone to adopting faster LH strategies characterized by a quest for immediate gratification of current needs instead of pursuits having long-term benefits [12, 27]. In general, overeating facilitates fat storage and protects against potential food scarcity as a result of HULC. That is, if the future availability of food is uncertain, then eating as much as possible while one has access to food is adaptive, at least in the short run [35]. However, for girls, in particular, overeating might be used more readily to cope with environmental stressors and subsequent emotional problems than it is for boys in similar circumstances. In line with this contention, some past research has found significant associations of perceived stress, worries, and tension/anxiety with overeating in response to negative affect for early adolescent girls but not among early adolescent boys (e.g., [38].

Boys who experienced baseline elevations in HULC were also more likely to prefer fast LH strategies in follow-ups 7, 13, and 20 months later. These findings converge with results for girls, other longitudinal studies of adolescent samples in China [31] and research on adolescents from different countries across the globe [6]. Paralleling experiences of girls, HULC predicted stronger preferences for fast LH strategies that emphasized immediate rewards among boys instead of strategies based on long-term investments of resources.

However, in contrast to results for girls, fast LH strategy preferences were not related to subsequent overeating for boys and did not explain why boys who experienced more HULC engaged in higher subsequent levels of overeating. The most parsimonious explanation for the lack of mediation from fast LH strategy adoption in associations between HULC and overeating among boys may be that "internalizing" behaviors such as overeating are less relevant outcomes for them than "externalizing" or "acting out" behaviors [13, 31].

Regarding other key findings, elevated HULC for girls compared to boys aligns with evidence that girls and women experience fewer opportunities for economic advancement and prestige [39], more life events and higher levels of stress and depression [26], and sometimes use less effective coping strategies (e.g., rumination) to manage stressors [11]. Relative to men, women are more biologically responsive to stressors (e.g., greater cortisol elevation) that increase risk for emotional distress [46]. In light of their experience of increased HULC, life-history theory would posit that girls more typically endorse fast LH strategies, as well. By and large this contention was supported: girls in our sample reported higher fast LH strategy scores than boys did during three of four assessments.

Nonetheless, gender differences in preferences for fast LH strategies are not entirely stable across samples. For example, other recent China-based research based on left behind children from rural areas [6] observed higher levels of fast LH preferences for boys than for girls. Such inconsistencies suggest that factors including the nature of one's living environment affect gender differences in fast LH strategies. As well, though we observed highly significant gender differences based on a large sample, associated effect sizes were small. In light of these caveats, extensions are needed to determine contexts in which gender differences in fast LH strategies are more prominent.

Finally, comparatively higher levels of overeating among girls in this study align with past studies based on adolescents in China [20, 52] and the U.S. [1]. This finding can be interpreted on the basis of life-history theory [16, 35]. Nonetheless, evidence based on competing sociocultural explanations suggests that girls are more likely than boys to prefer the thin attractiveness ideal during adolescence [24, 25] and pursue this ideal via dieting or other forms of calorie restriction [21–23, 33, 34]. Given that it is increasingly difficult to maintain lower than average levels of calorie intake over extended periods, binge-eating episodes, overeating, and possible weight gain are common consequences of dieting to lose weight [50]. Because the sociocultural model provides a viable alternative, future studies should incorporate measures reflecting thin ideal pursuit and dieting to evaluate relative merits of life-history theory versus sociocultural explanations of overeating. In addition, biological factors contributing to greater overweight among adolescent girls than boys include hormonal changes (for example, estrogen increases weight in comparison to testosterone) during puberty [44], centripetal increases in weight for adolescent boys vs. adolescent girls, and increases in total fat cells among pubertal girls relative to pubertal boys [17].

A key strength of this study was its use of a large sample of early-to-middle adolescents who provided appraisals of their current living conditions rather than adults retrospectively recalling experiences from late childhood or adolescence. Second, while past longitudinal studies of eating behaviors in Chinese adolescents have been limited to one follow-up [21, 33, 34], this study included three follow-up assessments that provided more nuanced

information about changes in living conditions, fast LH preferences, and overeating over time.

Despite these strengths, a possible limitation of assessing typically developing early adolescents from one urban region of China is that findings may not be generalizable to other age groups, early and middle adolescents in other regions of China or the world, or clinical samples with unique circumstances. Extensions to such groups can inform external validity. Second, a potential shortcoming of the exclusive reliance on questionnaire measures was possible susceptibility to reporting biases (e.g., social desirability biases in reporting of one's weight and height) as an influence on findings. Incorporating observer reports, objective measures of weight and biomarkers such as birth weight, age of reproductive maturation, changes in inflammation, or cortisol [5] in tandem with self-report measures may inform relations between these experiences more accurately and fully in future work. Third, we did not consider genetic factors [29] or their interactions with HULC as influences on LH strategy adoption and overeating. Fourth, in light of the four-wave study design, there was considerable attrition over the course of the study. Fortunately, results were similar whether imputation or case-wise deletion methods were used to manage missing values. Nonetheless, it is not clear how well responses generated from such methods would correspond to actual responses of those who dropped out of the study. Finally, experiments and intervention studies based on random assignment and manipulations of isolated factors are needed to test causal effects of specific experiences on overeating over extended periods of time.

