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Communication Problems? The Role of Parent-child Communication for the Subsequent Health Behavior of Adolescents

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Daniel Avdic and Tugba Büyükdurmus[1]

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Abstract

We contribute to the literature on the determinants of socioeconomic health disparities by studying how the health behavior of adolescents may arise from the degree of communication between parent and child. Parent-child communication may function as a mediator between family background and subsequent poor health behavior, potentially reconciling previous mixed evidence on the relationship between child health and social status. Using data from a unique German child health survey we construct an index of parent-child communication quality by comparing responses to statements about the children's well-being from both children and their parents. Applying the constructed communication measure in a continuous treatment empirical framework, allowing for estimation of non-linear effects, our results show that improved parent-child communication monotonously reduces the smoking prevalence of adolescents by as much as 70%, irrespective of social background. More complex relationships are found for risky alcohol consumption and abnormal body weight.

JEL Classification: C31, D83, I12, I14, J13

Keywords: Child health; health behavior; communication; intergenerational transmission; socioeconomic inequality; continuous treatment effect

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1 Daniel Avdic, UDE and CINCH; Tugba Büyükdurmus, UDE, CINCH, RWI, and RUB. *– We thank Per Johansson, Martin Karlsson, Stephanie von Hinke Kessler Scholder, Harald Tauchmann and seminar participants at the University of Duisburg-Essen, CINCH Academy 2014, 10th joint iHEA and ECHE Congress in Dublin and the 7th dggö Jahrestagung in Bielefeld for useful comments. Data provided by the Robert Koch Institute and financial support from the Bundesministerium für Bildung und Forschung (BMBF) are gratefully acknowledged.* *– All correspondence to: Tugba Büyükdurmus, CINCH–Health Economics Research Center, Edmund-Körner-Platz 2, 45127 Essen, Germany, e-mail: tugba.bueyuekdurmus@uni-due.de*

1 Introduction

The health of children and adolescents has recently become a major concern in many countries (Currie *et al.*, 2004). A leading example is the rapid growth in the prevalence of child obesity which has spurred considerable debate among both policy-makers and researchers (Lobstein *et al.*, 2004). Other areas of health behavior studied among the young includes tobacco smoking (Tyas and Pederson, 1998; Engels *et al.*, 1998; Anda *et al.*, 1999; Simantov *et al.*, 2000), alcohol use (Petraitis *et al.*, 1998; Settertobulte *et al.*, 2001; Schulenberg and Maggs, 2002), sexual health (Morris *et al.*, 1993; Tráen and Kvalem, 1996), cannabis use (Bauman and Ennett, 1996; Bachman *et al.*, 1998; Patton *et al.*, 2002), and oral health (Honkala *et al.*, 1990; Addy *et al.*, 1990). Policies targeted at reducing avoidable health problems related to individual behavior as early as possible are likely to be a cost-efficient way to achieve long-term improvements in public health (cf. European Commission, 2013).[1]

Closely related to general concerns about child health are the consequences of social inequalities in childhood on observed health disparities. A number of studies have found significant relationships between children's socioeconomic status and their subsequent health outcomes (see e.g., Bradley and Corwyn, 2002; Newacheck *et al.*, 2003). It has been estimated that over 70% of the factors determining health lies outside of the scope of health services and are instead attributed to demographic, social, economic and environmental conditions (NHH, 2000). Children and adolescents from families of low socioeconomic position are overrepresented with respect to many health problems, such as mortality, injury, prevalence of diagnosed illness, height, BMI, self-rated health and risk behavior (Currie *et al.*, 2012). Drewnowski (2010) provides a concrete example of this relationship, finding that budget restrictions play a role in the over-representation of obesity among children with low-income parents, as nutritious, and more expensive, food is unaffordable. Life-lasting health inequalities can therefore arise from differences in early life conditions during which the basis for a healthy lifestyle is formed (cf. Center on the Developing Child, 2010).

In contrast, Hanson and Chen (2007) reports in a recent literature review that the evidence on the relation between social background and health is less robust in childhood

[1] In particular, article (4) of the European Commission's recommendation states that "Early intervention and prevention are essential for developing more effective and efficient policies, as public expenditure addressing the consequences of child poverty and social exclusion tends to be greater than that needed for intervening at an early age" (European Commission, 2013, p. 5).

than in adulthood. Furthermore, Wang (2001) reports substantial variation in the socioeconomic health gradient in a cross-country study. Importantly, as socioeconomic status is a highly complex and multidimensional concept, but often empirically constructed using broad indicators such as earnings, income, education or occupation, some researchers have argued that the mixed evidence may be a consequence of a too crude definition (Dutton and Levine, 1989). For example, Bianchi (2000) find that employed mothers tend to offset their increased working hours by spending time with their children more intensively in their free time, while other studies has found an opposite pattern (see e.g., Anderson *et al.*, 2003). Adler *et al.* (1994) reviewed a number of potential psychosocial and behavioral mechanisms potentially explaining the association between social background and health, stressing the complexity of the relationship and calling for more detailed analysis of mediating factors.

The aim of this paper is to analyze whether and to which extent the communication quality between parents and their children may serve as such a link between socioeconomic status and health behavior of adolescents. The motivation is intuitive: a well-functioning communication in a family is characterized by a situation in which household members observe each other and listen to each others beliefs, attitudes and habits. Mental and social support is a fundamental form of communication which contributes to the child's personality, development and behavior in almost all contexts of life (see e.g., Kunkel *et al.*, 2006). As such, family communication should be a key factor influencing children's later health behavior and mediate effects related to more traditional measures of a family's socioeconomic status, as family communication is most likely related to factors such as income and education. The causal link between family communication and health has so far, to the best of our knowledge, not received much attention among researchers.[2]

To evaluate the impact of parent-child communication on adolescent health behavior we make use of a unique, nationally representative, German child health survey, which includes comprehensive information on the physical and mental health status as well as detailed information on socioeconomic characteristics for more than 17,000 children between 0 and 17 years (Kurth *et al.*, 2008). We use the data to construct a measure of the quality of communication between parent and child, based on the response correspondence to

[2]Parent-child communication has previously been analyzed descriptively in, for example, Laursen and Collins (2004) and Williams *et al.* (2010). Furthermore, in a related strand of literature, the impact of parental health behavior on child health has been studied in, for example, Snow Jones *et al.* (1999).

statements about the child's life satisfaction asked to both parents and their children. We use this information to measure how well parents know their children in six different categories; physical health, psychological health, self-esteem and their satisfaction with family, friends and school. This, indirect, technique is motivated by an attempt to reduce the risk of social desirability bias from more direct questions, such as self-reported family communication quality, where subjects may respond untruthfully because of a willingness to appear socially correct (cf. Maccoby and Maccoby, 1954; Fisher, 1993; Johnston *et al.*, 2014). We relate our constructed communication measure to a number of health behavioral outcomes (smoking, alcohol consumption and body weight) and adjust for the impact of confounding factors using a propensity score approach in a continuous treatment setting, as outlined in Hirano and Imbens (2004).

Our results show that parent-child communication quality may strongly influence the health behavior of adolescents, but it crucially depends on the specific outcome. In particular, our estimates imply a 70% reduction in smoking prevalence between the lower and the upper support of the communication distribution. Communication seem to be less important for body weight and, in particular, for risky alcohol consumption where no difference between the groups could be distinguished after adjustment for confounding factors. However, analyzing over- and underweight separately reveals that overweight is inversely, and significantly, related to parent-child communication, while underweight is not. Our findings suggest that communication may be an important factor mediating the relationship between family social background and subsequent health outcomes. Policies should therefore be directed towards counseling of families in order to encourage, in particular poorer, household's ability to establish well-functioning communication channels.

The remainder of this article proceeds as follows: Section two describes the data, the statistical methodology we apply to construct the communication index and the econometric framework used to isolate the impact of communication. Section three presents the empirical results, beginning with a descriptive analysis and followed by estimation results from the multivariate analysis. Finally, section four offers a summary together with some concluding remarks.

2 Data and Econometric Specification

This section begins with a brief introduction to the data and sample we use for our empirical analysis followed by a more detailed explanation on how we construct our parent-child communication measure from the data. We subsequently explain the econometric framework and estimation strategy we apply to isolate the causal effect of communication on health behavior.

2.1 Data

The data used in this study originates from the Robert Koch Institute and is collected for the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) between 2003 and 2006 (Kurth *et al.*, 2008). It is a nationally representative and comprehensive survey on the health of children in Germany 0-17 years, totaling 17,641 individuals. The data include detailed individual-level information on physical and mental well-being (in the form of an extensive clinical health assessment), health-related behavior (such as diet and tobacco and alcohol utilization) as well as a number of socioeconomic and demographic characteristics, acquired through the means of a computer-assisted personal interviewing (CAPI) technique.

