

Positive parenting improves multiple aspects of health and well-being in young adulthood

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Aspects of positive parenting have previously been linked to better offspring health and well-being^{1,2}, though often, individual outcomes have been examined separately. Examining multiple outcomes simultaneously, over multiple aspects of parenting, may provide a more holistic picture of the parenting–health dynamics^{3,4}. Methodological limitations such as reverse causation—good childhood outcomes that make parenting easier—also remain a concern in many previous observational studies⁵. Here we examined the associations between multiple aspects of parenting (including parent–child relationship satisfaction concerning love, parental authoritative and family dinner frequency) and various subsequent offspring psychosocial, mental, behavioural and physical health and well-being outcomes. We analysed longitudinal data from the Growing Up Today Study 1 ($N=8,476$, mean baseline age = 12.78 years) and Growing Up Today Study 2 ($N=5,453$, mean baseline age = 17.75 years). Both parenting and health outcomes were based on offspring self-reports. The results suggest that greater relationship satisfaction was associated with greater emotional well-being, lower risk of mental illness, eating disorders, overweight or obesity and marijuana use. To a lesser extent, greater parental authoritative and regular family dinner were also associated with greater offspring emotional well-being, fewer depressive symptoms, lower risk of overeating and certain sexual behaviours. This study strengthens the evidence for a public health focus on improving parenting to promote population health and well-being.

The family unit is sometimes understood as an interactive system in which members of the family reciprocally shape each other's emotions, behaviours and health⁶. Family functioning characterizes the extent to which family members effectively communicate and bond with each other, fulfil their family roles and perform daily routines⁷. Although family structures and processes are multifaceted, a positive parent–child relationship, in particular, contributes profoundly to effective functioning of the family and flourishing of the individual members⁶.

Empirical evidence has suggested positive associations between multiple aspects of positive parenting and offspring biopsychosocial health and well-being^{1,2}. For instance, greater offspring satisfaction with the parent–child relationship is associated with lower risk of subsequent drug use, unhealthy eating behaviours, insufficient sleep and obesity^{8,9}. Such a satisfactory relationship is often characterized by strong bonding and attachment⁸. Parental attachment provides a sense of security and shapes the child's expectation from others, which sets the trajectory of child development and health¹⁰.

Another major aspect of positive parenting considers the balance between expressing warmth and exercising discipline towards the child¹¹. Specifically, previous researchers identified three major parenting styles: the authoritative, the authoritarian and the permissive styles¹². Authoritative parents are responsive to their child's needs, respectful of their child's autonomy, but also set reasonable expectations and rules. In comparison, authoritarian parents have few nurturing skills and tend to enforce discipline; whereas permissive parents are characterized by excessive warmth but little regulation of the child's behaviours. Previous studies generally suggest that the authoritative parenting style is associated with better offspring outcomes, such as greater academic achievement, less psychosocial maladjustment, better mental health and fewer risky behaviours, than other parenting styles^{2,13–15}. Another related dimension of positive parenting is the provision of family routines, such as regular family meals. Family meals provide an opportunity for strengthening the bonding and communication between family members, and facilitate parental monitoring and modelling on a regular basis¹⁶. Previous work has suggested positive associations of family meals with adolescent psychosocial well-being and behavioural health (for example, improved diet and lower risk of depression and substance use)^{16–18}. However, a recent national survey revealed that 30% of the US families had no more than two family meals per week¹⁹.

Although such previous work has substantially advanced our understanding of parenting and offspring health, they are subject to certain limitations. First, much previous work has studied each aspect of parenting and individual health outcomes in separate studies, and evidence remains scattered across studies. Examining multiple outcomes simultaneously within a study provides a broader picture of the role of parenting across various offspring outcomes, helps to reduce publication bias and may better inform public health recommendations^{3,4}. Next, some methodological limitations, such as residual confounding and reverse causation, in observational studies remain a concern⁵. For instance, the association between family meals and health is probably bidirectional as poor health may impede the participation in family activities²⁰. However, previous studies on family meals have seldom used repeated measures of family meals and health to address the possibility of reverse causality²⁰.

To provide additional insights into the role of parenting, this study takes an outcome-wide analytic approach^{3,4} to prospectively examine multiple aspects of positive parenting (including offspring satisfaction with the parent–child relationship generally concerning love and attachment (hereafter called relationship satisfaction), the authoritative parenting style and family dinner frequency) in relation to a wide array of psychosocial, mental, behavioural and physical

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health and well-being outcomes in adolescents and young adults. These outcomes were selected following a previous model that suggested family has important effects on many of the major dimensions in assessing human flourishing²¹. To reduce confounding and the possibility of reverse causation, we adjusted for prior values of the exposure and outcome variables, simultaneously in all models, wherever data were available. For comparative purposes, we also examined two hypothesized suboptimal parenting practices (that is, the authoritarian and the permissive parenting styles) with the same sets of outcomes. Several sensitivity analyses were performed. Specifically, we assessed the robustness of the observed associations to unmeasured confounding, performed age-stratified analyses, examined the maternal and paternal relationship satisfaction separately, investigated the independent effects of relationship satisfaction and parenting styles, and performed complete-case analyses. We hypothesize that offspring relationship satisfaction, parental authoritativeness and family dinner frequency are each positively associated with offspring psychosocial, mental, behavioural and physical health and well-being. We also expect that parental authoritarianism and permissiveness are each inversely related to offspring health and well-being.

