The Effect of Medical Treatment of Attention Deficit Hyperactivity Disorder (ADHD) on Foster Care Caseloads: Evidence from Danish Registry Data

Peter Fallesen[1,2] and Christopher Wildeman[2,3]

Abstract

Since the early 2000s, foster care caseloads have decreased in many wealthy democracies, yet the causes of these declines remain, for the most part, a mystery. This article uses administrative data on all Danish municipalities (*N* = 277) and a 10% randomly drawn sample of all Danish children (*N* = 157,938) in the period from 1998 to 2010 to show that increasing medical treatment of attention deficit hyperactivity disorder (ADHD) accounts for a substantial share of the decrease in foster care caseloads. According to our estimates, the decline in foster care caseloads during this period would have been 45% smaller absent increases in medical treatment of ADHD. These findings are especially provocative in light of recent research showing ambiguous effects of medical treatment of ADHD. Future research should be attentive to how medical treatment aimed at addressing children's acute behavioral problems could also have a powerful effect on foster care caseloads.

Keywords

ADHD, administrative data, child welfare, children's behavioral problems, foster care

Toward the close of the twentieth century, several wealthy democracies experienced profound growth in foster care caseloads (e.g., Department of Health 2000; Swann and Sylvester 2006). In the United States, for instance, the number of caseloads increased from 276,000 in 1985 to 568,000 in 1999 (Swann and Sylvester 2006:309). Since the early 2000s, however, caseloads have decreased in countries such as Denmark and the United States (Cunningham and Finlay 2013; Fallesen, Emanuel, and Wildeman 2014; Wildeman and Emanuel 2014). Yet, the causes of these declines remain, for the most part, a mystery.

The logical starting point in understanding these declines is the predictors of foster care caseloads. Researchers have to date focused on two distinct types of factors that shape caseloads. First, they have identified a range of negative parenting behaviors—driven by a combination of poverty,

unemployment, drug use and abuse, poor mental health, homelessness, and single parenthood—that increase the risk of foster care placement for individual children and foster care caseloads (Barbell and Freundlich 2001; Cunningham and Finlay 2013; Paxson and Waldfogel 2002; for a review, see Wildeman and Waldfogel 2014). Second, they have focused on how social policies affect caseloads,

[1]The Swedish Institute for Social Research (SOFI), Stockholm University, Stockholm, Sweden
[2]Rockwool Foundation Research Unit, University of Copenhagen, Copenhagen C, Denmark
[3]Cornell University, Ithaca, NY, USA

Corresponding Author:
Peter Fallesen, Rockwool Foundation Research Unit, Sølvgade 10 2.tv, DK-1307 København K, Denmark.
E-mail: pf@rff.dk

finding that more generous adoption subsidies and welfare payments decrease caseloads while increases in imprisonment increase caseloads (Andersen and Wildeman 2014; Berger and Waldfogel 2004; Bitler, Gelbach, and Hoynes 2006; Buckles 2013; Paxson and Waldfogel 2003; Swann and Sylvester 2006; for a review, see Wildeman and Waldfogel 2014). However, because neither the micro-level nor the macro-level conditions discussed above shifted markedly during this period, these factors cannot fully account for the dramatic decline in caseloads that some countries have recently experienced.

In this article, we introduce a third possible cause of this decline: shifts in the share of children with extreme enough behavioral problems that parenting them is exceedingly difficult (Barbell and Freundlich 2001). Children entering foster care display far higher levels of attention deficit hyperactivity disorder (ADHD), oppositional defiant disorder, depression, mania, and posttraumatic stress disorder than do other children (McMillen et al. 2005). They are also more likely to score within the clinical range of the Child Behavior Checklist than are other children, with older children in foster care scoring the highest (Burns et al. 2004). Although the children who eventually end up in foster care disproportionately present symptoms of—and are diagnosed with—a range of serious behavioral and mental health problems, relatively little research has considered how shifts in the behavioral problems of children could affect foster care caseloads.

Based on the relative distrust of the medical treatment of "problem behaviors" by medical sociologists (e.g., Conrad 1975, 1992, 2005), this inattention is not surprising. It is also not surprising as there is now at least some evidence suggesting medical treatment of ADHD may not have the desired results. Two nonexperimental studies, for instance, find possible negative effects on learning and behavioral issues from ADHD treatment (Currie, Stabile, and Jones 2013; Government of Western Australia 2010)—exactly the opposite of the intended result. However, research from countries with markedly lower prescription rates of ADHD medication (such as Denmark) has found that medical treatment of ADHD significantly decreases not only family strain (Kvist, Nielsen, and Simonsen 2013; Schermerhorn et al. 2012) but also delinquency, the number of traffic accidents, and emergency room visits (Chang et al. 2014; Dalsgaard, Nielsen, and Simonsen 2013b). These findings suggest that increasing medical treatment of ADHD could lead to declines in foster care caseloads—provided the baseline treatment level is

quite low. If the baseline treatment level is high, there is a risk of overtreatment—where children without abnormal brain chemistry would receive stimulant medication—which in itself could cause increased hyperactivity and attention issues.

In this article, we contribute to the discussion of how children's behavioral problems affect foster care caseloads by using Danish registry data to test how medical treatment of ADHD affects foster care caseloads. In order to test the relationship, we use annual medical, child welfare, and population data on all Danish municipalities from 1998 to 2010 to examine whether the increased medical treatment of ADHD with prescription drugs like Ritalin led to declining caseloads in Denmark. Our results suggest that after taking observable municipality characteristics, year fixed effects, and municipality fixed effects into account, fully 45% of the decrease in Danish caseloads was attributable to increased use of ADHD medication. In comparison, in their seminal article on the causes of the increase in foster care caseloads in the United States, Swann and Sylvester (2006) found that the increase in female imprisonment accounted for 31% of the increase in caseloads between 1985 and 2000. To account for possible confounding driven by compositional changes in the child population, we also examine the effect of the rise in ADHD medication on children's individual-level risk of being in care. Here, we find a large individual-level response that strengthens our macro-level findings—even if it cannot completely assuage concerns about the ecological inference problem, unfortunately. To further test the robustness of the findings, we also run instrumental variable regressions. These corroborate our other findings, so for the sake of brevity we do not report them in detail.

Taken together, the results of our analysis suggest that medical treatment of ADHD has substantial effects on caseloads. Moreover, the results suggest that interventions that address children's acute behavioral problems may diminish caseloads dramatically. In so doing, they show that while parental behaviors and characteristics, welfare generosity, and the female imprisonment rate all shape foster care caseloads, future research should be more attentive to how medical treatment aimed at addressing children's acute behavioral problems could also have a powerful effect on foster care caseloads.