The KiGGS dataset is unique due to its comparatively large sample size and wide-ranging and detailed information on the health of children. For the aims of this study, one crucial feature of the data is that it contains a series of statements about the child's life satisfaction, asked to both the child *and* their accompanying parent. For each of these statements, the child and parent are jointly asked to indicate how applicable it is for them on scale from one to four ("does not match" to "matches exactly"). We use the responses from these statements to create our measure of parent-child communication by constructing an index of the degree to which the answers correspond. The underlying idea of this approach is simple; the better parents know their children, the higher should their responses correspond with the answers from the children. The degree of correspondence should then serve as an indicator for how well a parent know their child, or, in other words, as a proxy for the quality of communication between them. Using this indirect measure of parent-child communication is also likely to avoid empirical problems arising from using more direct measures (e.g.,

self-reported parental communication quality) as parents may want to respond in a socially desirable way and thereby introduce systematic measurement error into the analysis. (cf. Maccoby and Maccoby, 1954; Fisher, 1993).[3]

We restrict our analysis to adolescents aged 11–17 since the statements used to construct our communication measure are only available for these age groups. This leaves us with approximately 5,000 children remaining in the sample. In total 24 statements concerning the life satisfaction of the interviewed children are used to construct the parent-child communication quality measure (see Table A.1 in Appendix A for a complete list of the questions). We apply the Mahalanobis distance metric to comprise the information from the questions into a single index. Formally, the Mahalanobis distance is in our application defined as the square root of the sum of the squared distances between the parent and child's responses, weighted by the variance of the responses,

$$d(x^c, x^p) = \sqrt{(x^c - x^p)' S^{-1} (x^c - x^p)}, \tag{2.1}$$

where $d(\cdot, \cdot)$ is the communication index as a function of the response vectors for the (c)hild and the (p)arent, respectively (i.e., $x^j = \{x_1^j, x_2^j, \ldots x_i^j, \ldots, x_N^j\}$ for $i = 1, \ldots, 24; j = c, p$), weighted by the response covariance matrix, S. To normalize the range of $d(\cdot, \cdot)$ to lie within the unit interval and to transform it into an increasing function of parent-child response correspondence, we weight each distance value by the maximum distance and reduce this modified value from one[4]. Figure 2.1 plots the resulting distribution of the communication measure along with statistics of the distribution. As specific values of the communication index does not have a clear interpretation we will relate our analyses to the the quantiles of the communication distribution in most of what follows.

To analyze how the parent-child communication affect subsequent health behavior we consider three specific behavioral outcomes; the prevalence of smoking (defined as whether the individual reports smoking tobacco), the level of alcohol consumption (whether the individual reports a risky level of alcohol consumption[5]) and having an unhealthy diet (BMI

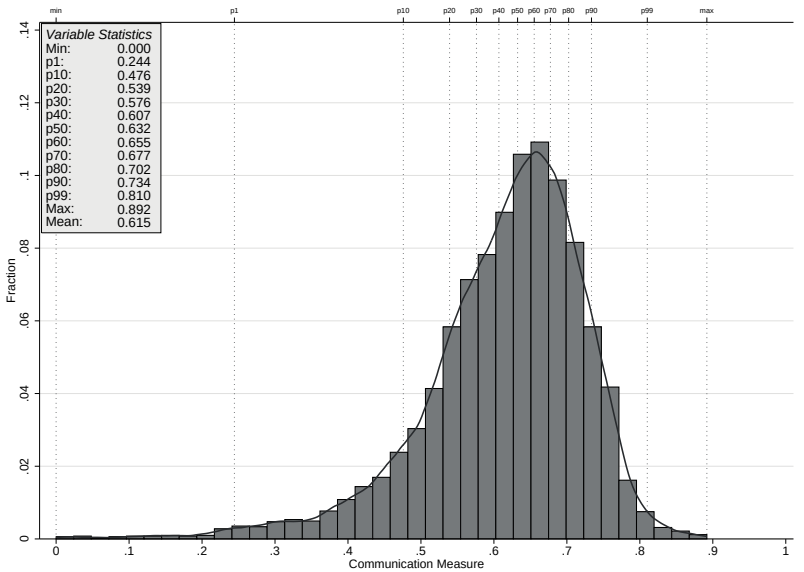
[3]None of the statements used to construct the communication index explicitly mentions the communication between parent and child in the family. See Table A.1 in Appendix A.

[4]Denoting the maximum possible value of the Mahalanobis distance metric $d_{max} = \max d(x^c, x^p)$, our normalized communication measure is $d_{norm}(x^c, x^p) = 1 - (d(x^c, x^p)/d_{max})$.

[5]According to the German Centre for Addiction Issues (DHS) risky alcohol consumption level for adults

outside of the normal range[6]). The outcomes are defined as binary indicators where a value of zero and one indicates the healthy and unhealthy condition, respectively. In additional analyses we also use further categorizations of these outcomes to investigate the sensitivity of the classifications.

FIGURE 2.1.
Distribution of the Constructed Communication Index



NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The graph shows the distribution of the constructed communication index by applying the Mahalanobis distance measure (equation (2.1)) on 24 separate questions about the well-being of the interviewed child asked to both the child and the accompanying parent. The full set of questions used to construct the index are listed in Table A.1 in Appendix A.

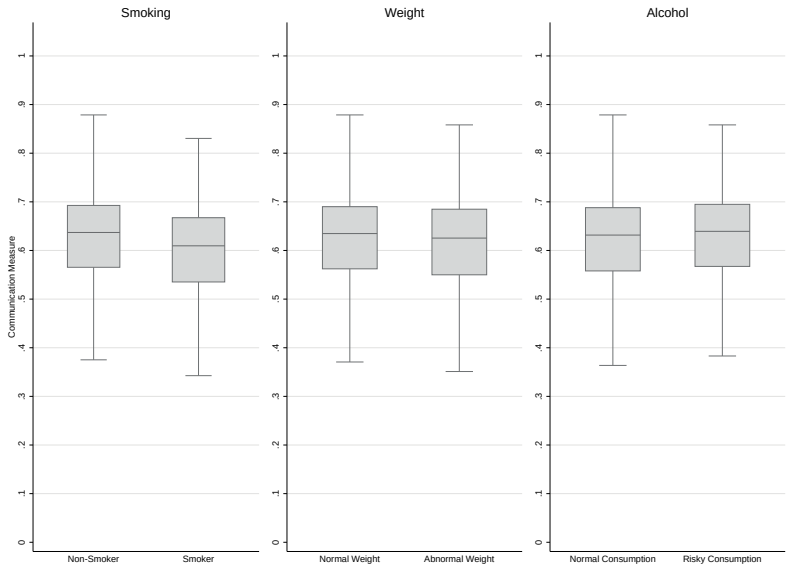
Figure 2.2 illustrates box-plots of the communication index outcome marginal distributions by health behavior category. Specifically, the left plot in each panel pertains to the healthy outcome and the right to the unhealthy outcome. The figure shows that the communication density is higher in the upper part of the distribution for non-smokers and children of normal weight compared to smokers and children with abnormal weight, while no such difference is discernible for children reporting risky and non-risky alcohol consumption,

is defined as an intake of more than 20 (30) grams per day, five times a week for women (men). (DHS, 2003). Relating this definition to adolescents in our data, we define risky alcohol consumption as reporting drinking alcohol at least 2-4 times per week.

[6]Defining over- or underweight for children is different than for adults. The weight categories are defined based on percentiles of the body mass index (BMI) of the Kromeyer-Hauschild reference system (Kromeyer-Hauschild *et al.*, 2001). According to this definition, a child is considered overweight (underweight) if they are above (below) the ninetieth (tenth) BMI percentile in its age-gender-class. Furthermore, extreme overweight/adiposity (underweight/anorexia) is defined as being above (below) the 97th (3rd) BMI percentile within its age-gender-class. As the KiGGS data is representative for Germany we use the sample distribution to identify the cutoffs for the different weight categories.

respectively.

FIGURE 2.2.
Box-plots of the Communication Index by Health Behavior Outcome



NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The graph shows box-plot figures of the communication index distribution separately for each of the health behavioral outcomes considered in the study. The left (right) plot in each panel indicates the distribution for the healthy (unhealthy) outcome. The horizontal line in the box indicates the median, the gray box the interquartile range and the whiskers the maximum and minimum values of the distributions, respectively.

In our econometric analysis we include a set of socioeconomic and demographic characteristics to adjust for heterogeneity across families which may distort the simple relationship between our communication measure and the health behavioral outcomes. Parent-child communication quality may be related to, for example, the parents' employment status, income and educational attainment which are all likely to affect children's subsequent health behavior. Table 2.1 reports means, differences in means and standard deviations for the healthy and unhealthy outcome, respectively, by health outcome category for a set of covariates; child gender and age, family income, whether the parents are smoking or are overweight, parent employment status and educational level, whether the children live with both parents, and characteristics of the region in which they live. The table reveals some interesting patterns; for example, smoking and abnormal weight prevalences are much higher among parents whose child is a smoker or has abnormal weight. Occupational status also matters; while drinking and smoking behavior seem to be more prevalent among children with full-time working parents, the opposite seems to be true for the likelihood that the child

is over- or underweight. The last rows of the table report group averages in the communication measure. Children who are smokers or have abnormal weight have, on average, significantly poorer communication compared to non-smokers and children with normal weight, while no such statistically significant difference exists for the prevalence of risky alcohol consumption.

