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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}, often examining individual outcomes 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 making parenting easier – also remain a concern in many prior observational studies⁵. Here, we examined the associations between multiple aspects of parenting (including parent-child relationship satisfaction concerning love, parental authoritativeness, 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 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

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Authors' 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.

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

Code Availability. All statistical analyses were performed in SAS 9.4. Code used to generate the results presented in the manuscript are available from the corresponding author upon request.

Data Availability. Data of The Nurses' Health Study II and the Growing Up Today Study are not publicly available. Data used to support the findings of this study may be available from the authors upon request and with the permission of the Channing Division of Network Medicine at Brigham and Women's Hospital.

Conflict of Interest: The authors declare no conflict of interest.

relationship satisfaction was associated with greater emotional well-being, lower risk of mental illness, eating disorders, overweight/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. While family structures and processes are multi-faceted, 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, prior researchers identified three major parenting styles, including the authoritative, the authoritarian and the permissive styles¹². Authoritative parents are responsive to their child's needs, respectful of 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. Prior studies generally suggests 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, as compared to 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 provides an opportunity for strengthening the bonding and communication between family members, and facilitates parental monitoring and modelling on a regular basis¹⁶. Prior work has suggested positive associations of family meals with adolescent psychosocial well-being and behavioural health (e.g., improved diet, lower risk of depression and substance use)¹⁶⁻¹⁸. A recent national survey, however, revealed that 30% of the U.S. families had no more than two family meals per week¹⁹.

While such prior work has substantially advanced our understanding of parenting and offspring health, they are subject to certain limitations. First, much prior 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 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 likely bidirectional since poor health may impede the participation in family activities²⁰. However, prior 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 health and well-being outcomes in adolescents and young adults. These outcomes were selected following a prior 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 (i.e., the authoritarian and the permissive parenting styles) with the same sets of outcomes. Several sensitivity analyses were performed. Specifically, we assessed 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 were slightly higher percentage female, primarily Non-Hispanic White and mostly healthy, with an average baseline age of 17.75 years (standard deviation [SD]=1.90, range: 12–22) (Supplementary Table S1). Most participants reported a high level of relationship satisfaction (mean=36.06, SD=6.34, range: 9–45). The analytic sample for family dinner frequency had similar characteristics, with a mean baseline age of 12.78 years (SD=1.69, range: 10–17). Around 80% of the participants reported having dinner with their family most days or everyday (Supplementary Table S2). Participant characteristics across level of relationships satisfaction are shown in Table 1 and across levels of family dinner frequency in Supplementary Table S3. Relationship satisfaction was positively associated with a number of subsequent psychological, mental and behavioural health and well-being outcomes in a monotonic fashion (Table 2 and Supplementary Table S4). For instance, the top vs. bottom tertile of relationship satisfaction was associated with substantially greater emotional well-being, and lower risk of depression, anxiety, overweight/obesity, overeating, eating disorders, and marijuana use. There was also evidence suggesting greater relationship satisfaction was related to lower risk of cigarette smoking, although the association did not reach $p < .05$ 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 S5). 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 S6). Results of a complete case analysis were similar and are available from the authors by request.

When maternal and paternal relationship were examined separately, each was associated with various outcomes in similar patterns as the averaged parental relationship (Supplementary Tables S7 and S8). However, when maternal and paternal relationship 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 S9).

The middle and top vs. bottom tertile of parental authoritative-ness 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 authoritative-ness was possibly related to better physical health outcomes, although the associations did not reach $p<.05$ after correction for multiple testing (Table 2 and Supplementary Table S10). In sensitivity analyses that additionally adjusted for subsequent depressive symptoms, almost all of the associations remained similar (Supplementary Table S5). 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 S11). Results of a complete case analysis were similar and are available from the authors by 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 (Table 2, Supplementary Tables S12 and S13).

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 S14).

The top vs. bottom level of family dinner frequency was associated with fewer depressive symptoms, fewer lifetime sexual partners, lower risk of early sexual initiation, history of STIs 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 PTSD, frequent binge drinking, marijuana use and prescription drug misuse, although the associations did not reach $p<.05$ after adjustment for multiple testing (Table 2, Supplementary Table S15). 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 S5). 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 S16). Results of a complete case analysis were similar and are available from the authors by request.