In our sample for analyses on parent–child relationship satisfaction and parenting styles, participants comprised a slightly higher percentage of females, primarily non-Hispanic white and mostly healthy, with an average baseline age of 17.75 years (standard deviation (s.d.) = 1.90, range: 12–22) (Supplementary Table 1). Most participants reported a high level of relationship satisfaction (mean = 36.06, s.d. = 6.34, range: 9–45). The analytic sample for family dinner frequency had similar characteristics, with a mean baseline age of 12.78 years (s.d. = 1.69, range: 10–17). Around 80% of the participants reported having dinner with their family most days or everyday (Supplementary Table 2). Participant characteristics across the level of relationship satisfaction are shown in Table 1 and across levels of family dinner frequency in Supplementary Table 3. Relationship satisfaction was positively associated with numerous subsequent psychological, mental and behavioural health and well-being outcomes in a monotonic manner (Table 2 and Supplementary Table 4). For instance, the top versus bottom tertile of relationship satisfaction was associated with substantially greater emotional well-being and lower risk of depression, anxiety, overweight or obesity, overeating, eating disorders and marijuana use. There was also evidence suggesting that greater relationship satisfaction was related to lower risk of cigarette smoking, although the association did not reach $P < 0.05$ after correction for multiple testing. In the sensitivity analysis that additionally adjusted for subsequent depressive symptoms, almost all of the associations remained robust (Supplementary Table 5). The age-stratified analyses suggested that patterns of the associations were similar between age groups, except that the inverse associations of relationship satisfaction with cigarette smoking and marijuana use were stronger in the younger versus the older group (Supplementary Table 6). Results of a complete-case analysis were similar and are available from the authors on request.

When maternal and paternal relationships were examined separately, each was associated with various outcomes in similar patterns as the averaged parental relationship (Supplementary Tables 7 and 8). However, when maternal and paternal relationships were simultaneously included in the models, the paternal relationship showed stronger associations with depression, overeating and eating disorder than the maternal relationship, whereas the maternal relationship had stronger associations with emotional well-being than the paternal relationship. The associations with other outcomes were attenuated, which may be due to the moderate correlation between the maternal and paternal relationship satisfaction ($r = 0.72$) (Supplementary Table 9).

The middle and top versus bottom tertile of parental authoritativeness was each associated with greater emotional processing and emotional expression, fewer depressive symptoms and lower

risk of overeating in offspring. There was also evidence that greater parental authoritativeness was possibly related to better physical health outcomes, although the associations did not reach $P < 0.05$ after correction for multiple testing (Table 2 and Supplementary Table 10). In sensitivity analyses that also adjusted for subsequent depressive symptoms, almost all of the associations remained similar (Supplementary Table 5). The age-stratified analyses suggested that the associations with smoking and marijuana use were stronger in the younger versus the older group, whereas the associations with emotional well-being were stronger in the older versus the younger participants (Supplementary Table 11). Results of a complete-case analysis were similar and are available from the authors on request.

In comparison, parental authoritarianism and parental permissiveness had weaker associations with various outcomes with only a few exceptions. Specifically, greater parental authoritarianism was associated with lower levels of emotional well-being and more depressive symptoms, whereas the associations of parental permissiveness with various outcomes were almost all close to null (Supplementary Tables 12 and 13).

When parenting styles and parent–child relationship satisfaction were simultaneously included in the model, the effects of relationship satisfaction were largely maintained, whereas the effects of parenting styles were mostly attenuated (Supplementary Table 14).

The top versus bottom level of family dinner frequency was associated with fewer depressive symptoms, fewer lifetime sexual partners, lower risk of early sexual initiation, history of sexually transmitted infections and abnormal Pap test results. Frequent family dinner was also possibly associated with greater life satisfaction, positive affect, self-esteem, emotional processing and forgiveness, as well as lower risk of depression diagnosis, probable post-traumatic stress disorder, frequent binge drinking, marijuana use and prescription drug misuse, although the associations did not reach $P < 0.05$ after adjustment for multiple testing (Table 2 and Supplementary Table 15). In sensitivity analyses that additionally adjusted for subsequent depressive symptoms and religious service attendance, the associations with psychological well-being outcomes were further attenuated, whereas the associations with sexual behaviours remained robust (Supplementary Table 5). The age-stratified analyses suggested that the associations with sexual behaviours were stronger in younger versus older participants, whereas the association with depressive symptoms was stronger in the older versus the younger group (Supplementary Table 16). Results of a complete-case analysis were similar and are available from the authors on request.

We assessed the robustness of the results to unmeasured confounding and reported 'E-values'^{22–24}, which are the minimum strength of association on the risk ratio scale that an unmeasured confounder would need to have with both the exposure and the outcome, above and beyond the measured covariates, to fully explain away a specific exposure–outcome association. There was evidence that the associations of parent–child relationship satisfaction with several outcomes were moderately robust to unmeasured confounding (Table 3). For example, the E-value for depression diagnosis was 3.11, which means that for an unmeasured confounder to explain away the observed association between relationship satisfaction and depression diagnosis, an unmeasured confounder that was associated with both higher relationship satisfaction and lower depression by 3.11-fold each, above and beyond the measured covariates, could suffice, but weaker confounding could not. Similarly, an unmeasured confounder associated with both relationship satisfaction and depression diagnosis by 2.35-fold each, conditional on the measured covariates, could suffice to shift the confidence interval to include the null value, but weaker confounding could not. The evidence that the associations of relationship satisfaction were robust to potential unmeasured confounding was particularly strong for depressive symptoms, depression diagnosis, anxiety diagnosis,

Table 1 | Participant characteristics across levels of parent–child relationship satisfaction at study baseline