TABLE 2.1.
Descriptive Sample Statistics

Variables	**Smoking**			**Weight**			**Alcohol**		
	No	Yes	Difference	No	Yes	Difference	No	Yes	Difference
Mother unhealthy	0.280	0.457	-0.178***	0.435	0.504	-0.069***	–	–	–
	(0.007)	(0.017)	(0.017)	(0.008)	(0.014)	(0.016)	–	–	–
Father unhealthy	0.359	0.505	-0.146***	0.410	0.495	-0.084***	–	–	–
	(0.008)	(0.017)	(0.018)	(0.008)	(0.014)	(0.016)	–	–	–
Age	13.476	15.444	-1.968***	13.828	13.822	0.006	13.552	15.919	-2.367***
	(0.030)	(0.046)	(0.067)	(0.032)	(0.055)	(0.064)	(0.028)	(0.048)	(0.079)
Male	0.507	0.485	0.022	0.505	0.503	0.001	0.477	0.702	-0.225***
	(0.008)	(0.017)	(0.018)	(0.008)	(0.014)	(0.016)	(0.008)	(0.019)	(0.022)
Unemployed	0.235	0.224	0.012	0.223	0.264	-0.041***	0.235	0.214	0.021
	(0.007)	(0.014)	(0.016)	(0.007)	(0.012)	(0.014)	(0.006)	(0.017)	(0.019)
Part-time employed	0.491	0.416	0.075***	0.479	0.476	0.003	0.482	0.460	0.022
	(0.008)	(0.016)	(0.018)	(0.008)	(0.014)	(0.016)	(0.008)	(0.021)	(0.022)
Full-time employed	0.273	0.360	-0.087***	0.300	0.261	0.037***	0.283	0.327	-0.043***
	(0.007)	(0.016)	(0.017)	(0.007)	(0.012)	(0.015)	(0.007)	(0.019)	(0.020)
No occupation	0.082	0.102	-0.021***	0.080	0.100	-0.020***	0.087	0.069	0.018
	(0.004)	(0.010)	(0.010)	(0.004)	(0.009)	(0.009)	(0.004)	(0.010)	(0.012)
Occupation	0.457	0.574	-0.115***	0.474	0.497	-0.023	0.474	0.519	-0.045***
	(0.008)	(0.017)	(0.018)	(0.008)	(0.014)	(0.016)	(0.008)	(0.021)	(0.022)
Graduate occupation	0.319	0.281	0.038***	0.319	0.292	0.026*	0.316	0.290	0.027
	(0.007)	(0.015)	(0.017)	(0.008)	(0.013)	(0.015)	(0.007)	(0.019)	(0.020)
Living in a rural area	0.492	0.505	-0.013	0.494	0.496	-0.002	0.481	0.603	-0.121***
	(0.008)	(0.017)	(0.018)	(0.008)	(0.014)	(0.016)	(0.008)	(0.020)	(0.022)
Immigrant	0.119	0.086	0.033***	0.112	0.117	-0.005	0.120	0.059	0.061***
	(0.005)	(0.009)	(0.012)	(0.005)	(0.009)	(0.010)	(0.005)	(0.010)	(0.014)
Number of children	2.378	2.885	-0.507***	2.488	2.416	0.071	2.347	3.382	-1.035***
	(0.027)	(0.073)	(0.067)	(0.030)	(0.051)	(0.060)	(0.026)	(0.094)	(0.079)
Living with both parents	0.814	0.709	0.105***	0.800	0.779	0.021	0.794	0.808	-0.014
	(0.006)	(0.015)	(0.015)	(0.007)	(0.017)	(0.013)	(0.006)	(0.016)	(0.018)
Living in West Germany	0.680	0.593	0.087***	0.664	0.665	-0.001	0.663	0.677	-0.014
	(0.007)	(0.016)	(0.017)	(0.008)	(0.013)	(0.015)	(0.007)	(0.019)	(0.021)
Disposable income under risk-of-poverty threshold	0.302	0.368	-0.066***	0.300	0.355	0.055	0.315	0.300	0.019
	(0.007)	(0.016)	(0.017)	(0.007)	(0.014)	(0.015)	(0.007)	(0.019)	(0.020)
Disposable income above risk-of-poverty threshold	0.513	0.498	0.014	0.521	0.480	0.041	0.507	0.540	-0.033*
	(0.008)	(0.017)	(0.018)	(0.008)	(0.014)	(0.016)	(0.008)	(0.021)	(0.022)
Disposable income above wealth-threshold	0.185	0.134	0.052***	0.179	0.166	0.014	0.178	0.163	0.015
	(0.006)	(0.011)	(0.014)	(0.006)	(0.011)	(0.012)	(0.006)	(0.015)	(0.017)
Communication	**0.620**	**0.591**	**0.028*** **	**0.617**	**0.607**	**0.010*** **	**0.614**	**0.620**	**-0.007**
	(0.002)	**(0.004)**	**(0.004)**	**(0.002)**	**(0.003)**	**(0.004)**	**(0.002)**	**(0.005)**	**(0.005)**

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports means (standard deviations) of covariates included in the empirical analysis by the healthy and unhealthy outcome and their difference for each of the different health behavior samples; smoking prevalence, weight problems and risky alcohol consumption. Statistics of the constructed communication measure are listed in boldface font at the bottom. Estimation of statistical significance is performed through a standard Wald test of equality of means. *, ** and *** denote significance at the 10, 5 and 1 percent levels. For detailed variable definitions, see Table A.2 in Appendix A.

2.2 Econometric framework

Table 2.1 showed that our constructed communication index is far from the only factor that varies across the health behavioral outcomes considered in this study. Parental and family-

specific characteristics also affect children's health behavior independently of the level of communication between parent and child. Even though systematic measurement error in the communication variable due to social desirability bias may not be an issue, correlations of parent characteristics and parent-child communication could still distort the effect of communication. To adjust for the influence of confounding factors in a continuous treatment framework, we apply a generalized version of the classical binary treatment propensity score matching approach (see e.g., Rosenbaum and Rubin, 1983), developed by Hirano and Imbens (2004), to estimate a dose-response function which allows us to evaluate the effect of communication across the whole distribution of the communication variable. Hence, in contrast to the classical binary treatment approach, we are able to estimate non-linear effects and analyze the causal relationship between parent-child communication and adolescent health behavior in more detail.

To briefly set the stage for our empirical approach we borrow the potential outcomes framework setup from Hirano and Imbens (2004). Consider our sample of $i = 1, ..., N$ children for which we observe one *realized* outcome, $Y_i = Y_i(C_i)$, from a set of *potential* outcomes, $Y_i(c)$, where $c \in \mathcal{C}$ is our index of parent-child communication. In the binary case we could define communication as either "good" or "bad", $\mathcal{C} = \{bad, good\}$, according to some assignment mechanism and apply the binary treatment propensity score matching framework. However, since our communication measure is an interval over $[c_{min}, c_{max}]$, a more general and informative approach would be to estimate the (average) marginal effect[7] of increasing communication between a parent and her child, say from c_t to c_{t+1}, on subsequent behavioral outcomes,

$$\mu^{c_{t+1},c_t} = E[Y_i(c_{t+1})] - E[Y_i(c_t)], \tag{2.2}$$

where $E[Y_i(c)]$ is the average *dose-response* function conditional on receiving communication level c and μ^{c_{t+1},c_t} is the treatment effect. Hirano and Imbens (2004) shows that this parameter can be consistently estimated under the assumption that, conditional on a set of covariates X, the level of communication received by each child is independent of the potential health behavior outcome for each value of the treatment, $Y(c) \perp C \mid X \; \forall \; c \in \mathcal{C}$. This

[7] As the communication interval is discretized in the estimation of the marginal treatment effect (see below) the estimated effect is, in practice, the *average* marginal effect *within* each communication bin. However, since we also estimate average treatment effect in a binary treatment setting we decided to exclude the "average" part from the continuous treatment framework terminology hereinafter to avoid confusion.

is a direct generalization of the original Rosenbaum and Rubin (1983) unconfoundedness assumption.

To adjust for confounding factors we estimate the *generalized* propensity score (GPS), $R_i = r(C_i, X_i)$, defined as the conditional density of received communication level given covariates X. The analogy to the binary treatment propensity score framework is that, rather than only balancing the covariates across children having a "good" or "bad" communication level with their parents, the corresponding balancing property for the GPS is that treatment assignment should be randomly distributed within each strata of $r(c, X)$. Hence, application of the GPS under the unconfoundedness assumption makes it possible to consistently estimate the dose-response function and, consequently, the marginal treatment effects over the entire support of the parent-child communication index.

In practice, the covariate-adjusted dose-response function is estimated in two steps. We first estimate the conditional expectation of the outcome of interest as a function of the GPS and the realized level of communication. Next, the estimated parameters from this model are used to estimate the conditional expectation evaluated at each communication level separately. We specify a flexible polynomial and estimate the parameters by ordinary least squares. The communication measure is discretized into ten categories defined by the deciles of its distribution, i.e., $\mathcal{C} = \{c_{q1}, c_{q2}, ..., c_{q9}, ..., , c_{q10}\}$, where $c_{q1} < p_c(10) \leq c_{q2} < p_c(20) ... \leq c_{q9} < p_c(90) \leq c_{q10}$.