We assessed 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 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 were 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, overeating, eating disorder, and cigarette smoking. There was also evidence that some associations of parental authoritative 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 which 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 prior work, this study found that greater parent-child relationship satisfaction generally concerning love and attachment, and to a lesser extent greater parental authoritative 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}. This study, however, found weaker associations between non-authoritative parenting styles and offspring risk of mental illness and certain behaviours as compared to previous studies^{13,14}. This might be due to the differences in the measurement of parenting styles. Specifically, prior work often grouped parenting styles into typologies and compared the non-authoritative style with the authoritative style. In comparison, this 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 prior 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 GUTS participants were also healthier compared to the general population of adolescents and young adults²⁷. It may be, therefore, harder to capture the associations of family dinner with certain risky behaviours, if any, due to the small number of participants with such risky behaviours in this sample.

While 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 authoritative facilitates the balance between affect expression and behavioural control in upbringing; family meals provide an opportunity to strengthen the bonding, communication, monitoring and parental modelling on a regular basis. All these processes are previously hypothesized major pathways leading to effective family functioning^{28,29}. Given the changing nature in the parent-child relationship during adolescence, however, certain adjustment in parenting may be warranted. For instance, adolescents may need a lower degree of proximity to their parents than younger children, since they have developed the ability to derive a sense of security by knowing their parents are nurturing and supportive. On the other hand, 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 heightened risks for mental distress and thrill seeking behaviours, and behavioural patterns formed in this period often persist into later life³¹. If a resilience 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. Some prior work, however, 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 (e.g., family connectedness, prior mental health) for which data was not available. However, the sensitivity analysis adjusting for subsequent depressive symptoms and the calculated "E-values" both suggest that a number 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.

There has been, however, evidence suggesting 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. Therefore, results of this study may not be generalizable to other populations.

These limitations are, however, balanced by a number of 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 (e.g., depression) may be more likely influenced by parenting practices, whereas other outcomes (e.g., binge drinking) may be less subject to parental influence as compared to other sources, such as peers. Second, the longitudinal design with up to a 16-year follow-up helps 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 reduce concerns about residual confounding and reverse causation. Next, the sensitivity analysis for unmeasured confounding provides further evidence to assess robustness to confounding for a number of the associations.

Parenting behaviours are potentially modifiable, and a number of parenting programmes are available^{35–37}. Such programmes seek to reduce barriers to parental involvement (e.g., reduce maternal depression) and improve specific parenting practices (e.g., 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 (e.g., low awareness, restricted access, lack of program 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 (e.g., 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 the Growing Up Today Study (GUTS) 1 and 2. The NHSII cohort was initiated in 1989 when 116,430 U.S.-based registered nurses, aged 25 to 42 years, completed questionnaires about

their health. In 1996, NHSII participants with children aged 9 to 14 years 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) aged 10 to 17 years were enrolled into 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 (5 imputed datasets 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 S17) were provided in the supplement. This study was approved by the Institutional Review Board at the Brigham and Women's Hospital.

Measurement

Exposure Assessment

Offspring satisfaction with the parent-child relationship.: In 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 9-item scale measuring parent-child relationship satisfaction (Supplementary Table S18)⁴⁵. Maternal ($\alpha=0.92$) and paternal ($\alpha=0.93$) relationship were queried separately (e.g., “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 satisfaction 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-point for this scale, we created tertiles of the score following a common practice when using a scale without established cut points⁴⁶.

Parenting styles.: In GUTS2 2008 questionnaire, parenting styles was measured with a 6-item short form of the Parental Authority Questionnaire⁴⁷ (Supplementary Table S18). Specifically, three 2-item subscales were used to query maternal and paternal authoritativeness (e.g., “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 2 items on each style

subscale, with a higher score representing greater presence of the style attributes. The authoritativeness subscale ($\alpha=0.78$) showed higher reliability compared to other subscales (see Supplementary Table S18). An overall score for each style was calculated by averaging the maternal and paternal scores. Because there was not an established cut-point for this scale, we created tertiles of the scores following prior work⁴⁶.