	Relationship satisfaction ^a			P value
Participant characteristics	Bottom tertile (N = 1,556)	Middle tertile (N = 1,713)	Top tertile (N = 1,625)	
Sociodemographic factors				
Age, in years, mean (s.d.) ^b	17.60 (1.86)	17.76 (1.93)	17.95 (1.92)	<0.001
Sex (male), %	39.01	42.97	38.89	0.02
Race/ethnicity (non-Hispanic white), %	92.15	92.78	93.60	0.29
Geographical region				0.89
West, %	16.73	15.81	16.52	
Midwest, %	36.10	37.12	37.42	
South, %	16.02	14.87	14.73	
Northeast, %	31.15	32.20	31.32	
Mother's age, in years, mean (s.d.) ^b	49.28 (3.68)	48.95 (3.60)	48.98 (3.58)	<0.001
Mother's race (white), %	97.69	97.78	98.28	0.45
Mother married, %	88.82	92.90	93.93	<0.001
Mother's subjective SES in the United States, mean (s.d.) ^b	7.10 (1.33)	7.18 (1.25)	7.37 (1.30)	<0.001
Mother's subjective SES in the community, mean (s.d.) ^b	6.97 (1.55)	7.12 (1.46)	7.23 (1.49)	<0.001
Pretax household income				0.10
<US\$50,000, %	12.81	11.05	11.68	
US\$50,000–74,999, %	27.14	25.50	23.58	
US\$75,000–99,999, %	22.29	23.07	21.65	
≥US\$100,000, %	37.76	40.38	43.08	
Census tract college education rate, mean (s.d.) ^b	34.27% (16.82%)	34.09% (15.88%)	34.36% (16.30%)	0.89
Census tract median income				0.80
<US\$50,000, %	18.83	18.74	19.45	
US\$50,000–74,999, %	48.71	49.80	46.89	
US\$75,000–99,999, %	24.49	23.76	25.17	
≥US\$100,000, %	7.97	7.71	8.49	
Maternal health				
Maternal depression diagnosis, %	10.41	9.28	8.80	0.28
Maternal current smoking, %	4.05	2.79	3.28	0.14
Previous health status and health behaviours				
Previous overweight or obesity, %	19.56	18.79	19.06	0.87
Previous cigarette smoking, %	17.06	15.16	12.26	<0.001
Previous history of sexual intercourse, %	32.90	29.23	27.30	0.002
Previous puberty development, mean (s.d.)	4.29 (0.97)	4.29 (0.96)	4.36 (0.92)	0.10

The study baseline was the GUTS2 2008 questionnaire wave (N = 4,894). ^aANOVA or chi-squared tests were used to examine the mean levels (s.d.) of the characteristic or proportion of individuals within each relationship satisfaction category with that characteristic. Relationship satisfaction was assessed in the 2008 questionnaire wave, and other covariates were assessed either before or in the 2008 questionnaire wave. ^bRange of the following participant characteristics were age (range: 12–22 years), mother's age (range: 43–61 years), mother's subjective socioeconomic status (SES) in the United States (range: 1–10), mother's subjective SES in the community (range: 1–10), census tract college education rate (range: 3.94–84.71%) and puberty development scale (range: 1–5).

overeating, eating disorder and cigarette smoking. There was also evidence that some associations of parental authoritativeness and family dinner frequency were partially robust to unmeasured confounding, especially with the outcomes of depression, overeating and several sexual behaviours (Table 3).

There has been increasing interest in studying protective factors that promote health and well-being, beyond the traditional approach that focuses on reducing risk factors and illness²⁵. By examining data from two large prospective cohorts of adolescents and young adults, this study adds to the evidence that positive parenting may be one such asset that leads to better functioning across multiple domains of offspring health and well-being.

Congruent with previous work, this study found that greater parent–child relationship satisfaction generally concerning love and attachment, and to a lesser extent greater parental authoritativeness and regular family dinner, were each associated with greater psychological well-being, fewer depressive symptoms and lower risk of several adverse behaviours^{8,9,13,14,17,18}. However, this study found weaker associations between non-authoritative parenting styles and offspring risk of mental illness and certain behaviours than previous studies^{13,14}. This might be owing to the differences in the measurement of parenting styles. Specifically, previous work often grouped parenting styles into typologies and compared the non-authoritative style with the authoritative style. In comparison, this

Table 2 | Parenting and offspring subsequent health and well-being in young adulthood^a