Results have potential implications for interventions. First, findings underscore HULC as possible risk factors for fast LH strategies that reflect a focus on impulsivity and immediate gratification as well as overeating, particularly among early adolescent girls. It follows that interventions designed to reduce poverty and increase stable, nurturing family, and community environments may aid in reducing problems with impulsivity (e.g., risk-taking, delinquency, aggression, and substance abuse) and overeating for adolescents of each gender [13, 31]. Moreover, for at risk girls, in particular, treatments focused on stress management and increasing cognitive control (e.g., [38]) warrant consideration as strategies for reducing overeating, binge-eating, and, possibly, obesity risk during adolescence and adulthood.

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Declarations

Conflict of interest The authors declare that they have no competinginterests.

References

1. Ackard DM, Neumark-Sztainer D, Story M, Perry C (2003) Overeating among adolescents: prevalence and associations with weight-related characteristics and psychological health. Pediatrics 111(1):67–74. https://doi.org/10.1542/peds.111.1.67
2. Anglé S, Engblom J, Eriksson T, Kautiainen S, Saha MT, Lindfors P, Rimpelä A (2009) Three factor eating questionnaire-R18 as a measure of cognitive restraint, uncontrolled eating and emotional eating in a sample of young Finnish females. Int J Behav Nutr Phys Act 6(1):41. https://doi.org/10.1186/1479-5868-6-41
3. Bartholdy S, Allen K, Hodsoll J, O'Daly OG, Campbell IC, Banaschewski T, Bokde A, Bromberg U, Büchel C, Quinlan EB, Conrod PJ, Desrivières S, Flor H, Frouin V, Gallinat J, Garavan H, Heinz A, Ittermann B, Martinot JL, Artiges E, Schmidt U (2017) Identifying disordered eating behaviours in adolescents: how do parent and adolescent reports differ by sex and age? Eur Child Adolesc Psychiatry 26(6):691–701. https://doi.org/10.1007/s00787-016-0935-1
4. Bibbins-domingo K, Coxson PG, Pletcher MJ, Lightwood J, Goldman L (2007) Adolescent overweight and future adult coronary heart disease. N Engl J Med 357(23):2371–2379. https://doi.org/10.1056/NEJMsa073166
5. Burghy CA, Stodola DE, Ruttle PL, Molloy EK, Armstrong JM, Oler JA (2012) Developmental pathways to amygdala-prefrontal function and internalizing symptoms in adolescence. Nat Neurosci 15(12):1736–1741. https://doi.org/10.1038/nn.3257
6. Chang L, Lu HJ, Lansford JE, Skinner AT, Bornstein MH, Steinberg L, Deater-Deckard K (2019) Environmental harshness and unpredictability, life history, and social and academic behavior of adolescents in nine countries. Dev Psychol 55(4):890–903. https://doi.org/10.1037/dev0000655
7. Chen BB, Chang L (2016) Procrastination as a fast life history strategy. Evol Psychol 14(1):1–5. https://doi.org/10.1177/1474704916630314
8. Chen H, Jackson T (2008) Prevalence and sociodemographic correlates of eating disorder endorsements among adolescents and young adults from China. Eur Eat Disord Rev 16:375–385. https://doi.org/10.1002/erv.837
9. Chen X, Luo Y, Chen H (2020) Body image victimization experiences and disordered eating behaviors among chinese female adolescents: the roles of body dissatisfaction and depression. Sex Roles. https://doi.org/10.1007/s11199-020-01122-4 (**in press**)
10. Cole DA, Maxwell SE (2003) Testing mediational models with longitudinal data: questions and tips in the use of structural equation modeling. J Abnorm Psychol 112(4):558–577. https://doi.org/10.1037/0021-843X.112.4.558
11. Cox SJ, Mezulis AH, Hyde JS (2010) The influence of child gender role and maternal feedback to child stress on the emergence of the gender difference in depressive rumination in adolescence. Dev Psychol 46(4):842–852. https://doi.org/10.1037/a0019813
12. Del Giudice M, Gangestad SW, Kaplan HS (2015) Life history theory and evolutionary psychology. In: Buss DM (ed) The handbook of evolutionary psychology. vol 1, foundations, 2nd edn. Wiley, New York, pp 88–114. https://doi.org/10.1002/9781119125563.evpsych102
13. Doom JR, Vanzomerendohm A, Simpson JA (2016) Early unpredictability predicts increased adolescent externalizing