To estimate the GPS we first apply a standard probit estimated by maximum likelihood,

$$Pr(c = C_i|X_i) = \phi(\alpha_0 + X_i'\alpha_1)^{-1}, \tag{2.3}$$

and then predict R_i using the estimated parameters from this equation. For the dose-response function we first estimate the quadratic function,

$$E[Y_i|C_i, R_i] = \beta_0 + \beta_1 C_i + \beta_2 C_i^2 + \beta_3 R_i + \beta_4 R_i^2 + \beta_5 (C_i \times R_i), \tag{2.4}$$

and then use the estimated parameters from this model to estimate the dose response func-

tion evaluated at the specific communication level, c, by plugging in the predicted GPS,

$$\widehat{E[Y(c)]} = \hat{\beta}_0 + \hat{\beta}_1 c + \hat{\beta}_2 c^2 + \hat{\beta}_3 \hat{r}(c, X_i) + \hat{\beta}_4 \hat{r}(c, X_i)^2 + \hat{\beta}_5 (c \times \hat{r}(c, X_i)). \tag{2.5}$$

Carrying out this procedure for each communication interval we are able estimate the dose-response function over the whole communication distribution and compute $\mu^{c_t, c_{t+1}}$ for each (c_t, c_{t+1}) pair.

Finally, to relate the GPS results to the binary treatment framework we also apply a standard nearest neighbor propensity score matching approach where we use different quantiles of the communication index distribution to assign children to good and bad parent-child communication levels. This corresponds approximately to estimating the marginal effect of communication for the same cutoffs in the continuous framework. That is, integrating over the relevant part of the marginal treatment effect distribution we can recover the average treatment effect for the specific assignment cutoff values. Denoting $T = \mathbf{1}(c > x)$ the assignment equation with cutoff x, the average treatment effect as ATE^{T_1, T_0} and the marginal treatment effect as MTE^{c_{t+1}, c_t}, we have,

$$ATE^{T_1, T_0} = \int_x^{\infty} MTE(c)dc - \int_{-\infty}^{x} MTE(c)dc. \tag{2.6}$$

We use the median and the first and fourth quartiles of the communication index as treatment cutoffs. Since the latter assignment scheme compares more extreme individuals with respect to the parent-child communication, we expect that this comparison would yield a stronger effect than the median cutoff comparison if the effect of communication is monotone in the outcomes we consider. Taken together, comparing the results from both approaches could yield further insights into the mechanics of the effect.

3 Results

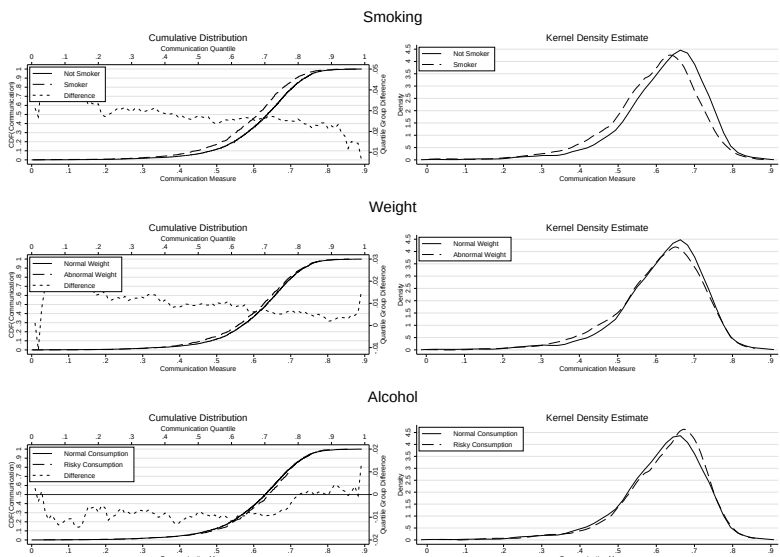
In this section we present the empirical results of the relation between parent-child communication level and the health behavioral outcomes we consider. We begin by presenting some initial descriptive evidence of the relationship before turning to the multivariate propensity

score matching framework.

3.1 Descriptive analysis

Figure 3.1 illustrates the marginal outcome distributions of our constructed communication index for each of the three behavioral categories we consider; tobacco smoking, body weight and alcohol consumption. The left and right panels plot the cumulative and probability density functions, respectively, where the latter are fitted using a Gaussian kernel smoothing function. Finally, the short dashed lines indicate the quantile-specific differences in the communication measure between the marginal distributions.

FIGURE 3.1.
Distribution of Communication Index by Health Behavioral Outcome



NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the cumulative (left panel) and kernel-estimated probability density (right panel) marginal distributions of the constructed communication index by the healthy and unhealthy outcome and their difference for each of the different health behavior samples; smoking prevalence, weight problems and risky alcohol consumption. The dotted line in the right panels indicate the quantile-specific difference in communication between the healthy and unhealthy behavioral outcome.

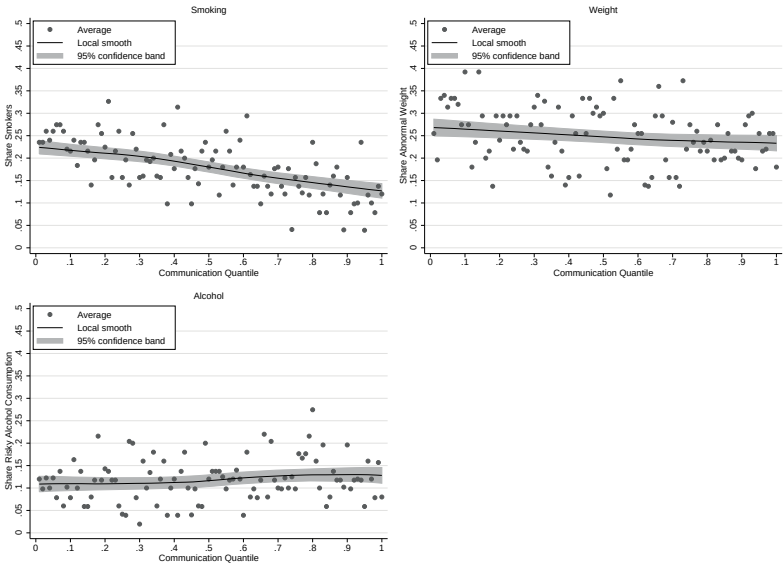
The figure shows that the healthy outcome (non-smoker, normal body weight and safe alcohol consumption) stochastically dominates the unhealthy outcomes (smoker, abnormal body weight and risky alcohol consumption) in the two first cases while the result for the alcohol category is ambiguous. In particular, the healthy outcome seem to dominate for alcohol consumption in the lower and middle part of the communication distribution but the

relationship becomes inverted in the upper part. The pattern is also visible in the kernel density functions where the healthy outcomes are shifted to the right for the smoking and weight categories but not for alcohol consumption. In general, differences in the communication measure are greatest in the lower part of the distributions; around .03 and .05 for the weight and smoking outcomes, corresponding to between .5 and 1 standard deviations, respectively. This descriptive evidence hence suggest that variation in adolescents' health behaviors arise primarily at the lower end of the communication distribution.

To further explore the relation between the communication measure and the behavioral outcomes, Figure 3.2 displays percentile-specific shares of sampled individuals with the unhealthy outcome for each behavioral category together with a locally smoothed regression trend. Again, the descriptive evidence tells us that a higher communication level is related to a lower prevalence of smokers and abnormal body weight, while the relation is less clear for risky alcohol consumption. In particular, the difference in smoking prevalence between the upper and lower part of the communication distribution is approximately 50%, while substantially lower for the two other behavioral categories (15% and 10% for the alcohol and weight outcomes, respectively).

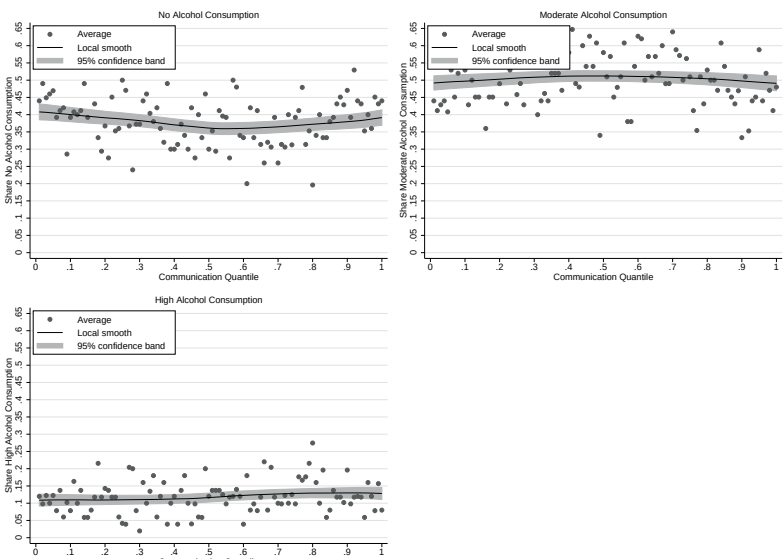
To provide further insight into the underlying mechanisms we further disaggregate the alcohol and weight outcomes into three and four categories, respectively. Specifically, alcohol consumption are divided into no, moderate and high alcohol consumption and body weight into two overweight (overweight and adipose) and two underweight (underweight and anorectic) categories. Figures 3.3–3.4 illustrate the corresponding percentile average shares for each of the new outcome categories. For alcohol consumption no obvious difference across the communication distribution of the new categories can be discerned. In contrast, we find an almost opposite relationship between the shares of over- or underweight children for the weight outcome. The probability of being overweight or adipose is strongly inversely related to the level of communication (with a 30% and 45% difference across the upper and lower support, respectively) while the opposite is true for underweight. Interestingly, these ambiguous results suggests that higher levels of communication between parents and children may not always be related to favorable health outcomes.