Health and well-being outcomes	Relationship satisfaction ^b				Parental authoritativeness ^b				Family dinner frequency ^c			
	Top versus bottom tertile				Top versus bottom tertile				Everyday versus never or some days			
	RR ^d	β ^e	95% CI	P value threshold ^f	RR ^d	β ^e	95% CI	P value threshold	RR ^d	β ^e	95% CI	P value threshold
Psychological well-being												
Life satisfaction			—				—		0.12		0.04–0.20	<0.01
Positive affect			—				—		0.09		0.01–0.16	<0.05
Self-esteem			—				—		0.12		0.04–0.19	<0.01
Emotional processing		0.28	0.20–0.35	<0.0038 ^f		0.28	0.18–0.38	<0.0038 ^f		0.09	0.01–0.17	<0.05
Emotional expression		0.33	0.25–0.41	<0.0038 ^f		0.33	0.25–0.40	<0.0038 ^f		0.08	–0.02 to 0.19	
Physical health												
Number of physical health problems		–0.07	–0.14 to 0.00			–0.08	–0.16 to –0.01	<0.05		–0.02	–0.10 to 0.06	
Overweight or obesity	0.86		0.77–0.95	<0.0038 ^f	0.88		0.80–0.96	<0.01	0.95		0.86–1.05	
Mental health												
Depressive symptoms		–0.54	–0.62 to –0.45	<0.0038 ^f		–0.31	–0.38 to –0.24	<0.0038 ^f		–0.13	–0.21 to –0.05	<0.0018 ^f
Depression diagnosis	0.54		0.44–0.67	<0.0038 ^f	0.80		0.64–1.00	<0.05	0.76		0.60–0.95	<0.05
Anxiety symptoms			—				—			–0.06	–0.15 to 0.02	
Anxiety diagnosis	0.61		0.47–0.78	<0.0038 ^f	0.98		0.75–1.29		0.87		0.68–1.10	
Probable PTSD			—				—		0.71		0.53–0.95	<0.05
Health behaviours												
Overeating	0.25		0.16–0.40	<0.0038 ^f	0.45		0.32–0.64	<0.0038 ^f	0.74		0.43–1.28	
Eating disorder	0.42		0.26–0.68	<0.0038 ^f	0.93		0.59–1.48		0.85		0.48–1.48	
Cigarette smoking	0.70		0.54–0.90	<0.01	0.89		0.73–1.09		0.89		0.75–1.06	
Frequent binge drinking	1.01		0.88–1.15		0.92		0.82–1.03		0.87		0.77–0.98	<0.05
Marijuana use	0.78		0.69–0.88	<0.0038 ^f	0.95		0.85–1.06		0.82		0.70–0.97	<0.05
Any other illicit drug use			—				—		0.76		0.56–1.03	
Prescription drug misuse			—				—		0.74		0.61–0.90	<0.01
Number of sexual partners			—				—			–0.17	–0.24 to –0.10	<0.0018 ^f
Early sexual initiation			—				—		0.64		0.53–0.78	<0.0018 ^f
History of STIs	0.69		0.46–1.02		0.74		0.52–1.06		0.71		0.58–0.87	<0.0018 ^f
Teen pregnancy			—				—		0.89		0.44–1.78	
Abnormal Pap test			—				—		0.72		0.61–0.84	<0.0018 ^f
Character and virtue												
Frequency of volunteering			—				—		0.02		–0.06 to 0.10	
Sense of mission			—				—		0.08		–0.01 to 0.16	
Forgiveness of others			—				—		0.11		0.03–0.18	<0.01
Registered to vote			—				—		0.99		0.96–1.02	

GUTS2 2008 to 2011 or 2013 questionnaire wave ($N=5,453$) and GUTS1 1997 to 2007, 2010 or 2013 questionnaire wave ($N=8,476$) were used. The analyses of relationship satisfaction and parental authoritativeness used data from GUTS2 and the analyses of family dinner frequency used data from GUTS1. Some outcomes were only assessed in GUTS1 but not in GUTS2. — indicates data are not available in that cohort. ^aFor analyses of relationship satisfaction and parental authoritativeness, the analytic sample was restricted to those who responded to the GUTS2 2008 questionnaire (in which the exposure was measured) and 2011 questionnaire (the earliest wave in which the outcomes were measured). For analyses on family dinner frequency, the analytic sample was restricted to those who had responded to the GUTS1 1997 questionnaire (in which the exposure was measured) and 2007 questionnaire (the earliest wave in which the outcomes were measured). Multiple imputation was performed to impute missing data on the exposure, outcomes and covariates for all analyses. The outcome of the abnormal Pap test was only available among female participants ($N=5,377$). ^bThe analyses on relationship satisfaction and parental authoritativeness controlled for participants' age, race/ethnicity, sex, geographical region, puberty development, their mother's age, race, marital status, SES (subjective SES, household income, census tract college education rate and census tract median income), maternal depression, maternal smoking, participants' previous weight status, previous cigarette smoking and previous history of sexual intercourse. ^cThe analyses on frequency of family dinner controlled for participants' age, race/ethnicity, sex, geographical region, family structure, puberty development, their mother's age, race, marital status, SES (subjective SES, household income, census tract college education rate and census tract median income), maternal depression, maternal smoking, participants' previous family dinner frequency, previous weight status, previous cigarette smoking and previous drinking. ^dThe effect estimates for the outcomes of overeating, eating disorder, sexually transmitted infections (STIs; GUTS2 only), post-traumatic stress disorder (PTSD), other illicit drug use and teen pregnancy were odds ratio (OR; examined with binomial distribution, logit link; these outcomes were rare (prevalence < 10%), so the OR would approximate the risk ratio (RR)). The effect estimates for other dichotomized outcomes were RR (examined with Poisson distribution, log link). ^eAll continuous outcomes were standardized (mean = 0, s.d. = 1), and β was the standardized effect size. ^f $P < 0.05$ after Bonferroni correction (the P value cut-off for Bonferroni correction = 0.05/13 outcomes = 0.0038 for analyses on relationship satisfaction and parental authoritativeness; the P value cut-off for Bonferroni correction = 0.05/28 outcomes = 0.0018 for analyses on family dinner frequency). CI, confidence interval.