behaviors and substance use: a life history perspective. Dev Psychopathol 28(4):1505–1516. https://doi.org/10.1017/S0954579415001169
14. Ellis BJ, Figueredo AJ, Brumbach BH, Schlomer GL (2009) Fundamental dimensions of environmental risk. Hum Nat 20:204–268. https://doi.org/10.1007/s12110-009-9063-7
15. Feigin VL, Roth GA, Naghavi M, Parmar P, Krishnamurthi R, Chugh S et al (2016) Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the global burden of disease study 2013. Lancet Neurol 15(9):913–924. https://doi.org/10.1016/S1474-4422(16)30073-4
16. Figueredo AJ, Wolf PSA, Olderbak SG, Gladden PR, Fernandes HBF, Wenner C, Rushton JP (2014) The psychometric assessment of human life history strategy: a meta-analytic construct validation. Evol Behav Sci 8(3):148–185. https://doi.org/10.1037/h0099837
17. Fried SK, Kral JG (1987) Sex differences in regional distribution of fat cell size and lipoprotein lipase activity in morbidly obese patients. Int J Obes 11(2):129–140
18. Herpertz-Dahlmann B, Dempfle A, Konrad K, Klasen F, Ravens-Sieberer U, BELLA study group (2015) Eating disorder symptoms do not just disappear: the implications of adolescent eating-disordered behaviour for body weight and mental health in young adulthood. Eur Child Adolesc Psychiatry 24(6):675–684. https://doi.org/10.1007/s00787-014-0610-3
19. Hill SE, Prokosch ML, DelPriore DJ, Griskevicius V, Kramer A (2016) Low childhood socioeconomic status promotes eating in the absence of energy need. Psychol Sci 27(3):354–364. https://doi.org/10.1177/0956797615621901
20. Jackson T, Chen H (2010) Sociocultural experiences of bulimic and non-bulimic adolescents in a school-based sample from China. J Abnorm Child Psychol 38:69–76. https://doi.org/10.1007/s10802-009-9350-0
21. Jackson T, Chen H (2011) Risk factors for disordered eating during early and middle adolescence: prospective evidence from Mainland Chinese boys and girls. J Abnorm Psychol 120:454–464. https://doi.org/10.1037/a0022122
22. Jackson T, Chen H (2014) Risk factors for disordered eating during early and middle adolescence: a two year longitudinal study of mainland Chinese boys and girls. J Abnorm Child Psychol 42(5):791–802. https://doi.org/10.1007/s10802-013-9823-z
23. Jackson T, Chen H (2015) Features of objectified body consciousness and sociocultural perspectives as risk factors for disordered eating among late-adolescent women and men. J Couns Psychol 62(4):741–752. https://doi.org/10.1037/cou0000096
24. Jackson T, Cai L, Chen H (2020) Asian versus Western appearance media influences and changes in body image concerns: a 12-month prospective study of young Chinese women. Body Image 33:214–221
25. Jackson T, Ye X, Hall BJ, Chen H (2021) "Have you taken the A4 challenge?": correlates and impact of a thin ideal expression from Chinese social media. Front Psychol. https://doi.org/10.3389/fpsyg.2021.669014
26. Jose PE, Brown I (2008) When does the gender difference in rumination begin? Gender and age differences in the use of rumination by adolescents. J Youth Adolesc 37(2):180–192. https://doi.org/10.1007/s10964-006-9166-y
27. Kaplan HS, Gangestad SW (2005) Life history theory and evolutionary psychology. In: Buss DM (ed) Handbook of evolutionary psychology. Wiley, New York, pp 68–95
28. Lamerz A, Kuepper-Nybelen J, Bruning N, Wehle C, Trost-Brinkhues G, Brenner H, Herpertz-Dahlmann B (2005) Prevalence of obesity, binge eating, and night eating in a cross-sectional field survey of 6-year-old children and their parents in a German urban population. J Child Psychol Psychiatry 46(4):385–393. https://doi.org/10.1111/j.1469-7610.2004.00363.x
29. Levitan RD, Masellis M, Basile VS, Lam RW, Kaplan AS, Davis C, Macciardi F (2004) The dopamine-4 receptor gene associated with binge eating and weight gain in women with seasonal affective disorder: an evolutionary perspective. Biol Psychiat 56(9):665–669. https://doi.org/10.1016/j.biopsych.2004.08.013
30. Little TD (2013) Longitudinal structural equation modeling. Guilford Press, Berlin
31. Lu HJ, Chang L (2019) Aggression and risk-taking as adaptive implementations of fast life history strategy. Dev Sci. https://doi.org/10.1111/desc.12827
32. Lu HJ, Wong K, Chang L (2017) The association between life history strategy and mate preference in men. Pers Individ Differ 116:157–163. https://doi.org/10.1016/j.paid.2017.04.047
33. Luo YJ, Niu GF, Chen H (2020) Early life environmental unpredictability and overeating: based on life history theory. Acta Psychol Sin 52(10):1224–1236. https://doi.org/10.3724/SP.J.1041.2020.01224
34. Luo YJ, Jackson T, Niu GF, Chen H (2020) Effects of gender and appearance comparisons on associations between media-based appearance pressure and disordered eating: testing a moderated mediation model. Sex Roles 82(5):293–305. https://doi.org/10.1007/s11199-019-01058-4
35. Maner JK, Dittmann A, Meltzer AL, McNulty JK (2017) Implications of life-history strategies for obesity. Proc Natl Acad Sci 114(32):8517–8522. https://doi.org/10.1073/pnas.1620482114
36. Mittal C, Griskevicius V, Simpson JA, Sung S, Young ES (2015) Cognitive adaptations to stressful environments: when childhood adversity enhances adult executive function. J Pers Soc Psychol 109(4):604–621. https://doi.org/10.1037/pspi0000028
37. National Bureau of Statistics of China (2021) The income and expenditure report of Chinese residents from January to June. Retrieved from: http://www.stats.gov.cn/tjsj/zxfb/202107/t20210715_1819442.html
38. Nguyen-Rodriguez ST, Unger JB, Spruijt-Metz D (2009) Psychological determinants of emotional eating in adolescence. Eat Disord 17:211–224. https://doi.org/10.1080/10640260902848543
39. Petrongolo B (2019) The gender gap in employment and wages. Nat Hum Behav 3:316–318. https://doi.org/10.1038/s41562-019-0558-x
40. Prentice AM (2001) Overeating: the health risks. Obes Res 9(S11):234S-238S. https://doi.org/10.1038/oby.2001.124
41. Proffitt Leyva RP, Hill SE (2018) Unpredictability, body awareness, and eating in the absence of hunger: a cognitive schemas approach. Health Psychol 37(7):691–699. https://doi.org/10.1037/hea0000634
42. Reilly JJ, Kelly J (2010) Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. Int J Obes 35(7):891–898. https://doi.org/10.1038/ijo.2010.222
43. Ross LT, Hill EM (2000) The family unpredictability scale: Reliability and validity. J Marriage Fam 62(2):549–562. https://doi.org/10.1111/j.1741-3737.2000.00549.x
44. Santosa S, Khosla S, McCready LK, Jensen MD (2010) Effects of estrogen and testosterone on resting energy expenditure in older men. Obesity 18(12):2392–2394. https://doi.org/10.1038/oby.2010.98
45. Schafer JL, Graham JW (2002) Missing data: our view of the state of the art. Psychol Methods 7(2):147–177. https://doi.org/10.1037//1082-989X.7.2.147
46. Stroud LR, Salovey P, Epel ES (2002) Sex differences in stress responses: social rejection versus achievement stress. Biol Psychiat 52(4):318–327. https://doi.org/10.1016/S0006-3223(02)01333-1
47. Suor JH, Sturge-Apple ML, Davies PT, Cicchetti D (2017) A life history approach to delineating how harsh environments and hawk temperament traits differentially shape children's problem-solving