FIGURE 3.2.
Communication Index Quantile Averages by Health Behavioral Outcome



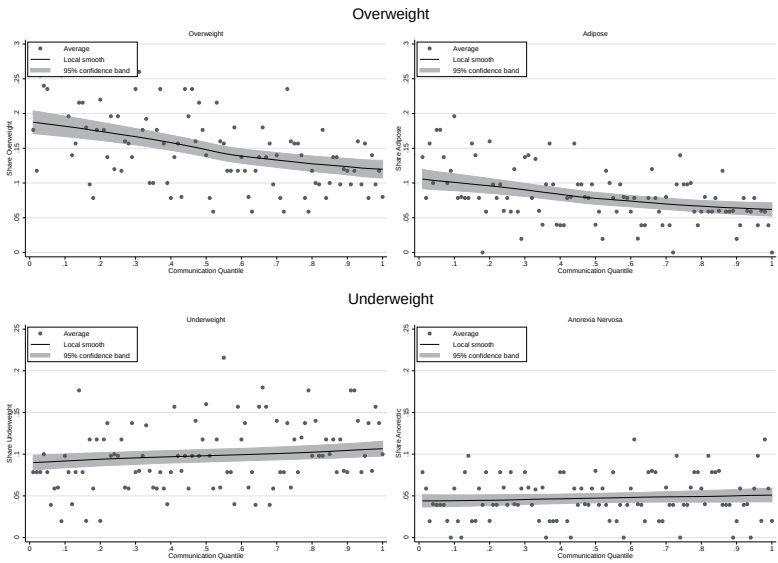
NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the communication quantile-average share of individuals with the unhealthy outcome for each of the different health behavior samples; smoking prevalence, weight problems and risky alcohol consumption. The solid line in each panel indicates the relationship estimated using a local polynomial regression smoother and the gray area its corresponding 95% confidence interval.

FIGURE 3.3.
Communication Index Quantile Averages by Health Behavioral Outcome: Alcohol Categories



NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the communication quantile-average share of individuals for an alternative categorization of the alcohol outcome. See the text for category definitions. The solid line in each panel indicates the relationship estimated using a local polynomial regression smoother and the gray area its corresponding 95% confidence interval.

FIGURE 3.4.
Communication Index Quantile Averages by Health Behavioral Outcome: Weight Categories



NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the communication quantile-average share of individuals for an alternative categorization of the weight outcome. See the text for category definitions. The solid line in each panel indicates the relationship estimated using a local polynomial regression smoother and the gray area its corresponding 95% confidence interval.

3.2 Multivariate analysis

In this section we use the propensity score methods described in Section 2.2 to adjust for bias in observed personal characteristics. We first report the results from the binary treatment case using different communication level quantile cutoffs as definition and subsequently report the results from the continuous dose-response empirical framework.

Table 3.1 reports results from the binary treatment propensity score matching model by outcome category for each of the two treatment cutoffs we consider; the median and the first and the last quartile of the communication distribution. We estimate the propensity score with maximum likelihood using a standard probit specification and the nearest neighbor matching algorithm to generate the groups.[8] As expected, most variables, such as employment and immigrant status and family income levels, are significantly related to the communication measure, making explicit the relationship between parent-child communication and socioeconomic factors.

[8]Specifically, we match children who are assigned the "good" communication level to a propensity score matched control group of children assigned to the "bad" communication level, implying that our estimated parameter can be interpreted as the treatment effect of the treated (ATET) estimand.

TABLE 3.1.
Results from Propensity Score Estimation by Outcome Category and Treatment Definition

	Communication (Median Threshold)			**Communication** (1^{st} vs 4^{th} Quartile Threshold)		
	Smoking	*Weight*	*Alcohol*	*Smoking*	*Weight*	*Alcohol*
Mother unhealthy	-0.074	-0.093*	–	-0.162*	-0.131*	–
	(0.040)	(0.036)	–	(0.060)	(0.052)	–
Father unhealthy	-0.108**	-0.064	–	-0.115*	-0.122*	–
	(0.040)	(0.037)	–	(0.060)	(0.054)	–
Age	0.021*	0.020*	0.020*	0.017	0.019	0.020
	(0.011)	(0.009)	(0.011)	(0.013)	(0.014)	(0.016)
Unemployed	-0.113*	-0.108*	-0.117*	-0.198**	-0.187**	-0.197**
	(0.054)	(0.046)	(0.056)	(0.071)	(0.068)	(0.072)
Full-time employed	0.013	-0.001	-0.004	-0.073	-0.108	-0.111
	(0.054)	(0.055)	(0.055)	(0.071)	(0.072)	(0.071)
No occupation	-0.233**	-0.246***	-0.252***	-0.401***	-0.422***	-0.424***
	(0.072)	(0.071)	(0.073)	(0.117)	(0.119)	(0.116)
Graduate occupation	0.079*	0.090**	0.104**	0.140**	0.139**	0.167***
	(0.043)	(0.041)	(0.041)	(0.062)	(0.061)	(0.060)
Immigrant	-0.605***	-0.607***	-0.607***	-0.854***	-0.834***	-0.837***
	(0.071)	(0.072)	(0.068)	(0.094)	(0.093)	(0.094)
Number of children	0.013	0.017	0.017	0.017	0.021	0.020
	(0.011)	(0.012)	(0.011)	(0.021)	(0.022)	(0.021)
Living in West	-0.043	-0.028	-0.030	-0.058	-0.047	-0.048
Germany	(0.046)	(0.045)	(0.042)	(0.067)	(0.066)	(0.067)
Living with both parents	0.108*	0.155***	0.170***	0.205**	0.225**	0.262***
	(0.055)	(0.054)	(0.054)	(0.075)	(0.078)	(0.077)
Disposable income under	-0.171***	-0.171***	-0.177***	-0.311***	-0.307***	-0.315***
risk-of-poverty threshold	(0.041)	(0.041)	(0.043)	(0.064)	(0.064)	(0.065)
Disposable income above	0.146**	0.148**	0.151**	0.222**	0.211**	0.214**
wealth threshold	(0.053)	(0.056)	(0.056)	(0.082)	(0.081)	(0.071)
Observations	4886	5074	5074	2432	2537	2537

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports parameter point estimates (standard errors) from the estimation of the matching propensity score using the probit model specification from equation (2.3) and the maximum likelihood estimator for each health behavior sample (smoking, weight and alcohol) and by treatment assignment cutoff (median and the first and fourth quartile) of the communication index distribution. Robust standard errors in parentheses are clustered at the individual level. *, ** and *** denote significance at the 10, 5 and 1 percent levels. For detailed variable definitions, see Table A.2 in Appendix A.

Table 3.2 reports the covariate balancing results from matching on the smoking prevalence outcome by treatment cutoff (matching results for the two other outcomes are listed in Tables A.3–A.4 in Appendix A). The second column in the table specify whether the sample considered is the unmatched or matched sample. For each treatment cutoff, the first two columns reports the conditional means given the assigned communication level, and the last two columns report the percent bias reduction between the unmatched and matched sample and the p-value from a test of the difference between the means, respectively. As can be seen from the table, the matching algorithm is successful in balancing the covariates across the groups and the test for the equality of means cannot be rejected for any of the variables included. Similar results are obtained for the two other behavioral outcomes.

TABLE 3.2.
Covariate Balancing Results from Propensity Score Matching: Smoking Outcome

		Communication (Median Threshold)				Communication (1st vs 4th Quartile Threshold)			
		$E[X\|c=C]$		*SB red.*		$E[X\|c=C]$		*SB red.*	
	Sample	*Good*	*Bad*	*in %*	*p-value*	*Good*	*Bad*	*in %*	*p-value*
Mother unhealthy	U	0.275	0.327		0.000	0.251	0.341		0.000
	M	0.275	0.270	90.6	0.701	0.251	0.250	99.1	0.963
Father unhealthy	U	0.344	0.426		0.000	0.346	0.460		0.000
	M	0.344	0.339	93.5	0.696	0.346	0.339	93.5	0.701
Age	U	13.904	13.745		0.005	13.903	13.768		0.101
	M	13.904	13.913	94.6	0.879	13.903	13.939	73.2	0.659
Unemployed	U	0.198	0.265		0.000	0.182	0.291		0.000
	M	0.198	0.185	79.7	0.232	0.182	0.181	99.3	0.958
Full-time employed full	U	0.303	0.271		0.014	0.304	0.282		0.221
	M	0.303	0.300	92.3	0.852	0.304	0.317	45.8	0.512
No occupation	U	0.050	0.119		0.000	0.040	0.155		0.000
	M	0.050	0.047	94.7	0.551	0.040	0.040	100.0	1.000
Graduate occupation	U	0.350	0.279		0.000	0.376	0.260		0.000
	M	0.350	0.334	77.7	0.241	0.376	0.353	80.2	0.239
Immigrant	U	0.058	0.168		0.000	0.052	0.237		0.000
	M	0.058	0.057	98.9	0.854	0.052	0.040	93.8	0.176
Number of children	U	2.498	2.478		0.691	2.528	2.522		0.936
	M	2.498	2.463	-70.1	0.491	2.528	2.617	-1356.9	0.223
Living in West	U	0.649	0.684		0.010	0.651	0.691		0.040
Germany	M	0.649	0.643	82.5	0.655	0.651	0.703	-31.4	0.006
Living with both parents	U	0.832	0.800		0.004	0.854	0.798		0.000
	M	0.832	0.855	26.0	0.023	0.854	0.869	74.0	0.292
Disposable income under	U	0.250	0.367		0.000	0.224	0.421		0.000
risk-of-poverty threshold	M	0.250	0.260	91.9	0.452	0.224	0.243	90.4	0.272
Disposable income above	U	0.213	0.140		0.000	0.227	0.115		0.000
wealth threshold	M	0.213	0.188	65.3	0.027	0.227	0.213	87.5	0.406
Observations		4860				2418			

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports balancing results of included covariates before and after propensity score matching (rows U and M) for the smoking behavioral sample by treatment status. Treatment status ("Good","Bad") is determined by the respective treatment assignment cutoff of the communication index distribution (median and the first and fourth quartile, respectively). The third and fourth columns of each cutoff category indicates the percentage reduction in the difference of the means between the unmatched and matched samples and the p-value from a standard Wald test of difference in means across the treatment categories, respectively. For detailed variable definitions, see Table A.2 in Appendix A.