Table 3 | Robustness to unmeasured confounding (E-values^a) for assessing the causal associations between parenting and offspring subsequent health and well-being

	Relationship satisfaction		Parental authoritative ^b ness		Family dinner frequency	
	For effect estimate ^b	For CI limit ^c	For effect estimate ^b	For CI limit ^c	For effect estimate ^b	For CI limit ^c
Life satisfaction	—	—	—	—	1.47	1.24
Positive affect	—	—	—	—	1.39	1.12
Self-esteem	—	—	—	—	1.47	1.24
Emotional processing	1.90	1.69	1.90	1.64	1.39	1.12
Emotional expression	2.04	1.83	2.04	1.83	1.36	1.00
Number of physical health problems	1.33	1.00	1.36	1.08	1.16	1.00
Overweight or obesity	1.60	1.29	1.53	1.25	1.29	1.00
Depressive symptoms	2.65	2.41	1.98	1.77	1.50	1.27
Depression diagnosis	3.11	2.35	1.81	1.11	1.96	1.29
Anxiety symptoms	—	—	—	—	1.30	1.00
Anxiety diagnosis	2.66	1.88	1.16	1.00	1.56	1.00
Probable PTSD	—	—	—	—	2.17	1.29
Overeating	7.46	4.44	3.87	2.50	2.04	1.00
Eating disorder	4.19	2.30	1.36	1.00	1.63	1.00
Cigarette smoking	2.21	1.46	1.50	1.00	1.50	1.00
Frequent binge drinking	1.11	1.00	1.39	1.00	1.56	1.16
Marijuana use	1.88	1.53	1.29	1.00	1.74	1.21
Any other illicit drug use	—	—	—	—	1.96	1.00
Prescription drug misuse	—	—	—	—	2.04	1.46
Number of sexual partners	—	—	—	—	1.61	1.39
Early sexual initiation	—	—	—	—	2.50	1.88
History of STIs	2.26	1.00	2.04	1.00	2.17	1.56
Teen pregnancy	—	—	—	—	1.50	1.00
Abnormal Pap test	—	—	—	—	2.12	1.67
Frequency of volunteering	—	—	—	—	1.47	1.00
Sense of mission	—	—	—	—	1.36	1.00
Forgiveness of others	—	—	—	—	1.45	1.20
Registered to vote	—	—	—	—	1.11	1.00

The GUTS2 2008–2011 or 2013 questionnaire wave ($N = 5,453$) and GUTS1 1997–2007, 2010 or 2013 questionnaire wave ($N = 8,476$) were used. The analyses on relationship satisfaction and parental authoritative^bness used data from GUTS2 and the analyses on family dinner frequency used data from GUTS1. Some outcomes were only assessed in GUTS1 but not in GUTS2. — indicates data are not available in that cohort. ^aSee VanderWeele and Ding for the formula²³ and Mathur et al. for the website and R package²⁴ for calculating E-values. ^bThe E-values for the effect estimates are the minimum strength of association on the risk ratio scale that an unmeasured confounder would need to have with both the exposure and the outcome, above and beyond the measured covariates, to fully explain away the observed exposure–outcome association as shown in Table 2. ^cThe E-values for the limit of the 95% CI closest to the null denote the minimum strength of association on the risk ratio scale that an unmeasured confounder would need to have with both the exposure and the outcome, above and beyond the measured covariates, to shift the CI to include the null value.

study considered parenting styles as continuous variables and compared the effects of having more versus less of the style attributes. This study also showed weaker associations between family dinner and some behavioural outcomes than previous work. For instance, this study did not find an association between family dinner and adolescent disordered eating, which is somewhat contrary to previous cross-sectional studies²⁶. The discrepant results may be due to the longitudinal design and the confounding control approach in this study. The Growing Up Today Study (GUTS) participants were also healthier than the general population of adolescents and young adults²⁷. Thus, it may be harder to capture the associations of family dinner with certain risky behaviours, if any, owing to the small number of participants with such risky behaviours in this sample.

Although adolescence and emerging adulthood are characterized by increasing independence from the family, this study adds to the evidence that parenting still exerts profound influences on adolescents' and young adults' health and well-being broadly. A satisfactory parent–child relationship promotes the emotional connection and attachment between family members; greater parental

authoritativeness facilitates the balance between affect expression and behavioural control in upbringing; and family meals provide an opportunity to strengthen the bonding, communication, monitoring and parental modelling on a regular basis. All of these processes are previously hypothesized major pathways leading to effective family functioning^{28,29}. However, given the changing nature in the parent–child relationship during adolescence, certain adjustment in parenting may be warranted. For instance, adolescents may need a lower degree of proximity to their parents than younger children, as they have developed the ability to derive a sense of security by knowing their parents are nurturing and supportive. Conversely, a reasonable amount of supervision from parents still plays an essential role in facilitating a healthy transition into adulthood³⁰. To fulfil these needs, both parents and adolescents need to respect each other's opinions and be tolerant of disagreements, to maintain a balance between 'connectedness' and 'individuality' in their relationship. Adolescence is also characterized by increased risks for mental distress and thrill-seeking behaviours, and behavioural patterns formed in this period often persist into later life³¹. If a resil-

ience factor can protect adolescents from developing mental illness or certain behaviours, it may also profoundly reduce their risk of developing such conditions in later life³¹. This study adds to the evidence that positive parenting may be one such protective factor.

This study is subject to certain limitations. First, for some participants, relationship satisfaction and parenting styles were retrospectively reported in young adulthood. However, some previous work has suggested that retrospective reports of childhood experiences are relatively valid measures when compared with prospective records^{32,33}. The longitudinal nature of this study and the adjustment for baseline health characteristics may have also reduced the concern about reverse causality. Second, there may be residual confounding by some familial and health characteristics (for example, family connectedness and previous mental health) for which data were not available. However, the sensitivity analysis adjusting for subsequent depressive symptoms and the calculated *E*-values suggests that several of the observed associations are relatively robust to unmeasured confounding. The null findings on parental authoritarianism and permissiveness may also serve as ‘negative controls,’ which provide further evidence that the observed associations on other parenting practices may not be entirely due to confounding. Next, both parenting and health outcomes were self-reported by the offspring, which may be subject to social desirability and common methods bias. However, evidence exists suggesting the validity of such self-reported health outcomes in GUTS and other cohorts³⁴. The longitudinal nature of the study also provides some reassurance that the findings are not entirely due to report bias. Next, the GUTS participants were predominantly white, all participants had a mother working in the nursing field and the family dynamics in this sample may also differ from the general population of adolescents and young adults. Thus, the results of this study may not be generalizable to other populations.