BACKGROUND

Foster Care in Denmark

The share of Danish children in foster care on any given day has been remarkably stable during the
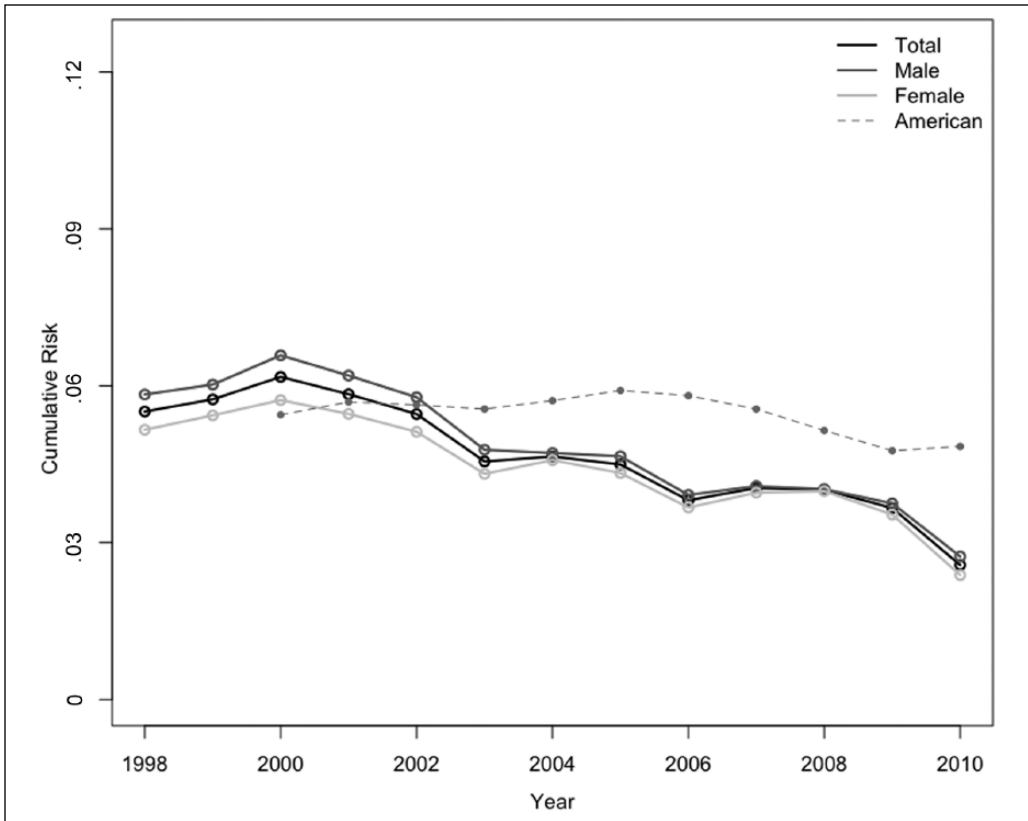
Figure 1. Cumulative Risk of Foster Care Placement for Danish Children Age 0–17, 1998–2010.
Source: Fallesen, Emanuel, and Wildeman (2014).

past 100 years at around 1% (Ebsen and Andersen 2010). The cumulative risk of entering foster care at any point during childhood has, however, decreased for Danish children since 2000 (Fallesen et al. 2014), indicating a decline in first admissions to care. Figure 1 shows changes in the cumulative risk of foster care placement for Danish children from 1998 until 2010 across ages 0 to 18. While the cumulative risk was .06 in 2000, by 2010, the cumulative risk had declined to roughly .03—a 50% decline in only a 10-year period, predominantly driven by a decrease in teenage admissions (Fallesen et al. 2014). The cumulative risk for boys decreased more than that for girls.

In Denmark, foster care is a social service program aimed at providing children with a substitute living arrangement if social services deem the children's parents unable to provide proper care or a child's parents no longer feel capable of providing proper care. Local municipalities manage foster care, with social workers and representatives of the municipal government having the final say in

whether or not to instigate a placement. The state provides funding as a specific grant to each municipality, and funding levels have remained constant for the period we consider (Andersen, Madsen, and Enemark 2013). Between 85% and 90% of Danish foster care placements are instigated with parental consent (Ebsen and Andersen 2010; although Hestbæk 1999 shows there is a grey area of voluntary placements that are de facto involuntary), and the risk of first entry is highest among teenagers, followed by infants (Fallesen et al. 2014). The use of voluntary placements and high share of first-timers among teenagers stand in stark contrast to the United States, where infants have by far the highest risk of first entry (Wildeman and Emanuel 2014) and where parental consent is considered relevant only when the parent requests the placement, a rare event.

As in other wealthy democracies, Danish children in foster care are more likely to come from single-parent families; their mothers are more likely to be on disability pension, welfare, or unemployment
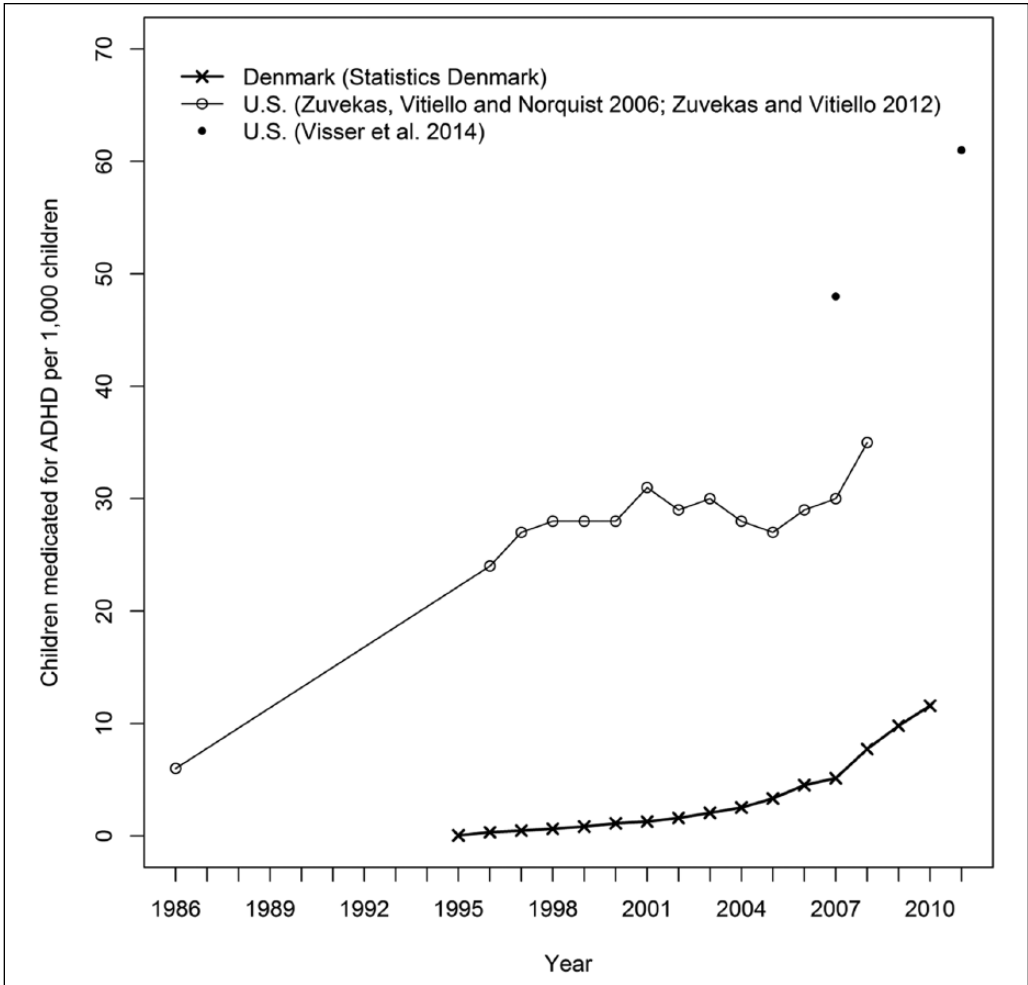
Figure 2. Number of Children Receiving Medical Treatment of ADHD, 1995–2011.
Source: Statistics Denmark; Visser et al. (2014); Zuvekas and Vitiello (2012); Zuvekas, Vitiello, and Norquist 2006.