Given the successful balancing of the covariates we now move on to present the results of the effect of communication on the behavioral outcomes. The upper and lower panel of Table 3.3 report the results for the median and the first and the last quartile treatment cut-offs, respectively. Once again, we present the results for both the unmatched and matched samples, indicated in column two, followed by the estimated conditional means for each of the two potential outcomes and their difference, the treatment effect. The last two columns of the table report the standard error and significance level of the effect.

First, it is interesting to note that matching attenuates the effect of communication for both the alcohol and the weight outcomes while, in contrast, accentuates the effect on smoking prevalence. The latter is highly significant while the effect of communication on alcohol seem to be completely driven by the covariates and is close to zero after the matching. The effect on the weight outcome drops and becomes insignificant after covariate adjustment. However, this result seem to be primarily driven by reduced statistical precision.

The magnitude of the effects are substantial for the weight and, in particular, the smoking outcomes. The effect for the median cutoff implies a change in the prevalence of smoking and abnormal weight of 35% $\left({}^{.075}/_{.218}\right)$ and 12% $\left({}^{.031}/_{.263}\right)$, respectively. This difference increases to 48% and 14% when comparing the two more extreme groups in the first and fourth quartile of the communication index distribution. The difference in the prevalence of risky alcohol consumption is close to zero for both cutoffs, indicating no important effect of communication in this dimension.

TABLE 3.3.
Estimated Average Treatment Effect of the Treated by Outcome and Treatment Definition

Outcome	*Sample*	$E[Y(G)]$	$E[Y(B)]$	$E[Y(G) - E[Y(B)]$	*Std. Err.*	*p-value*
Panel A: Treatment Definition – Median Threshold						
Smoking	U	0.144	0.209	-0.065	0.011***	<0.001
	M	0.144	0.218	-0.075	0.019***	<0.001
Weight	U	0.231	0.268	-0.036	0.012***	0.003
	M	0.231	0.263	-0.031	0.019	0.110
Alcohol	U	0.127	0.109	0.019	0.009**	0.038
	M	0.127	0.116	0.012	0.019	0.542
Panel B: Treatment Definition – 1^{st} vs 4^{th} Quartile Threshold						
Smoking	U	0.121	0.229	-0.108	0.015***	<0.001
	M	0.121	0.233	-0.112	0.027***	<0.001
Weight	U	0.232	0.278	-0.046	0.017***	0.008
	M	0.232	0.271	-0.039	0.028	0.153
Alcohol	U	0.135	0.108	0.028	0.013**	0.033
	M	0.135	0.134	0.002	0.024	0.944

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports the estimated conditional means given the treatment status ("Good","Bad") and their difference (the average treatment effect) for (U)nmatched and propensity score (M)atched samples for each health behavior outcome; smoking prevalence, weight problems and risky alcohol consumption. Treatment status ("Good","Bad") is determined by the respective treatment assignment cutoff of the communication index distribution (median and the first and fourth quartile, respectively) and shown in panels A and B of the table, respectively. The two last columns indicate the standard errors of the treatment effect and the respective *p*-value of a standard Wald test of equality of the conditional means. *, ** and *** denote significance at the 10, 5 and 1 percent levels.

As the results of the weight outcome were inconclusive we ran additional analyses for the over- and underweight categories separately. Results from this exercise are reported in Table 3.4 and largely confirms the earlier pattern from Figure 3.4. In particular, the effect of communication on the probability that a child is overweight is strongly negative and statistically significant, while the results for underweight go in the opposite direction. The former estimate implies approximately a 25% increased risk of overweight if the child had a poor, rather than a good, communication with their parent. The reversed relationship between communication and underweight is curious but could reflect a situation in which, for example, overly worried parents induce unhealthy dietary stress in their children, as they may consider underweight less of a health risk than overweight.

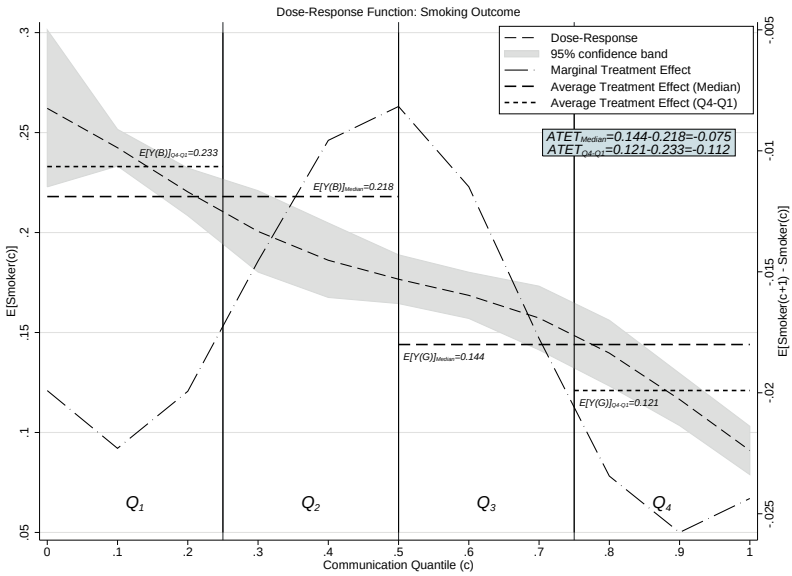
TABLE 3.4.
Estimated Average Treatment Effect of the Treated for Subcategories of the Weight Outcome

Outcome	*Sample*	$E[Y(G)]$	$E[Y(B)]$	$E[Y(G) - E[Y(B)]$	*Std. Err.*	*p-value*
Treatment: Median Threshold						
Overweight	U	0.122	0.181	-0.058	0.010***	<0.001
	M	0.122	0.163	-0.041	0.018**	0.024
Underweight	U	0.109	0.087	0.022	0.008***	0.008
	M	0.109	0.095	0.015	0.015	0.342
Treatment: 1^{st} vs 4^{th} Quartile Threshold						
Overweight	U	0.115	0.196	-0.081	0.014***	<0.001
	M	0.115	0.160	-0.045	0.026*	0.082
Underweight	U	0.117	0.081	0.035	0.012***	0.003
	M	0.117	0.085	0.032	0.020	0.107

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports the estimated conditional means given the treatment status ("Good","Bad") and their difference (the average treatment effect) for (U)nmatched and propensity score (M)atched samples for subcategories of the weight behavioral outcome. Treatment status ("Good","Bad") is determined by the respective treatment assignment cutoff of the communication index distribution (median and the first and fourth quartile, respectively) and shown in panels A and B of the table, respectively. The two last columns indicate the standard errors of the treatment effect and the respective p-value of a standard Wald test of equality of the conditional means. *, ** and *** denote significance at the 10, 5 and 1 percent levels.

We now proceed with analyzing the dose-response relationship between our communication index and the behavioral outcomes using the continuous treatment framework. To briefly explain how the results from the binary and continuous treatment approaches are related, Figure 3.5 combine the binary treatment effect results from Table 3.3 and the estimated dose-response function for the smoking outcome. The long dashed line indicates the dose-response function for each the treatment level (i.e., communication quantile) and the gray area around the line is a 95% confidence band of this estimate. The dot-dashed line, scaled by the right y-axis, shows the marginal treatment effect of increasing communication from c to $c + 1$ (i.e., the derivative of the dose-response function). Finally, the horizontal lines indicate the conditional means for the two separate treatment cutoff definitions in the binary treatment model, with their corresponding differences, the average treatment effects, calculated in the small upper right text box in the figure. As can be seen, the conditional means are weighted averages of the dose-response relationship and the average treatment effects are weighted averages of the marginal treatment effects across the relevant parts of the communication distribution. Hence, the additional information provided by the continuous treatment framework allows us to analyze heterogeneity and non-linearities in the effect of communication more in detail.