Family dinner frequency.: In 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, 3: every day).

Outcome Assessment—A wide range of psychological well-being (life satisfaction, positive affect, self-esteem, emotional processing, emotional expression), character strengths (frequency of volunteering, sense of mission, forgiveness, registered to vote), physical health (overweight/obesity, 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, number of lifetime sexual partners, early sexual initiation, STIs, teen pregnancy, abnormal Pap test result) were examined. Details of the outcome measurement were provided in Supplementary Text and Supplementary Tables S19 and S20.

Covariate Assessment—To establish temporal ordering, covariates were taken from questionnaire waves prior to the exposure assessment; if no such data were available, we used covariates that were measured contemporaneously with the exposure (see Table S19 for a timeline of assessments).

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

We also adjusted for maternal health characteristics including maternal depression (measured with clinician-diagnosed depression and the 5-item Mental Health Index⁵⁰) and maternal current smoking (yes, 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 prior body weight status, prior cigarette smoking and prior drinking; in analyses on family dinner, adjustment was made for prior family dinner frequency, prior body weight status, prior cigarette smoking, and prior 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/week, at least once/week). Because these measures were only available two to three 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-square 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, SD=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 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}, 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 an association.

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 satisfaction separately. Specifically, the primary models were reanalysed with maternal and paternal relationship satisfaction 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 two and three years subsequent to the exposure assessment, thus were not included in the primary analyses. Finally, we also reanalysed the primary sets of models using complete-case analyses.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

NHSII	Nurses' Health Study II
GUTS1	Growing Up Today Study 1
GUTS2	Growing Up Today Study 2
STIs	sexually transmitted infections
SD	standard deviation

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Table 1. Participant characteristics across levels of parent-child relationship satisfaction at study baseline (Growing Up Today Study 2 [GUTS2] 2008 questionnaire wave, N=4,894)

Participant characteristics	Relationship satisfaction ^a			P-value
	Bottom tertile (n=1,556)	Middle tertile (n=1,713)	Top tertile (n=1,625)	
<i>Sociodemographic factors</i>				
Age, in years, mean (SD) ^b	17.60 (1.86)	17.76 (1.93)	17.95 (1.92)	<.001
Gender (boy), %	39.01	42.97	38.89	.02
Race/ethnicity (Non-Hispanic White), %	92.15	92.78	93.60	.29
Geographic region				.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 (SD) ^b	49.28 (3.68)	48.95 (3.60)	48.98 (3.58)	<.001
Mother's race (white), %	97.69	97.78	98.28	.45
Mother married, %	88.82	92.90	93.93	<.001
Mother's subjective SES in the US, mean (SD) ^b	7.10 (1.33)	7.18 (1.25)	7.37 (1.30)	<.001
Mother's subjective SES in the community, mean (SD) ^b	6.97 (1.55)	7.12 (1.46)	7.23 (1.49)	<.001
Pretax household income				.10
<\$50,000, %	12.81	11.05	11.68	
\$50,000–\$74,999, %	27.14	25.50	23.58	
\$75,000–\$99,999, %	22.29	23.07	21.65	
\$100,000, %	37.76	40.38	43.08	
Census tract college education rate, mean (SD) ^b	34.27% (16.82%)	34.09% (15.88%)	34.36% (16.30%)	.89
Census tract median income				.80
<\$50,000, %	18.83	18.74	19.45	
\$50,000–\$74,999, %	48.71	49.80	46.89	
\$75,000–\$99,999, %	24.49	23.76	25.17	

Participant characteristics	Relationship satisfaction ^a			P-value
	Bottom tertile (n=1,556)	Middle tertile (n=1,713)	Top tertile (n=1,625)	
\$100,000, %	7.97	7.71	8.49	
<i>Maternal health</i>				
Maternal depression diagnosis, %	10.41	9.28	8.80	.28
Maternal current smoking, %	4.05	2.79	3.28	.14
<i>Prior health status and health behaviours</i>				
Prior overweight or obesity, %	19.56	18.79	19.06	.87
Prior cigarette smoking, %	17.06	15.16	12.26	<.001
Prior history of sexual intercourse, %	32.90	29.23	27.30	.002
Prior puberty development, mean (SD)	4.29 (0.97)	4.29 (0.96)	4.36 (0.92)	.10

Abbreviations: SD, standard deviation; SES, socioeconomic status.