benefits; and their parents are more likely to have been incarcerated at some point (Andersen and Wildeman 2014; Ejrnæs, Ejrnæs, and Frederiksen 2011). Danish children in foster care are also markedly more likely to suffer from a host of behavioral and mental health problems, including disorders such as ADHD, the diagnosing of which often preceded—and possibly precipitated—the child's eventual foster care placement (Egelund and Laustsen 2009).[1]

The Rise of Ritalin

ADHD is a psychiatric disorder of the neurodevelopmental kind associated with poorer executive functioning, arising in children prior to age 12. Hallmark symptoms are inattention, impulsivity,

and hyperactivity. Psychiatrists and pediatricians started to use the ADHD diagnosis in 1987, yet pediatricians have described similar conditions as far back as 1902, and stimulant treatment for symptoms consistent with what we would now call ADHD dates back to the 1930s (Centers for Disease Control and Prevention 2013).[2] Medical treatment of ADHD and earlier versions of the diagnosis, though dating back to the 1930s, has risen dramatically since the mid-1980s to late 1990s depending on country. Figure 2 shows the number of children in Denmark and the United States (per 1,000 children) who filled a prescription for Ritalin, Adderall (for the United States), or other medications used to treat ADHD.[3] The share of U.S. children receiving medical treatment for ADHD in 2007 was between
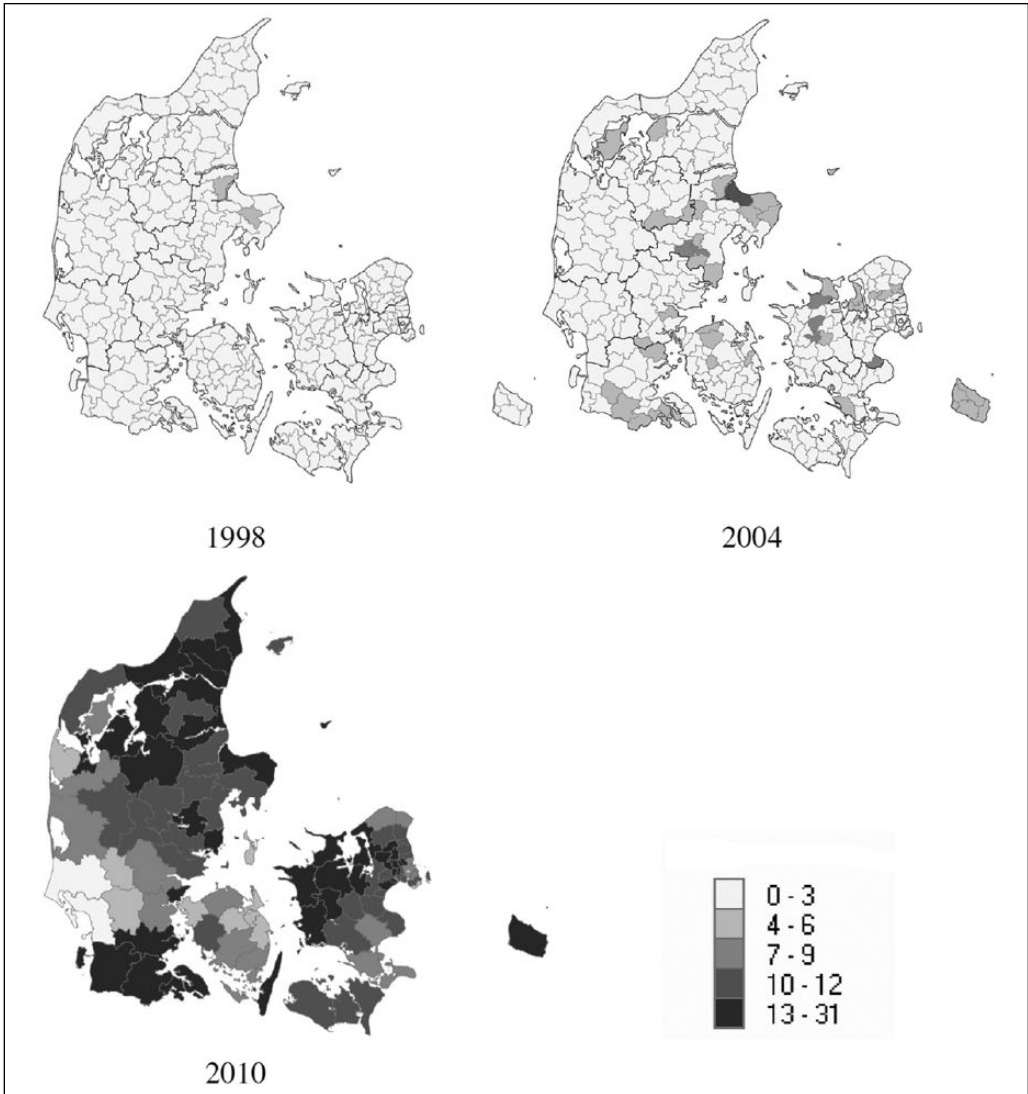
Figure 3. Municipal Variation in Number of Children Receiving Medical Treatment of ADHD per 1,000 Children Living in each Municipality.
Source: Statistics Denmark, Danish Registry of Medicinal Product Statistics, 1998-2010. Full annual population data for all Danish children ages 0 to 17.

30 (Zuvekas and Vitiello 2012; Zuvekas, Vitilelo, and Norquist 2006) and 48 (Visser et al. 2014) per 1,000. The Danish share was just above 5 per 1,000 in 2007. These massive differences are due partially to differences in diagnostic criteria, diagnostic practice, and the amount of evaluation necessary to receive medical treatment of ADHD, because Danish children go through a six-month specialist screening before receiving an ADHD diagnosis. The share of children receiving medication in

Denmark increased moderately until the mid-2000s, after which the rate increased much more rapidly. Children age 10 and older experienced the largest increase in Denmark, with small increases for very young children (Dalsgaard, Nielsen, and Simonsen 2013a). Overall, baseline treatment levels in Denmark are much lower than in the United States across our entire study period.