However, these limitations are balanced by several strengths of this study. First, this study compares multiple aspects of parenting across various domains of offspring health and well-being outcomes simultaneously. Such an approach may provide a broader evaluation of the impact of parenting, and may reveal certain patterns of the associations that may not be immediately clear if individual outcomes were examined in separate studies. For instance, by examining multiple outcomes within the same sample, this study suggests that some adolescent outcomes (for example, depression) may be more likely influenced by parenting practices, whereas other outcomes (for example, binge drinking) may be less subject to parental influence than to other sources, such as peers. Second, the longitudinal design with up to a 16-year follow-up helps to establish temporality and facilitate understanding from a lifecourse perspective. Third, the adjustment for a wide range of covariates and prior values of the exposure and the outcome variables helped to reduce concerns about residual confounding and reverse causation. Next, the sensitivity analysis for unmeasured confounding provides further evidence to assess the robustness to confounding for a number of the associations.

Parenting behaviours are potentially modifiable, and several parenting programmes are available^{35–37}. Such programmes seek to reduce barriers to parental involvement (for example, reduce maternal depression) and improve specific parenting practices (for example, improve skills in teaching healthy behaviours), and have been linked to better health outcomes in children^{35,38}. The World Health Organization has, in fact, called for implementing multifaceted and wide-scale parenting programmes^{39,40}, yet the progress on implementing such programmes has been relatively slow and multiple challenges remain (for example, low awareness, restricted access and lack of programme evaluation at the population level)⁴¹. Effective policies and strategies are warranted to heighten awareness of positive parenting, increase access to parenting programmes and reduce barriers to parental involvement (for example, reduce irregular working hours to increase family activities).

This study strengthens the evidence for a public health focus on improving parenting and reinforces the importance of targeting parenting as one prevention strategy to promote population health and well-being.

Methods

Study sample. This study used longitudinal data from the Nurses’ Health Study II (NHSII) and GUTS1 and GUTS2. The NHSII cohort was initiated in 1989 when 116,430 US-based registered nurses, 25–42 years of age, completed questionnaires about their health. In 1996, NHSII participants with children 9–14 years of age were invited to have their children participate in another longitudinal cohort study known as GUTS1. A total of 16,882 male and female GUTS1 participants returned completed questionnaires. In 2004, a second group of the NHSII children ($N=10,920$), 10–17 years of age, were enrolled in GUTS2. NHSII and GUTS participants continued to be followed annually or biennially.

The sample for analyses on parent–child relationship satisfaction and parenting styles was drawn from participants who responded to both the GUTS2 2008 questionnaire (in which the exposures were assessed) and the 2011 questionnaire (the earliest wave in which the outcomes were assessed) ($N=5,453$). Similarly, the analytic sample for family dinner frequency was drawn from those who responded to both the GUTS1 1997 questionnaire (in which the exposure was assessed) and the 2007 questionnaire (the earliest wave in which the outcomes were assessed) ($N=8,476$). We performed a multivariate normal multiple imputation procedure to impute missing data on all variables (five imputed data sets were created)^{42–44}. Details about the sample derivation (Supplementary Text) and comparison of participant characteristics between those retained in the cohort and those lost to follow-up (Supplementary Table 17) were provided in the supplement. This study was approved by the Institutional Review Board at the Brigham and Women’s Hospital (Boston, MA, USA).

Measurement. Exposure assessment. Offspring satisfaction with the parent–child relationship. In the GUTS2 2008 questionnaire, participants reported their satisfaction with regard to love and attachment, communication, conflict resolution and emotional connection with their parents, in response to a nine-item scale measuring parent–child relationship satisfaction⁴⁵ (Supplementary Table 18). Maternal ($\alpha=0.92$) and paternal ($\alpha=0.93$) relationships were queried separately (for example, “I am satisfied with the love and affection my mother/father shows me”). Response categories ranged from 1 (strongly disagree) to 5 (strongly agree). Participants had the option to skip questions on either parent if non-applicable. Maternal and paternal relationship satisfactions were calculated separately by averaging responses across items on each subscale, with a higher score representing greater satisfaction. An overall score of parental relationship satisfaction was derived by averaging the maternal and paternal scores. Because there was not an established cut-off point for this scale, we created tertiles of the score following a common practice when using a scale without established cut-off points⁴⁶.

Parenting styles. In the GUTS2 2008 questionnaire, parenting styles were measured with a six-item short form of the Parental Authority Questionnaire⁴⁷ (Supplementary Table 18). Specifically, three two-item subscales were used to query maternal and paternal authoritativeness (for example, “My mother/father allowed me to discuss with them their expectations when I felt they were unreasonable”), authoritarianism (“My mother/father did not allow me to question any decision they had made”) and permissiveness (“My mother/father allowed me to decide most things for myself without a lot of direction”) separately. Response categories ranged from 1 (strongly disagree) to 5 (strongly agree). Participants were able to opt out of the questions regarding either parent if non-applicable. Maternal and paternal styles were assessed separately by summing responses to the two items on each style subscale, with a higher score representing a greater presence of the style attributes. The authoritativeness subscale ($\alpha=0.78$) showed higher reliability than other subscales (see Supplementary Table 18). An overall score for each style was calculated by averaging the maternal and paternal scores. Because there was not an established cut-off point for this scale, we created tertiles of the scores following previous work⁴⁶.