^a ANOVA or chi-square tests were used to examine the mean levels (SD) 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 in or prior to the 2008 questionnaire wave.

^b Range of the following participant characteristics were age (range: 12–22 years), mother's age (range: 43–61 year), mother's subjective SES in the US (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).

Parenting and offspring subsequent health and well-being in young adulthood (Growing Up Today Study 2 [GUTS2] 2008 to 2011 or 2013 questionnaire wave, N=5,453; Growing Up Today Study 1 [GUTS1] 1997 to 2007, 2010 or 2013 questionnaire wave, N=8,476^a)

Table 2.

Health and well-being outcomes	Relationship satisfaction ^b			Parental authority/attentiveness ^b			Family dinner frequency ^c			
	RR ^d	β^e	95% CI	RR ^d	β^e	95% CI	RR ^d	β^e	95% CI	P value Threshold
Psychological Well-being										
Life satisfaction			<i>f</i>			<i>f</i>		0.12	0.04, 0.20	<.01
Positive affect			<i>f</i>			<i>f</i>		0.09	0.01, 0.16	<.05
Self-esteem			<i>f</i>			<i>f</i>		0.12	0.04, 0.19	<.01
Emotional processing		0.28	0.20, 0.35		0.28	0.18, 0.38		0.09	0.01, 0.17	<.05
Emotional expression		0.33	0.25, 0.41		0.33	0.25, 0.40		0.08	-0.02, 0.19	<.05
Physical Health										
No. of physical health problems		-0.07	-0.14, 0.00		-0.08	-0.16, -0.01		-0.02	-0.10, 0.06	
Overweight/obesity	0.86		0.77, 0.95	0.88		0.80, 0.96	0.95		0.86, 1.05	
Mental Health										
Depressive symptoms		-0.54	-0.62, -0.45		-0.31	-0.38, -0.24		-0.13	-0.21, -0.05	<.0018 ^d
Depression diagnosis	0.54		0.44, 0.67	0.80		0.64, 1.00	0.76		0.60, 0.95	<.05
Anxiety symptoms			<i>f</i>			<i>f</i>		-0.06	-0.15, 0.02	
Anxiety diagnosis	0.61		0.47, 0.78	0.98		0.75, 1.29	0.87		0.68, 1.10	
Probable PTSD			<i>f</i>			<i>f</i>		0.71	0.53, 0.95	<.05
Health Behaviours										
Overeating	0.25		0.16, 0.40	0.45		0.32, 0.64	0.74		0.43, 1.28	
Eating disorder	0.42		0.26, 0.68	0.93		0.59, 1.48	0.85		0.48, 1.48	
Cigarette smoking	0.70		0.54, 0.90	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	<.05

Health and well-being outcomes	Relationship satisfaction ^b			Parental authority/attentiveness ^b			Family dinner frequency ^c			
	RR ^d	β^e	95% CI	RR ^d	β^e	95% CI	RR ^d	β^e	95% CI	P value Threshold
Marijuana use	0.78	0.69, 0.88	<.0038 ^d	0.95	0.85, 1.06		0.82	0.70, 0.97		<.05
Any other illicit drug use		f			f		0.76	0.56, 1.03		
Prescription drug misuse		f			f		0.74	0.61, 0.90		<.01
No. of sexual partners		f			f			-0.17	-0.24, -0.10	<.0018 ^d
Early sexual initiation		f			f		0.64	0.53, 0.78		<.0018 ^d
History of STIs	0.69	0.46, 1.02		0.74	0.52, 1.06		0.71	0.58, 0.87		<.0018 ^d
Teen pregnancy		f			f		0.89	0.44, 1.78		
Abnormal Pap test		f			f		0.72	0.61, 0.84		<.0018 ^d
Character and Virtue										
Frequency of volunteering		f			f			0.02	-0.06, 0.10	
Sense of mission		f			f			0.08	-0.01, 0.16	
Forgiveness of others		f			f			0.11	0.03, 0.18	<.01
Registered to vote		f			f		0.99	0.96, 1.02		

Abbreviations: CI, confidence interval; OR, odds ratio; PTSD, posttraumatic stress disorder; RR, risk ratio; STIs, sexually transmitted infections.