There is also substantial geographical variation in ADHD medication usage. Figure 3 shows the

share of children who filled a prescription for ADHD medication across Danish municipalities for the years 1998, 2004, and 2010. While the intensity maps mirror the overall rise in medication use, they also show substantial differences between municipalities. These differences were most pronounced in 2010, where some municipalities continued to have fewer than 3 per 1,000 children receiving medical treatment for ADHD, while others had up to 31 per 1,000 children receiving it. This is in line with the literature on geographical variation in the adoption of medical technologies (see Gelijns and Rosenberg 1994; Nattinger et al. 1992 for a general discussion and Bruckner et al. 2012; Dalsgaard, Nielsen, and Simonsen 2012 for discussion on geographical variation in use).

ADHD Treatment as a Protective Factor

Suffering from ADHD thus appears to be a possible contributing cause to foster care placement. Medical treatment of ADHD increased at the same time foster caseloads declined dramatically and appears to be designed to treat precisely the children who disproportionately enter foster care. Increasing medical treatment of ADHD in countries like Denmark, therefore, might cause fewer children to enter foster care, provided medical treatment of ADHD directly or indirectly improves behavior. Earlier studies of the effect of medical treatment of ADHD on behavior partly corroborate this hypothesis, as medical treatment of ADHD has been shown to cause children suffering from ADHD to have fewer emergency room visits and to commit fewer crimes (Dalsgaard et al. 2013b), do better in school (Keilow, Holm and Fallesen 2015; Scheffler et al. 2009), and (as adults) get into fewer traffic accidents (Chang et al. 2014), to name just three possible benefits.

Yet, despite some clear benefits of medical treatment of ADHD, other research shows possible harmful effects when treating a large proportion of the child population (Currie et al. 2013; Government of Western Australia 2010). In one especially provocative study, Currie et al. (2013) exploit a quasi-experiment that increased the share of a population that received ADHD medication and find that the increase is associated with lower educational attainment among boys and higher levels of emotional problems among girls when a large number of children in the population were already medicated for ADHD. On balance, therefore, it seems that the benefits of medical treatment of ADHD are most pronounced in a positive direction when very few children in the population are medicated. Beyond this initial point, the effects may even change course since treating too large a proportion of a child population would be the equivalent of giving stimulants to children who would respond to these stimulants not with greater focus but with less focus. As we speculate in more detail below, it might be that the United States is on the other side of such a tipping point compared to Denmark or that the United States may be treating the wrong part of the population.

Obstacles to Causal Inference

Although analyses of the effects of medical treatment of ADHD on children's behavioral outcomes provide suggestive evidence of a link between medical treatment of ADHD and foster care placement, there are a host of possible confounders that an analysis must account for to render a causal relationship likely. First, children whose families have low socioeconomic status, who were low-birth-weight babies, and who had mothers who smoked during pregnancy, for instance, are markedly more likely both to be diagnosed with ADHD and to be placed in foster care at some point (e.g. Ejrnæs et al. 2011; Langley et al. 2007; Swanson et al. 2007). Therefore, to convincingly render a causal link between medical treatment of ADHD and foster care caseloads probable, we would ideally have macro-level analyses (to show how population-level shifts in ADHD medication shape foster care caseloads) and micro-level analyses (to show that we fully adjust for individual-level factors shaping ADHD diagnosis and foster care placement).

Second, social services may be less inclined to place a child in foster care if the child is already receiving medical treatment for ADHD. In such a case, it would not be the treatment of behavioral issues that drove the decrease in foster care but the labeling effect of a diagnosis. Yet, research shows that treating ADHD with Ritalin or similar drugs may have substantial impact on child and family characteristics known to affect the risk of entering foster care (Chang et al. 2014; Dalsgaard et al. 2013b; Kvist et al. 2013; Schermerhorn et al. 2012), implying that not all of any detected effects should be due to labeling.

Third, if other confounding factors affected both foster care caseloads and the use of ADHD medication, this could lead to confounding bias. Denmark did not enact any policies during the study period that aimed at lowering foster care rates while increasing treatment of behavioral issues (Hestbæk 2011). Nor is there any evidence of any medical policies directly

Table 1. Descriptive Statistics for Danish Municipalities, 1998–2010.

Variable	M	SD
Foster care caseload per 1,000 children	26.214	12.694
ADHD medicated per 1,000 children	2.923	3.446
Age of children	8.543	.383
Non-Western immigrants/descendants	.031	.032
Working mother	.811	.051
Missing father	.017	.007
Sibship	1.837	.120
Household income in 10,000 DKK[a]	41.016	5.583
Unemployed	.016	.015
Welfare dependency	.143	.025
Female incarcerations per 1,000 females	.568	.419
Male incarcerations per 1,000 males	5.057	2.009
N		2,853

Note: ADHD = attention deficit hyperactivity disorder.
Source: Data obtained from Statistics Denmark's annual registers. N = 2,853.
[a]Calculated at the 2003 level. Source: Own calculations on data from Statistics Denmark.

affecting or causing the increase in ADHD medication rates (Dalsgaard et al. 2013a; Pottegård et al. 2013). In addition, health services and child welfare services receive their funding from different parts of both the municipal and the state budget, so informal substitution of funding from social services to health services is also not likely (see Christiansen 2002; Pedersen, Christiansen, and Bech 2005 for details on Danish Health Services). However, we cannot fully reject that other reforms or similar confounding factors may have affected both medication rates and foster care caseloads. Thus, we must be assured that controlling for observable and time-constant unobservable factors together with robustness tests can render such confounding improbable. We have, however, also run instrumental variable estimations (excluded in the interest of reserving space) that give us additional confidence in our estimates.

DATA AND METHODS

Foster Care Caseloads

All Danish municipalities have reported all instances of instigation or conclusion of a foster care case to Statistics Denmark since 1977. Because these data originate from administrative registers used in the processing of all cases and undergo a thorough control where Statistics Denmark validates new data annually against data from previous years before Statistics Denmark makes them available to researchers, the data had high validity. Thus, there were no sample selection or attrition issues because

the data included all children in foster care (Statistics Denmark 2013).

The dependent variable used was the logarithm of the annual foster care caseload (per 1,000) for each Danish municipality measured each year from 1998 to 2010.[4] We log-transformed foster care caseloads because the variable was highly skewed. However, all results were robust to using an untransformed version of the variable (results available upon request). We measured the foster care caseload as the number of children in foster care during the year per 1,000 children from age 0 to age 17 from a given municipality. Table 1 reports summary statistics for foster care caseloads as well as the explanatory variables discussed in the next subsection.