FIGURE 3.5.
Detailed analysis of the Effects of Communication on Smoking Behavior



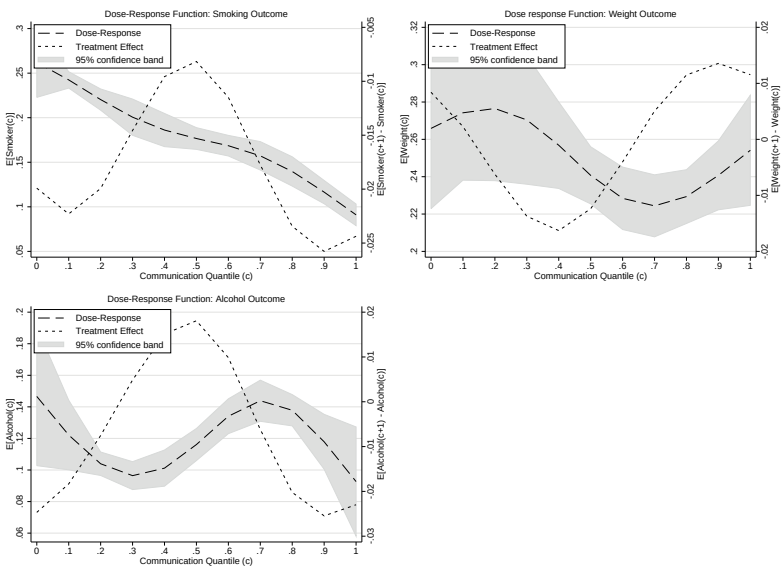
NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the combined results from applying the nearest neighbor binary propensity matching and continuous treatment generalized propensity score estimation methodology suggested by Hirano and Imbens (2004) for the smoking behavioral outcome. See Section 2.2 for estimation details. The long dashed line indicates the dose-response function conditional on the communication quantile together with a 95% confidence interval. The short dashed line shows the corresponding estimated marginal treatment effect conditional on the communication quantile, defined as the difference in the estimated dose-response between treatment level $c+1$ and c. The horizontal lines show the corresponding conditional means as reported in Table 3.3 for the respective treatment assignment cutoff of the communication index distribution (median and the first and fourth quartile, respectively).

Figure 3.6 show the dose-response function and the associated marginal treatment effects for each health behavior category separately. If the effect of parent-child communication is monotonously reducing unhealthy behavior, the latter should always be below zero. However, as we can see from the figure, this is only the case for the smoking outcome. The prevalence of smoking, conditional on the set of covariates, decreases by as much as 70% $\left(^{.175}/_{.263}\right)$ between the lower and the upper support of the communication distribution. This is a remarkably profound effect, underscoring the potential importance of the parent's influence on children's behavior even when family social background has been accounted for.

Furthermore, the estimated non-linear relationships between parent-child communication and prevalence of risky alcohol consumption and abnormal weight status in the other two panels of the figure improves the inference derived from the binary treatment results. The share of children with abnormal weight is generally higher in the lower part of the communication distribution, but increases at very high communication levels. However, the difference in prevalence across the communication is never statistically significant, as can

be seen from the wide confidence bands around the estimated dose-response parameters. A similar, but more precisely estimated, pattern is discernible for the alcohol category, in which risky alcohol consumption is most prevalent in the first and in the third quartile of the communication distribution. One explanation for this non-linear pattern could be that, while most parents would consider smoking initiation of their children something unambiguously negative, the level of alcohol consumption may be more related to the level of trust that exist between parents and their children. Parents who trust their children, due to, for example, a well-functioning communication channel, may be more liberal in their stance on alcohol consumption, leaving this choice to be made more independently by the latter.

FIGURE 3.6.
Dose-Response Functions by Health Behavioral Outcome

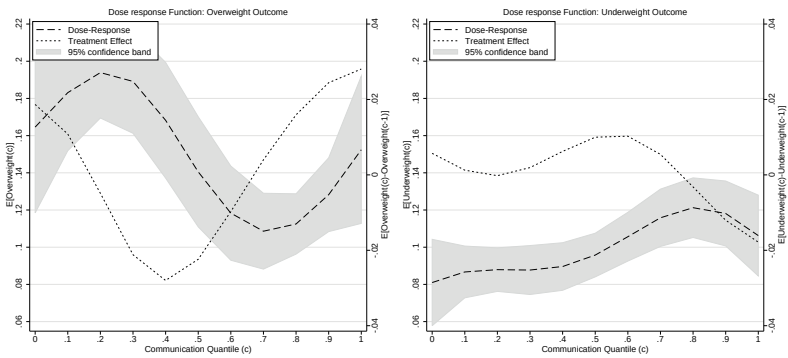


NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the results from applying the continuous treatment generalized propensity score estimation methodology suggested by Hirano and Imbens (2004) for each health behavior outcome; smoking prevalence, weight problems and risky alcohol consumption. See Section 2.2 for estimation details. The long dashed line indicates the dose-response function conditional on the communication quantile together with a 95% confidence interval. The short dashed line shows the corresponding estimated marginal treatment effect conditional on the communication quantile, defined as the difference in the estimated dose-response between treatment level $c+1$ and c.

Finally, as in the binary treatment analysis we estimated the dose-response functions for the under- and overweight categories separately due to their counter-acting results. These results are reported in Figure 3.7 and, in all relevant aspects, supports the previous findings. Children with low communication levels are more prone to be overweight while the relationship is reversed for underweight. We conclude that the evidence on the impact of the

quality of communication between parents and their children on health behavior seem to depend crucially on the behavioral outcome in question. These findings further stresses the complexity of the relationship between socioeconomic status and disparities in health.

FIGURE 3.7.
Dose-Response Functions for Subcategories of the Weight Outcome



NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The figure depicts the results from applying the continuous treatment generalized propensity score estimation methodology suggested by Hirano and Imbens (2004) for subcategories of the weight behavioral outcome. See Section 2.2 for estimation details. The long dashed line indicates the dose-response function conditional on the communication quantile together with a 95% confidence interval. The short dashed line shows the corresponding estimated marginal treatment effect conditional on the communication quantile, defined as the difference in the estimated dose-response between treatment level $c+1$ and c.

4 Summary and Concluding Remarks

This paper empirically analyzes how the degree of communication between parents and their children may impact the latter's subsequent health behaviors. This intuitively important mechanism have hitherto been largely neglected as a potential explanation for the large observed variation in child and adolescent health and its relation to family socioeconomic factors in many countries. To this end we use data from a large and nationally representative German survey on child health, conducted between 2003 and 2006, including rich information on the children's physical and mental health status as well as socioeconomic characteristics. To reduce the risk of social desirability bias in reporting we construct a communication index based on the correspondence of a set of statements about the child's well-being asked to both the surveyed children and their accompanying parent. We use the level of correspondence in the answers to the statements as a measure of the degree to which the parents know their children, which we interpret as a proxy of the quality of parent-child communication. We link our communication index to a set of health behavioral outcomes reported

in the data (smoke tobacco, have abnormal body weight and report a risky level of alcohol consumption) and relate our communication measure to the propensity of engaging in these unhealthy activities. Furthermore, to adjust for confounding factors we apply a propensity score matching method generalized to the continuous treatment context to estimate flexible dose-response functions of the effect of communication.

Our empirical results show that children who have a well-developed communication channel to their parents run a dramatically lower probability of smoking tobacco. Between the lower and the upper support of the constructed communication measure, the estimated difference in smoking prevalence is about 70%. Furthermore, we find an inverse relationship between parent-child communication and the probability of child overweight while the pattern is reversed for the risk of being underweight. With respect to risky alcohol consumption, we find no impact from communication once covariates adjustments were made. Hence, one important conclusion we draw from our results is that the degree of parent-child communication may indeed be important for adolescent's life style choices, but it seem to depend crucially on the type of health behavior considered.

Why are some children in good health while others are in poor health? The determinants and consequences of health and well-being among children is a topic that has gathered an impressive body of research in recent years. Many policy-makers also are of the opinion that improving child health is one of the most important future challenges due to its potentially long-lasting effects on aggregate health, productivity and, not the least, socioeconomic equality. Focusing on child health is different from actions directed towards improving adult health because outside factors are likely to play a much greater role in shaping the, potentially life-lasting, outcomes of the latter. Factors such as family background, peers and in utero and early life conditions have been reported to play important roles in determining, not only health outcomes, but also social status, cognitive and non-cognitive skills and general life satisfaction, among other things. Hence, focusing on child health have the potential of generating substantial welfare gains for the society if early life health concerns are tackled and prevented before they become irreversible.

In conclusion, previous research seeking to understand the causal link between a child's social background and later health outcomes have often focused directly on the effect of

socioeconomic status. This has sometimes led to contradicting empirical results and one reason such inconsistencies might occur is due to the lack of knowledge of the mediating mechanisms which forms the causal link between these factors. Our findings support this notion by finding evidence that parent-child communication may independently affect child health, irrespective of a parent's socioeconomic status, while simultaneously being strongly linked to the latter. Related research, such as National Scientific Council on the Developing Child (2004), arrive at a similar conclusion, reporting that the impact of relationships on all aspects of a child's development even shape brain circuits and lay the foundation for later developmental outcomes. Taken together, this, and our, scientific evidence suggest that interventions designed to improve interactions and to foster reciprocal interpersonal knowledge between parent and child, such as parental counseling or more generous child care and parental leave policies, may prove to be of substantial long-term value, both for the individual child and to the society.