Family dinner frequency. In the GUTS1 1997 questionnaire, participants reported their family dinner frequency in response to the question: “How often do you sit down with other members of your family to eat dinner or supper”. Response categories ranged from 1 (never) to 4 (every day). The bottom two categories were collapsed to reduce data sparsity, resulting in a three-level variable (1: never or some days; 2: most days; and 3: every day).

Outcome assessment. A wide range of psychological well-being (life satisfaction, positive affect, self-esteem, emotional processing and emotional expression), character strengths (frequency of volunteering, sense of mission, forgiveness and registered to vote), physical health (overweight or obesity and the number of physical health problems: cancer, diabetes, high cholesterol, high blood pressure and asthma), mental health (depression, anxiety, probable post-traumatic stress disorder) and health behavioural outcomes (overeating, eating disorder,

cigarette smoking, frequent binge drinking, marijuana use, other illicit drug use, prescription drug misuse, the number of lifetime sexual partners, early sexual initiation, sexually transmitted infections, teen pregnancy and an abnormal Pap test result) were examined. Details of the outcome measurement are provided in the Supplementary Text and Supplementary Tables 19 and 20.

Covariate assessment. To establish temporal ordering, covariates were taken from questionnaire waves before the exposure assessment; if no such data were available, we used covariates that were measured contemporaneously with the exposure (see Supplementary Table 19 for a timeline of assessments).

We adjusted for a wide range of sociodemographic covariates, including participant age (in years), sex (male or female), race/ethnicity (non-Hispanic white or others), geographical region (West, Midwest, South or Northeast), family structure (lived with both biological parents, lived with a step-parent or others), puberty development (assessed with the validated tanner stage score^{34,48}), and mother's age (in years), race (white or non-white), marital status (currently married or others), subjective social standing in the United States and in the community measured with validated scales⁴⁹ (both on a 10-point scale), and pre-tax household income (1: <US\$50,000, 2: US\$50,000–74,999, 3: US\$75,000–99,999 and 4: ≥US\$100,000). We also considered neighbourhood socioeconomic status indicators, including the college education rate (used as a continuous variable) and the median income in the census tracts where participants resided (1: <US\$50,000, 2: US\$50,000–74,999, 3: US\$75,000–99,999 and 4: ≥US\$100,000).

We also adjusted for maternal health characteristics, including maternal depression (measured with clinician-diagnosed depression and the five-item Mental Health Index⁵⁰) and maternal current smoking (yes or no).

To reduce confounding and the possibility of reverse causation, we controlled for prior values of the exposure and outcome variables, simultaneously in all models, whenever data were available. Specifically, in all analyses on relationship satisfaction and parenting styles, adjustment was made for previous body weight status, previous cigarette smoking and previous drinking; in analyses on family dinner, adjustment was made for previous family dinner frequency, previous body weight status, previous cigarette smoking and previous history of sexual intercourse.

As a sensitivity analysis, we also adjusted for subsequent depressive symptoms (assessed with the Centre for Epidemiological Studies-Depression Scale⁵¹) and subsequent religious service attendance (never or seldom, less than once a week, or at least once a week). Because these measures were only available 2–3 years subsequent to the exposure assessment, they were examined as a sensitivity analysis but not included in the primary analyses.

Statistical analyses. Statistical analyses were performed in SAS 9.4 (all tests were two-sided). Analysis of variance tests and chi-squared tests were used to examine participant characteristics across levels of relationship satisfaction and family dinner frequency.

Multiple generalized estimating equation models were used to regress each outcome on the exposure in separate models, adjusting for all covariates and for clustering by sibling status. Continuous outcomes were standardized (mean = 0, s.d. = 1) so that effect estimates could be compared across outcomes. Bonferroni correction was used to correct for multiple testing, which is conservative when outcomes are correlated⁵².

To evaluate the robustness of the observed associations to unmeasured confounding^{22,23}, we used sensitivity analyses to assess the extent to which an unmeasured confounder would need to be associated with both the exposure and the outcome to explain away the observed association. For this, we calculated *E*-values^{23,24}.

We also performed several other sensitivity analyses. First, we performed age-stratified analyses (analyses on relationship satisfaction and parenting styles were stratified by <18 or ≥18 years of age; analyses on family dinner were stratified by <13 or ≥13 years of age). Second, we examined maternal and paternal relationship satisfactions separately. Specifically, the primary models were reanalysed with maternal and paternal relationship satisfactions as the exposure variables in separate models, and then also with them included simultaneously in the same model. Next, given the weak-to-moderate correlation between parenting styles and relationship satisfaction (*r* ranged from −0.22 to 0.50), we also included parenting styles and relationship satisfaction simultaneously in the model, to examine their independent associations with various outcomes. Next, we also adjusted for subsequent depressive symptoms and religious service attendance, but unfortunately, these variables were only available 2 and 3 years subsequent to the exposure assessment; thus, these variables were not included in the primary analyses. Finally, we also reanalysed the primary sets of models using complete-case analyses.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

The data of the NHSII and the GUTS are not publicly available. Further information including the procedures to obtain and access data from the NHSII and the GUTS is described at <https://www.nurseshealthstudy.org/>

researchers (email: nhsaccess@channing.harvard.edu) and <http://nhs2survey.org/gutswordpress/index.php/researchers/information-for-researchers/>.

Code availability

All statistical analyses were performed in SAS 9.4. The code used to generate the results presented in the manuscript are available from the corresponding author on reasonable request.

Received: 18 July 2018; Accepted: 1 April 2019;

Published online: 6 May 2019

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Acknowledgements

This study was supported by funding from the Templeton Foundation (grant no. 52125 and no. 61075) and the US National Institutes of Health (grant CA222147) awarded to T.J.V. The National Institutes of Health supports the NHSII (grant UM1CA176726) and the GUTS1 and GUTS2 (grants R01HD066963, R01DA033974 and 2R01OH0098003CDC). The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript. We thank the Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School for their support in conducting this study.