Measuring Medical Treatment of ADHD

We obtained data on prescribed drugs used to treat ADHD from the Danish medical database. All pharmacies have since 1994 reported all redeemed prescriptions to Statistics Denmark (see Johannesdottir et al. 2012 for data description). It was possible to link redeemed prescriptions to individuals through their social security numbers. Because customers or patients must supply their social security numbers in order to obtain their prescriptions, these data were highly reliable. In addition, the Danish Health and Medicine Authority oversees all Danish pharmacies, so we captured all redeemed prescriptions in our data. Through the population register, we could isolate all

prescriptions redeemed by or for children in each municipality. We measured the ADHD medication rate as the number of children per 1,000 who had redeemed at least one prescription for medicine used to treat ADHD. We did not include individuals who obtained a prescription but did not redeem it.

Other Explanatory Factors

In the macro-level portion of the analysis, we controlled for female and male incarceration rates, the share of the municipal population who were receiving welfare benefits, unemployment level, and average household income, all of which have been linked to foster care caseloads in previous research (e.g., Andersen and Wildeman 2014; Berger and Waldfogel 2004; Bitler et al. 2006; Buckles 2013; Paxson and Waldfogel 2003; Swann and Sylvester 2006). We accounted for individual-level risk factors by including the share of non-Western immigrants and descendants; the share of mothers employed; the share of missing, deceased, or unknown fathers; and average sibship size. We also control for municipality fixed effects.

Empirical Approach

Macro-level Model. Our macro-level sample consisted of annual observations of foster care caseloads, ADHD medication rates, and a set of covariates. The data had a panel format with annual observations (t) nested within municipalities (j). We regressed the log of foster care caseloads measured as the number of children in foster care per 1,000 on the number of children per 1,000 medicated for ADHD, a set of time-varying municipality characteristics, municipality fixed effects,[5] and year fixed effects.[6] Municipal-level data were the lowest level available to us if we were to credibly link the child population with their experienced geographical medication level. Once we accounted for both varying and fixed municipality characteristics, we assumed that the variation in ADHD medication rates was caused by stochastic variation in the diffusion of the use of Ritalin and similar drugs throughout municipalities. This led to the following macro-level model:

$$
\begin{aligned}
\log(Caseload)_{jt} = \sum_{j=1}^{J} Municipality_j \\
+ \sum_{t=1998}^{2010} Year_t + \delta\, ADHD_{jt} + X\boldsymbol{\beta}_{jt} + \varepsilon_{jt},
\end{aligned}
\tag{1}
$$

where δ captured the impact of ADHD medication rates on foster care caseloads.

As previously discussed, the increase in ADHD medication usage was limited to older children, so including young children may only contribute with statistical noise.[7] Therefore, we also estimated equation 1 using only foster care caseloads and ADHD treatment share for children age 6 to 17. If the rise in ADHD medication caused foster care caseloads to drop, we should expect to see a more pronounced and statistically significant effect when only examining the limited but actually treated age group.

A final concern was that social services may have chosen to treat children for ADHD because they did not place the children in foster care (reverse causality). As discussed previously, there was little evidence that this would be the case. Nevertheless, if the drop in foster care caseload rates led to more children receiving medication or if a common factor affected foster care caseloads negatively and ADHD medication rates positively, that would bias our estimates. To examine whether reverse causality or confounding drove our results, we also estimated a model using one-year-lagged ADHD rates as our predictor of interest. (We also included two- and three-year-lagged variables as controls for the municipality-specific trend in ADHD prescription in this model.)

Individual-level Risk

Whereas our macro-level model provided a strong test of the association between medical treatment of ADHD and caseloads, it remained vulnerable to the ecological inference problem (e.g., Drake et al. 2003). To provide a test at a lower level of aggregation, we used a randomly drawn 10% sample of all Danish children age 6 to 17 from 1998 to 2010, which left us with a large but computationally manageable number of observations (157,938 children observed 1,016,286 times). The outcome was foster care placement. We used a one-year-lagged indicator on municipal ADHD load (calculated at the individual level to take movement between municipalities into account), individual-level information on parental characteristics, and municipality fixed effects. We obtained all data from Statistics Denmark. Table A1 http://hsb.sagepub.com/supplemental presents all sample statistics.

The individual-level models assess the impact of increased ADHD medication use on the average risk of entering foster care. If medical treatment of ADHD directly affected the risk of being in care, the individual-level effect of increases in ADHD medication on foster care risk should align closely to the

estimated caseload-level effect. In addition, the individual-level data allow us to remove individual-level fixed effects. This gives the following model:

$$Foster\ Care_{it} = \sum_{j=1}^{J} Municipality_j + \varphi Year_t \\ + \delta ADHD_{it-1} + X\beta_{it} + Z\gamma_{jt} + \alpha_i + \varepsilon_{it}. \quad (2)$$

Foster care_{it} was equal to "1" if the child *i* was in foster care at any time in year *t*, "0" otherwise. *Year_t* was the linear time term, *ADHD_{it-1}* is the ADHD-medication rate for the municipality the child lived in at year *t*-1, *Xβ_{it}* was the set of child characteristics, and *Zγ_{it}* was the set of municipality characteristics. We included time as a linear term to avoid the age-period-cohort issue (e.g., Winship and Harding 2008) and because our measure of medical treatment of ADHD became highly collinear with time once we controlled for municipality fixed effects. We use a one-year-lagged measure of ADHD medication rate to further address any issues of simultaneity bias.[8]

RESULTS

We first present results from the macro-level models that examine the relationship between municipal-level ADHD medication rates and foster care caseloads. We then submit our results to a number of robustness tests that take into account (1) that only children above a certain age are likely to receive medical treatment for ADHD and (2) that time trends and ADHD medication rates are heavily intertwined. Last, we examine how ADHD medication rates affect the individual risk of being in foster care to address the ecological inference problem.

Macro-level Results

Table 2 reports the results from the macro-level models. Model 1 shows that there is a strong negative relationship between the logarithm of foster care caseloads and the rate of children treated for ADHD, controlling for time-varying municipal-level covariates. When including neither municipality nor time fixed effects, we find that increasing medication rates with one additional child per 1,000 leads to a 2.9% decrease in foster care caseloads (translating into roughly a 29% decrease per 1 percentage point increase in ADHD medication rates).

When we control for both the time trend and the municipality fixed effects (Model 2), which provides a more rigorous and appropriate test, the rate of medical treatment of ADHD is negatively and significantly associated with log foster care caseloads. Though the parameter estimate for ADHD is only –.005, it is important to remember that (1) this is a lower-bound estimate (see discussion below) and (2) the number of children who received medical treatment for ADHD rose from less than 1 in 1,000 in 1998 to almost 12 in 1,000 in 2010, still leading to a large effect at the aggregate level. For each additional child per 1,000 children who received medication for ADHD, foster care caseloads drops .5% (if we assume a constant semi-elasticity), meaning that, at the least, the 11 per 1,000 change in the rate of medical treatment of ADHD during this period decreased the number of foster care caseloads by 5.5%.