^aFor analyses on relationship satisfaction and parental authority/attentiveness, the analytic sample was restricted to those who responded to the GUTS2 2008 (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 (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 abnormal Pap test was only available among female participants (n=5,377).

^bThe analyses on relationship satisfaction and parental authority/attentiveness controlled for participants' age, race/ethnicity, sex, geographic 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' prior weight status, prior cigarette smoking, and prior history of sexual intercourse.

^cThe analyses on frequency of family dinner controlled for participants' age, race/ethnicity, sex, geographic 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' prior family dinner frequency, prior weight status, prior cigarette smoking, and prior drinking.

^dThe effect estimates for the outcomes of over eating, eating disorder, STIs [GUTS2 only], PTSD, other illicit drug use, and teen pregnancy were odds ratio (examined with Binomial distribution, logit link; these outcomes were rare [prevalence<10%]), so the odds ratio would approximate RR). The effect estimates for other dichotomized outcomes were RR (examined with Poisson distribution, log link).

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^eAll continuous outcomes were standardized (mean=0, standard deviation=1), and β was the standardized effect size.

^f“—” indicates data not available in that cohort. The analyses on relationship satisfaction and parental authoritative 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.

^g $P<0.05$ after Bonferroni correction (the p value cutoff for Bonferroni correction=0.05/13 outcomes=0.0038 for analyses on relationship satisfaction and parental authoritative; the p value cutoff for Bonferroni correction=0.05/28 outcomes =0.0018 for analyses on family dinner frequency).

Table 3.

Robustness to unmeasured confounding (E-values^a) for assessing the causal associations between parenting and offspring subsequent health and well-being (Growing Up Today Study 2 [GUTS2] 2008 to 2011 or 2013 questionnaire wave, N=5,453; Growing Up Today Study 1 [GUTS1] 1997 to 2007, 2010 or 2013 questionnaire wave, N=8,476)

	Relationship satisfaction		Parental authoritative ^b		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	--- ^d	--- ^d	--- ^d	--- ^d	1.47	1.24
Positive affect	--- ^d	--- ^d	--- ^d	--- ^d	1.39	1.12
Self-esteem	--- ^d	--- ^d	--- ^d	--- ^d	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
No. of physical health problems	1.33	1.00	1.36	1.08	1.16	1.00
Overweight/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	--- ^d	--- ^d	--- ^d	--- ^d	1.30	1.00
Anxiety diagnosis	2.66	1.88	1.16	1.00	1.56	1.00
Probable PTSD	--- ^d	--- ^d	--- ^d	--- ^d	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	--- ^d	--- ^d	--- ^d	--- ^d	1.96	1.00
Prescription drug misuse	--- ^d	--- ^d	--- ^d	--- ^d	2.04	1.46
Number of sexual partners	--- ^d	--- ^d	--- ^d	--- ^d	1.61	1.39
Early sexual initiation	--- ^d	--- ^d	--- ^d	--- ^d	2.50	1.88
History of STIs	2.26	1.00	2.04	1.00	2.17	1.56
Teen pregnancy	--- ^d	--- ^d	--- ^d	--- ^d	1.50	1.00
Abnormal Pap test	--- ^d	--- ^d	--- ^d	--- ^d	2.12	1.67
Frequency of volunteering	--- ^d	--- ^d	--- ^d	--- ^d	1.47	1.00
Sense of mission	--- ^d	--- ^d	--- ^d	--- ^d	1.36	1.00
Forgiveness of others	--- ^d	--- ^d	--- ^d	--- ^d	1.45	1.20
Registered to vote	--- ^d	--- ^d	--- ^d	--- ^d	1.11	1.00

Abbreviations: CI, confidence interval.

^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 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% confidence interval 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 confidence interval to include the null value.

^d“---” indicates data not available in that cohort. The analyses on relationship satisfaction and parental authoritativeness 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.