Author contributions

T.J.V. developed the study concept. Y.C., J.H., B.M.C. and T.J.V. contributed to the study design. Y.C. had full access to the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis. Y.C. drafted the manuscript. Y.C., J.H., B.M.C. and T.J.V. provided critical revisions and approved the final submitted version of the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information is available for this paper at <https://doi.org/10.1038/s41562-019-0602-x>.

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Behavioural & social sciences study design

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Study description	Longitudinal observational study
Research sample	The Nurses' Health Study II (NHSII) cohort was initiated in 1989 when 116,430 U.S.-based registered nurses aged 25 to 42 years were enrolled. In 1996, NHSII participants with children aged 9 to 14 years were invited to have their children participate in another cohort study known as Growing Up Today Study (GUTS1). A total of 16,882 male and female GUTS1 participants completed questionnaires about their health. In 2004, a second group of the NHSII children (N=10,920) aged 10 to 17 years were enrolled into the Growing Up Today Study 2 (GUTS2). NHSII and GUTS 1 and 2 participants continue to be followed annually or biennially. The analytic samples for this study were drawn from participants who responded to both the GUTS2 2008 and 2011 questionnaire (for analyses on parent-child relationship satisfaction and parenting styles), and from participants who responded to both the GUTS1 1997 and 2007 questionnaire (for analyses on family dinner frequency).
Sampling strategy	This study performs secondary analyses of data from the The Nurses' Health Study II and the Growing Up Today Study 1 and 2. Details of the sampling strategy were reported in prior work (Bao et al., 2016; Field et al., 1999). Bao, Y., Bertoia, M. L., Lenart, E. B., Stampfer, M. J., Willett, W. C., Speizer, F. E., & Chavarro, J. E. (2016). Origin, methods, and evolution of the three Nurses' Health Studies. <i>American journal of public health</i>, 106(9), 1573-1581. Field, A. E., Camargo Jr, C. A., Taylor, C. B., Berkey, C. S., Frazier, A. L., Gillman, M. W., & Colditz, G. A. (1999). Overweight, weight concerns, and bulimic behaviors among girls and boys. <i>Journal of the American Academy of Child & Adolescent Psychiatry</i>, 38(6), 754-760.
Data collection	This study performs secondary analyses of data from the The Nurses' Health Study II and the Growing Up Today Study 1 and 2. Details of the data collection procedures were reported in prior work (Bao et al., 2016; Field et al., 1999).
Timing	The Nurses' Health Study II (NHSII) was initiated in 1989. The Growing Up Today Study (GUTS1) was initiated in 1996, and the Growing Up Today Study 2 (GUTS2) was established in 2004. The NHSII, GUTS1 and GUTS2 participants have been followed annually or biennially. The analytic samples for this study were drawn from participants who responded to both the GUTS2 2008 and 2011 questionnaire (for analyses on parent-child relationship satisfaction and parenting styles), and from participants who responded to both the GUTS1 1997 and 2007 questionnaire (for analyses on family dinner frequency). We used outcome variables assessed at the most recent waves (mainly GUTS2 2013 wave [if not available in 2013 wave, we used outcome data from the 2010 wave] for analyses on relationship satisfaction and parenting styles; mainly GUTS1 2010 wave [if no available in 2010 wave, we used outcome data from the 2007 or 2013 wave] for analyses on family dinner).
Data exclusions	For analyses on relationship satisfaction and parenting styles, we drew the analytic sample from respondents of both the GUTS2 2008 questionnaire (in which the exposures were assessed) and the 2011 questionnaire (the earliest wave in which the outcomes were assessed). Similarly, For analyses on family dinner frequency, we drew the analytic sample from respondents of both the GUTS1 1997 questionnaire (in which the exposures were assessed) and 2007 questionnaire (the earliest wave in which the outcomes were assessed). We used multiple imputation to impute missing data on all variables.
Non-participation	Non-participation and the response rate in the original Nurses' Health Study II and The Growing Up Today Study 1 and 2 were reported previously (Bao et al., 2016; Field et al., 1999). Around 90% response rate has been maintained for follow-up questionnaires in these cohorts.
Randomization	This is an longitudinal observational study. We controlled for a wide range of sociodemographic characteristics, maternal health and baseline values of the outcome variables wherever data were available, with the aim to make the comparison groups exchangeable.

Reporting for specific materials, systems and methods

Materials & experimental systems

n/a	Involvement in the study
☒	☐ Unique biological materials
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☒	☐ Animals and other organisms
☐	☒ Human research participants

Methods

n/a	Involvement in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Human research participants

Policy information about [studies involving human research participants](#)

Population characteristics

The sample characteristics of the original Nurses' Health Study II and The Growing Up Today Study 1 and 2 were reported previously (Bao et al., 2016; Field et al., 1999).

In this study, the sample for analyses on relationship satisfaction and parenting styles was primarily white and slightly higher percentage female, with the mean age of 17.75 years (SD=1.90, range: 12-22) at the study baseline. The analytic sample for family dinner had similar characteristics, with the mean age of 12.78 years (SD=1.69, range: 10-17) at the study baseline.

Recruitment

The recruitment procedures of the original Nurses' Health Study II and The Growing Up Today Study 1 and 2 were reported previously (Bao et al., 2016; Field et al., 1999). All participants of the Nurses' Health Study II were female nurses, and all participants of the Growing Up Today Study 1 and 2 had a mother who worked in the nursing field. Therefore, results of this study may not be generalizable to other populations.