As discussed earlier, children younger than 5 almost never receive medication for ADHD and did not experience any rise in their medication rates (Dalsgaard et al. 2013a). The youngest group of children therefore only contributed statistical noise to the results presented in Models 1 and 2, so in Models 3 through 6, we replicate the analyses with medication rates only calculated for children ages 6 to 17 (Model 3 and Model 4), and with both medication rates and foster care caseloads only calculated for children ages 6 to 17 (Models 5 and 6).

Models 3 and 5 again report the result from the model without municipality fixed effects and time effects. The parameter estimates for ADHD medication rates are lower (–.019 and –.017) than what we observed in Model 2 (–.027). The difference is, however, a function of variable specification because we only include children who are likely to receive ADHD treatment by excluding children younger than 6. Hence, we get higher ADHD medication shares when only examining children ages 6 to 17 (meaning the aggregate effect is similar).

To skip to the most rigorous models (Models 4 and 6), the ADHD estimate for the model including both municipality and time effects are identical to the one found in Model 2 but more statistically significant in the case of Model 6. Because the range for the rate of medical treatment of ADHD is greater in Models 3 through 6 than in Models 1 and 2, coefficients that are roughly the same size across models have a larger impact in Models 3 through 6 than in Models 1 and 2. This age group experienced a rise in ADHD medication from just below 1 in 1,000 in 1998 to more than 15 in 1,000 in 2010 (see Figure A1 http://hsb.sagepub.com/supplemental). Assuming a constant elasticity across ADHD medication increases, we calculate that under this lower-bound specification increased ADHD medication caused approximately a 7.5% decrease in foster

Table 2. Regression Results from Macro-level Model for Foster Care Caseloads.

	Caseloads for all children Medication rate for all children		Caseloads for all children Medication rates for ages 6–17		Caseloads for ages 6–17 Medication rates for ages 6–17	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
ADHD medicated per 1,000 children	−.027***	−.005*	−.019***	−.005*	−.017***	−.005**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
Log of non-Western immigrant per 1,000	−.135***	−.020	−.150***	−.021	−.140***	−.019
	(.012)	(.017)	(.013)	(.018)	(.013)	(.018)
Male incarceration per 1,000	.020***	.004	.019***	.005	.019***	.005
	(.005)	(.003)	(.005)	(.003)	(.005)	(.003)
Female incarceration per 1,000	.017	.006	.009	.006	.001	−.006
	(.019)	(.010)	(.019)	(.010)	(.019)	(.010)
Household income	.008***	.007	.009***	.005	.009***	.004
	(.002)	(.006)	(.002)	(.006)	(.002)	(.007)
Share dependent on welfare	6.408***	3.784***	7.237***	3.742***	6.828***	3.394***
	(.517)	(.813)	(.512)	(.814)	(.514)	(.836)
Unemployment rate	.001	.000	.001	.000	−.000	−.000
	(.006)	(.004)	(.007)	(.004)	(.007)	(.004)
Average age of children	.222***	.104**	.177***	.087*	.116**	.078†
	(.023)	(.033)	(.039)	(.043)	(.039)	(.045)
Average sibship	.405***	−.299	.471***	−.216	.433***	−.149
	(.068)	(.187)	(.068)	(.191)	(.069)	(.196)
Employed mother	−.970***	−1.972***	−.886***	−1.935***	−.764**	−1.847***
	(.244)	(.290)	(.247)	(.290)	(.248)	(.297)
Divorced mother	5.605***	2.286***	6.579***	2.556***	6.757***	2.808***
	(.516)	(.598)	(.508)	(.592)	(.510)	(.608)
Father unknown, dead, or emigrated	1.376	2.730*	−.277	2.673*	.456	2.530†
	(1.199)	(1.320)	(1.196)	(1.322)	(1.201)	(1.357)
Fixed effects		X		X		X
Time effects		X		X		X
$E(log(\text{Caseload}))$	3.155	3.155	3.155	3.155	3.363	3.363
$E(\text{ADHD medicated})$	2.923	2.923	3.943	3.943	3.943	3.943

Note: Standard errors are in parentheses. $N = 2,853$. ADHD = attention deficit hyperactivity disorder.
Source: Data obtained from Statistics Denmark's annual registers. $N = 2,853$.
†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$ (two-tailed t test).

care caseloads (which, again, is about a 2.0% greater decrease than predicted decrease based on the results from Model 2).[9] In addition, since the parameter estimate for Model 4 is similar to that for Model 2, there might be positive externalities of treating one child for ADHD on siblings' risk of entering foster care.

The fact that we find larger and more statistically significant results after controlling for municipality fixed effects and time effects demonstrates that younger children only contribute statistical noise, as we hypothesized. Thereby, the results gives credence

to the argument that increased use of ADHD medication *directly* affected foster care caseloads for older children.

Sensitivity Analyses

Using measures for foster care caseloads and ADHD prescription from the same year may cause issues of simultaneity bias. To address issues of reverse causality and confounding, we estimate the model using one-, two-, and three-year-lagged ADHD treatment share. All models shown include municipality fixed

Table 3. Results from Macro-level Model for Foster Care Caseloads with Lagged ADHD Variable.

	Full sample	Full sample	Full sample	Age 6–18	Age 6–18	Age 6–18
ADHD year-1	−.004	−.005	−.005	−.004[†]	−.006[†]	−.006[†]
	(.003)	(.004)	(.004)	(.002)	(.003)	(.003)
ADHD year-2		.002	−.002		.003	.001
		(.005)	(.006)		(.004)	(.004)
ADHD year-3			.007			.005
			(.006)			(.004)
N	2,853	2,853	2,853	2,853	2,853	2,853

Note: Standard errors are in parentheses. ADHD = attention deficit hyperactivity disorder.
Source: Data obtained from Statistics Denmark's annual registers. N = 2,853.
[†]*p* < .10 (two-tailed *t* test).

effects and time effects. We calculate the lagged medication rates at the individual level before aggregating them, thereby taking into account that parts of the child population might move between municipalities from year to year. Table 3 shows the lagged results. Models 1 to 3 show the results for the one-year-lagged ADHD variable for the full sample. The point estimates are similar to those in Table 2 but insignificant. Models 4 to 6 show results for the one-year-lagged ADHD variable for the sample of children age 6 to 17. The point estimates are similar to those shown in Table 3 and significant at the α = .10 level. Overall, results become weaker when using one-year-lagged ADHD medication rates but ultimately support the conclusion even when also controlling for two- and three-year-lagged ADHD medication rates.[10]

Predicting Caseload Change

In order to examine how much of the overall change in foster care caseload rates that changes in ADHD medication can account for, we calculate foster care caseloads for 2010 but with 1998 levels of ADHD medication use and then compare this counterfactual change in foster care caseloads to the change in foster care caseloads predicted by our model. When comparing the differences in changes, we find that the dramatic rise in ADHD medication use from 1998 to 2010 accounts for fully 45% of the changes in foster care caseloads in the same period.