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Appendix A Tables and Figures

TABLE A.1.
Interview Statements Used to Construct the Communication Index

Physical Well-Being	**Family**
In the past weeks the child...	In the past weeks the child...
felt sick.	got on well with parents.
had a headache or a stomachache.	felt comfortable at home.
felt tired or worse for wear.	had a great dispute with the parents.
had power and stamina.	felt patronized from the parents.
Psychological Well-Being	**Friends**
In the past weeks the child...	In the past weeks the child...
laughed a lot and had fun.	spent time with friends.
had no inclination to do sth.	obtained attention and acceptance from friends.
felt lonely.	was on good terms with friends.
felt anxious and insecure.	felt left out and different than the friends.
Self-Esteem	**School**
In the past weeks the child...	In the past weeks the child...
was proud of her-/himself.	managed to do the homework well.
felt well and comfortable.	enjoyed the classes.
liked him-/herself.	had anxiety about the future.
had a lot of good ideas.	was afraid of bad grades.

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table lists the 24 statements used to construct the communication index in the study. The accompanying parent and the child are both asked to respond on a scale from one to four how much they agree with the specific statement (ranging from "do not agree" to "fully agree").

TABLE A.2.
Description of Included Variables

Variable	**Description**
Child characteristics	
Smoking	=1 if the child reports smoking; 0 otherwise.
Weight	=1 if the child is over- or underweight; 0 otherwise.
Alcohol Use	=1 if the child reports a risky alcohol consumption level; 0 otherwise.
Communication	Constructed communication measure based on questions from Table A.1 and constructed using the Mahalanobis distance method. Ranges from $[c_{min}, c_{max}]$.
Age	Age of the child in years.
Gender	=1 if the child is a boy; 0, otherwise.
Living with Both Parents	=1 if the child lives with both parents; 0 otherwise.
Immigrant	=1 if the the child was born in a different country and at least one parent or if both parents are immigrants; 0 otherwise.
Living in West Germany	=1 if the child lives in West Germany, 0 otherwise.
Parent characteristics	
Smoking	=1 if the parents reports smoking; 0 otherwise.
Weight	=1 if the parent is over- or underweight; 0 otherwise.
Unemployed	=1 if the mother is unemployed; 0 otherwise.
Part-Time Employed (*Ref*)	=1 if the mother is part-time-employed; 0 otherwise.
Full-Time Employed	=1 if the mother is full-time-employed; 0 otherwise.
No Occupation	=1 if the mother does not have an occupation; 0 otherwise.
Undergraduate Occupation (*Ref*)	=1 if the mother has an undergraduate occupation; 0 otherwise.
Graduate Occupation	=1 if the mother has an graduate occupation
Number of Children	Number of children living in the household.
Disposable income under risk-of-poverty threshold	=1 if the equivalent income is below the risk-of-poverty threshold; 0 otherwise.
Disposable income above risk-of-poverty threshold (*Ref*)	=1 if the equivalent income is above the risk-of-poverty threshold and below wealth threshold; 0 otherwise.
Disposable income above wealth threshold	=1 if the equivalent income is above the wealth threshold; 0 otherwise.

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. *Ref* refers to the reference group in the propensity score regressions reported in Table 3.2 and Tables A.3–A.4.

TABLE A.3.
Covariate Balancing Results from Propensity Score Matching: Weight Outcome

		Communication (Median Threshold)				**Communication** (1st vs 4th Quartile Threshold)			
		$E[X\|c = C]$		*SB red.*		$E[X\|c = C]$		*SB red.*	
	Sample	*Good*	*Bad*	*in %*	*p-value*	*Good*	*Bad*	*in %*	*p-value*
Mother unhealthy	U	0.428	0.475		0.001	0.430	0.494		0.001
	M	0.428	0.405	50.4	0.093	0.430	0.408	65.6	0.260
Father unhealthy	U	0.406	0.457		0.000	0.388	0.480		0.000
	M	0.406	0.402	93.8	0.819	0.388	0.370	79.2	0.326
Age	U	13.905	13.747		0.004	13.903	13.761		0.075
	M	13.905	13.883	86.1	0.688	13.903	14.039	4.6	0.092
Unemployed	U	0.199	0.268		0.000	0.185	0.293		0.000
	M	0.199	0.181	74.1	0.107	0.185	0.222	65.5	0.021
Full-time employed	U	0.302	0.275		0.033	0.301	0.288		0.467
	M	0.302	0.297	79.7	0.668	0.301	0.270	-133.4	0.087
No occupation	U	0.050	0.120		0.000	0.040	0.155		0.000
	M	0.050	0.042	87.5	0.141	0.040	0.044	96.6	0.622
Graduate occupation	U	0.348	0.276		0.000	0.374	0.259		0.000
	M	0.348	0.328	71.4	0.116	0.374	0.310	44.1	0.001
Immigrant	U	0.058	0.168		0.000	0.052	0.232		0.000
	M	0.058	0.055	97.1	0.626	0.052	0.046	96.5	0.462
Number of children	U	2.487	2.451		0.487	2.508	2.489		0.802
	M	2.487	2.429	-62.6	0.245	2.508	2.387	-550.8	0.099
Living in West	U	0.649	0.680		0.022	0.652	0.688		0.054
Germany	M	0.649	0.667	40.3	0.173	0.652	0.686	3.7	0.063
Living with both parents	U	0.818	0.772		0.000	0.836	0.769		0.000
	M	0.818	0.834	62.9	0.111	0.836	0.851	77.7	0.299
Disposable income under	U	0.255	0.373		0.000	0.228	0.424		0.000
risk-of-poverty threshold	M	0.255	0.264	91.7	0.423	0.228	0.212	92.0	0.338
Disposable income above	U	0.212	0.140		0.000	0.227	0.118		0.000
wealth threshold	M	0.212	0.177	51.4	0.002	0.227	0.221	94.9	0.739
Observations		5074				2537			

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports balancing results of included covariates before and after propensity score matching (rows U and M) for the weight behavior sample by treatment status. Treatment status ("Good", "Bad") is determined by the respective treatment assignment cutoff of the communication index distribution (median and the first and fourth quartile, respectively). The third and fourth columns of each cutoff category indicates the percentage reduction in the difference of the means between the unmatched and matched samples and the p-value from a standard Wald test of difference in means across the treatment categories, respectively. For detailed variable definitions, see Table A.2 in Appendix A.

TABLE A.4.
Covariate Balancing Results from Propensity Score Matching: Alcohol Outcome

		Communication (Median Threshold)				**Communication** (1st vs 4th Quartile Threshold)			
		$E[X\|c = C]$		*SB red.*		$E[X\|c = C]$		*SB red.*	
	Sample	*Good*	*Bad*	*in %*	*p-value*	*Good*	*Bad*	*in %*	*p-value*
Age	U	13.910	13.752		0.004	13.908	13.767		0.077
	M	13.910	13.929	88.5	0.743	13.908	13.953	68.2	0.573
Unemployed	U	0.198	0.266		0.000	0.184	0.289		0.000
	M	0.198	0.187	83.5	0.318	0.184	0.197	87.9	0.418
Full-time employed	U	0.301	0.276		0.051	0.301	0.290		0.560
	M	0.301	0.299	93.6	0.902	0.301	0.286	-41.9	0.407
No occupation	U	0.050	0.119		0.000	0.040	0.153		0.000
	M	0.050	0.042	87.8	0.159	0.040	0.043	97.9	0.765
Graduate occupation	U	0.349	0.277		0.000	0.374	0.260		0.000
	M	0.349	0.334	78.7	0.247	0.374	0.323	55.1	0.007
Immigrant	U	0.058	0.167		0.000	0.052	0.230		0.000
	M	0.058	0.058	99.6	0.952	0.052	0.045	96	0.406
Number of children	U	2.490	2.449		0.429	2.514	2.484		0.689
	M	2.490	2.420	-70.5	0.168	2.514	2.442	-141.8	0.314
Living in West	U	0.650	0.679		0.030	0.652	0.686		0.069
Germany	M	0.650	0.640	64.2	0.444	0.652	0.636	53.7	0.406
Living with both parents	U	0.819	0.773		0.000	0.835	0.769		0.000
	M	0.819	0.840	56.7	0.056	0.835	0.869	50.0	0.019
Disposable income under	U	0.254	0.372		0.000	0.229	0.422		0.000
risk-of-poverty threshold	M	0.254	0.266	89.9	0.335	0.229	0.233	97.5	0.777
Disposable income above	U	0.213	0.140		0.000	0.226	0.118		0.000
wealth threshold	M	0.213	0.194	74.0	0.093	0.226	0.213	87.6	0.414
Observations		5034				2519			

NOTE.— Data source: KiGGS study conducted by the Robert Koch Institute. The table reports balancing results of included covariates before and after propensity score matching (rows U and M) for the alcohol consumption behavior sample by treatment status. Treatment status ("Good", "Bad") is determined by the respective treatment assignment cutoff of the communication index distribution (median and the first and fourth quartile, respectively). The third and fourth columns of each cutoff category indicates the percentage reduction in the difference of the means between the unmatched and matched samples and the p-value from a standard Wald test of difference in means across the treatment categories, respectively. For detailed variable definitions, see Table A.2 in Appendix A.