skills. J Child Psychol Psychiatry 58(8):902–909. https://doi.org/10.1111/jcpp.12718
48. Szepsenwol O, Simpson JA, Griskevicius V, Raby KL (2015) The effect of unpredictable early childhood environments on parenting in adulthood. J Pers Soc Psychol 109(6):1045–1067. https://doi.org/10.1037/pspi0000032
49. Volkow N, Wang GJ, Fowler JS, Tomasi D, Baler R (2011) Food and drug reward: overlapping circuits in human obesity and addiction. In: Dalley JW, Carter CS (eds) Brain imaging in behavioral neuroscience. Springer, Berlin, pp 1–24
50. Ward A, Mann T (2000) Don't mind if i do: disinhibited eating under cognitive load. J Pers Soc Psychol 78(4):753–763. https://doi.org/10.1037//0022-3514.78.4.753
51. Zhang J, Wang H, Wang Z, Du W, Su C, Zhang J et al (2018) Prevalence and stabilizing trends in overweight and obesity among children and adolescents in china, 2011–2015. BMC Public Health 18(1):571. https://doi.org/10.1186/s12889-018-5483-9
52. Zhu H, Luo X, Cai T, He J, Lu Y, Wu S (2016) Life event stress and binge eating among adolescents: the roles of early maladaptive schemas and impulsivity. Stress Health 32(4):395–401. https://doi.org/10.1002/smi.2634

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