Two factors make it likely that our results from Table 2 are lower-bound estimates. When the cumulative risk of foster care drops, it leaves room in the foster care system for higher retention rates of children already in the system. In addition, the ADHD medication share is partly a function of time, so including time fixed effects could cause multicollinearity. Assuming a constant time effect,

changes in ADHD medication rates might account for as much as a 32% drop in foster care caseloads. We also estimate a first difference model that use the within municipality change scores between years for each variable in equation 2 (i.e., using $\Delta Y_{it} = Y_{it} - Y_{it-1}$, ΔX_{it}, etc.) to control for time-constant effects within municipalities. The first difference approach places the estimate at 25%. Using lagged ADHD medication rate and a first difference model gives a predicted 29% drop in caseloads. Whether time effects are included or not, the rise in medical treatment of ADHD has had a substantial effect on the size of Danish foster care caseloads, causing a 5% to 29% decrease in caseloads, and explaining up to 45% of the decrease in Danish foster care caseloads since 1998.

Micro-level Results

Although our macro-level estimates provide robust results that indicate that increased medical treatment of ADHD leads to decreased foster care caseloads, the macro-level results are vulnerable to the ecological inference problem. To address this, we estimate individual-level fixed effect models regressing whether a child was in foster care in any given year on ADHD medication rates in the child's municipality and a set of controls. We assume that variation in one-year-lagged ADHD medication load is exogenous once we have taken individual and municipality characteristics into account. We limit the sample to children ages 6 to 17.[11]

Table 4 shows the results of the individual-level fixed effect regressions. A rise in ADHD medication load causes a significant decrease in the risk of entering foster care when we control for only individual fixed effects, municipality fixed effects, and a linear time trend (Model 1). The estimate expresses the

Table 4. Individual-level Fixed Effect Regression Results for Children Age 6 to 17, 1998–2010.

	Fixed effect 1	Fixed effect 2	Fixed effect 3
ADHD medicated per 100 children in year 1	−.008***	−.007***	−.008***
	(.001)	(.001)	(.001)
Share dependent on welfare		.163***	.191***
		(.016)	(.021)
Unemployment rate		.005***	.004***
		(.001)	(.001)
Male incarceration per 1,000		.359***	.319**
		(.095)	(.124)
Female incarceration per 1,000		.483	.334
		(.335)	(.437)
Father missing			.005
			(.003)
Mother missing			−.038**
			(.013)
Mother employed			−.004***
			(.000)
Mother divorced			.007***
			(.000)
Parents' gross income			−.000***
			(.000)
N	1,016,286	1,016,286	1,016,286

Note: Municipality dummies and time trend not shown. Standard errors are in parentheses. ADHD = attention deficit hyperactivity disorder.
Source: Own calculations on data obtained from Statistics Denmark's annual registers. *N* = 1,016,286.
**p < .01, ***p < .001 (two-tailed *t* test).

effect of an increase of 1 child per 100 receiving medical treatment for ADHD on the probability of being in foster care when not controlling for time-varying observables. For every 1 child per 100 receiving medical treatment, the risk of being in foster care drops .8 percentage points. Controlling for municipality- and family-level characteristics does not substantially change the estimate. Calculating the individual-level effect based on the increase in the use of ADHD medication among children ages 6 to 17 from 1998 to 2010 (from a municipal average of just less than 1 in 1,000 to greater than 15 in 1,000) translates into a decrease in the risk of being in foster care of 1.05 percentage points. Measured against the share of children in the micro-level sample that was in foster care in 1998, we then calculate that increased use of ADHD medication caused a 33% decrease in the foster care placement of children ages 6 to 17 by 2010. We also estimated Bayesian tipping point models across the distribution of share of ADHD medicated to examine whether the effect decreases or even changes as ADHD medication shares increase, but we

find no evidence of Denmark's having reached a tipping point for the negative effect of ADHD medication rates on children's individual-level foster care risk.[12]

Figures 2 and A1 show that the share of children medicated for ADHD increased more rapidly after 2007, and Figure 3 indicates some autocorrelation between certain municipalities, so we rerun our model limiting the sample period to 1998 to 2006. We also control for general medicalization trends for children by including the municipal medication rates for antipsychotic drugs to capture any general trends. The results (available upon request) do not differ substantially from the results provided by the models that include the entire study period and do not control for antipsychotics. We also run additional robustness tests using the lagged municipal ADHD medication load as an instrument for whether an individual child received medical treatment for ADHD in a given year and still find significant negative effects of ADHD treatment on the risk of being in foster care (results available upon request).

DISCUSSION

Research on the causes of foster care placement and fluctuations in foster care caseloads has tended to focus on the roles of parents and social policies in shaping the risk of foster care placement for children and the size of foster care caseloads. Yet, parents are only one aspect of the foster care equation, and the state policies that affect them are only one more aspect. In this article, we broadened the discussion about the causes of foster care placement for individual children and fluctuations in the number of foster care caseloads by considering how the medical treatment of ADHD affected children in Denmark from 1998 to 2010, a period in which foster care caseloads declined in Denmark.

This test is uniquely appropriate and strong for a number of reasons. First, because we have registry data, which covers the entire Danish population and has virtually no attrition, our results do not have to deal with concerns about missing data endemic to research on the foster care system (and, to a lesser degree, medical treatment of ADHD). Second, children in foster care have a much higher propensity for exhibiting behavioral problems such as ADHD than children in the general population. Thus, considering how the medical treatment of ADHD might modify the risk of foster care placement is an especially direct test of how factors that change children's behavioral problems may also modify their risk of foster care placement. Third, by modeling these processes both at the individual level and at the population level, we provide insight not only into what proportion of the decrease in foster care caseloads happening during this period is attributable to increases in medical treatment of ADHD but also into whether these effects hold at the individual level, decreasing concerns about the ecological inference problem.

The results from our analyses show that increased medical treatment of ADHD likely was significantly and substantially associated with lowered foster care caseloads in Denmark. According to the estimates based on our preferred model, 45% of the decrease in foster care caseloads that took place in Denmark from 1998 to 2010 is attributable to the rise in the use of medical treatment for ADHD. Furthermore, even in arguably our most conservative macro-level model (25%) and our micro-level model (33%), we find pronounced associations between increases in ADHD medication and the decrease in foster care caseloads in Denmark, and our host of robustness tests makes it likely that the association is causal.

To consider the magnitude of these effects, in their seminal analysis of U.S. foster care caseloads, Swann and Sylvester (2006) showed that increases in the female imprisonment rate, the factor that most strongly drove the increase in foster care caseloads in the United States from the mid-1980s to 2000, accounted for roughly 31% of the foster care boom during this period. Within this context, even the results from our models that provide evidence of smaller effects still suggest powerful effects. Indeed, the estimates provided range from 25% (for the most conservative macro-level model) to 45% (for our preferred macro-level model), implying that the magnitude of effects we isolate here are well within the range Swann and Sylvester (2006) identify with shifts in female imprisonment. Moreover, our results go substantially beyond the effects of other factors they considered, such as shifts in welfare generosity.

In providing this strong, broad test, we make at least two major contributions. First, we provide the first test to show that interventions that lead to behavioral modification in children can fundamentally alter the foster care system. This finding is of the utmost importance not only because it suggests that some of the scarce governmental resources dedicated to child protective services could be directed toward interventions designed to alter children's behavior in ways that make them easier to parent (instead of focusing mostly on things that parents may need to change), but also because it suggests that other (nonmedical) types of interventions designed to diminish children's behavioral problems could too have macro-level effects, a possibility little research to date has considered (to our knowledge).

Second, it shows that while the concerns about social control and the social construction of problem behaviors voiced by some medical sociologists are invaluable (e.g., Conrad 1975, 1992, 2005), there is a point at which medical treatment of behavioral problems holds great value not only for the children themselves and their families but also for the broader society. A parallel may be in order here in terms of imprisonment, which, like the overtreatment of ADHD through medication, has received a tremendous amount of attention, much of it critical, from scholars of social control (e.g., Wacquant 2001; Western 2006). Largely missing from the discussions of imprisonment in the United States, however, is the idea that at low levels, imprisonment is quite likely to be a societal good, and that it is only when the rate of imprisonment becomes high—and highly concentrated—that it starts to exert grave

social costs (for a broader discussion, see Clear 2007). Furthermore, society might benefit additionally from properly identifying the group that should receive treatment, be it imprisonment or medical treatment for ADHD, rather than just ascribing it to a broad group of the population. Thus, our results are broadly consistent with what we expect to see in terms of imprisonment: While too much might have a host of societal costs, a small amount targeted at a well-defined group might do much good.

Although each of these conclusions is important in its own right, this study nonetheless has four key limitations. First, our analyses offer little insight into what the optimal level of medical treatment of ADHD might be. Denmark and the United States may be on opposite sides of an optimal tipping point of treatment levels, or they may be treating vastly different types of children altogether. Second, although we provided strong tests at both the macro level and the micro level, we rely on municipal variation to provide an exogenous shock in medical treatment of ADHD, which may suffer from some degree of confounding. This is, to be sure, an important limitation. Third, although our analyses considered how municipality-level rates of medical treatment of ADHD affected individual-level risks of foster care placement, we lack an individual-level test that directly models how receiving medical treatment for ADHD affects children's risk of foster care placement beyond using the municipal variation as an instrumental variable. Finally, the Danish foster care system and the American system differ in many regards, including (but not limited to) the fact that the Danish system provides for more teenagers, that having children in foster care (or being in foster care) appears to be less stigmatized in Denmark than in the United States, and that more Danish children are placed in foster care at the request of their parents than is the case in the United States. Thus, it remains unclear how well the analyses presented here would translate to the American context.

Limitations aside, this article has provided the first strong test of how the widespread use of medical treatment of ADHD could improve children's behaviors in ways so substantial as to be discernible at the macro level. The results are also important because they show that a medical treatment now widely considered to be too liberally used in the United States has benefits when used at a modest level. And the results thus show that while the concern among medical sociologists and sociologists of social control about overprescriptions are well taken, the benefits of the medical treatment of ADHD through the use of drugs such as Ritalin for children's behavioral problems are, quite simply, too large to ignore, provided relatively few children receive the treatment.

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SUPPLEMENTAL MATERIAL

The online appendices are available at http://jhsb.sagepub .com/supplemental.

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NOTES

1. A similar American study found that up to 75% of children in foster care received their attention deficit hyperactivity disorder (ADHD) diagnoses prior to their placement, suggesting behavioral problems may precipitate foster care placement (McMillen et al. 2005).

2. Sociologists began to study medicalization of "hyperkinetic" children in the 1970s (Conrad 1975), building upon theories of deviance and social control (e.g., Foucault 1965). This research viewed medicalization as a depoliticization and individualization of social problems through medical social control prescribed by a system of medical professionals, medical technologies, and pharmaceutical companies (e.g., Conrad 1992, 2005). According to those working in this tradition, therefore, overmedicalization can do individuals serious harm because it relabels and "sickens" normal responses to situations (e.g., Horwitz and Wakefield 2007).

3. This includes amphetamine, dexamphetamine, dextromethamphetamine, methylphendiate, atomoxetine, dexmethylphendiate, and lisdexamfetamine. Unlike in the United States, Adderall is not available as a prescription drug, and the most common drug prescribed is Ritalin (Pottegård et al. 2013).

Some of the drugs listed are also used to treat children with autism spectrum disorders. Dalsgaard, Nielsen, and Simonsen (2013a) show that 16% of Danish children with autism spectrum disorders receive one of these medications.

4. We drop 16 observations of municipalities with fewer than 100 children in the population in a given year.

5. A number of municipalities merged in 2007, as evident from Figure 3. The number of municipalities went from 271 to 98. To account for this we include fixed effects for municipalities both before 2007 and from 2007 on.

6. It has been standard to weight macro-level models with the number of individuals aggregated in each observation. However, recent work by Solon, Haider, and Wooldridge (2013) has shown this is not necessarily the best strategy. As suggested by them, we use a Breusch-Pagan test where we include the number of children in the municipality on the right-hand side to examine whether we should weight our model and find that weighting would not benefit our model.

7. The increase was 25% higher in the sample of children ages 6 to 17.

8. A different approach would be to use a hierarchical model that captures cohort and individual-level effects as random parameters. This would give us more information on the cohort effect, but we already know from Figure 1 that entrance rates into foster care are decreasing between cohorts, and the additional information gained from modeling this explicitly are of little interest. We also have no interest in testing the effect of fixed individual traits such as gender and ethnicity (see Yang and Land 2008 for discussion). Thus, we use fixed effect models.

9. If we allow for more decimals on the estimates, we find that the estimate for the ADHD medication rate in Model 6 is actually lower than the estimate for Model 2 (.00497 compared to .00538). Nevertheless, as the mean for the dependent variable is 35% higher in Model 6 than in Model 2, this does not significantly influence our interpretation.

10. To test whether a general uptake in medicalization among low-socioeconomic-status groups drives our results, we also run our analyses controlling for the rate of children receiving medical treatment with antipsychotics. The results (available upon request) do not indicate that a general increase in medicalization drives our results.

11. We also run the micro-level model for only children ages 0 to 5. If the ADHD measure were capturing a different underlying process that generally led to lower foster care rates, we should see a negative association between ADHD medication rates and foster care rates for this group as well. The results (not shown here but available) find no significant association between ADHD medication rates and the risk of being in foster care for children ages 0 to 5.

12. Result available upon request.

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AUTHOR BIOGRAPHIES

Peter Fallesen is a postdoctoral researcher at the Swedish Institute for Social Research, Stockholm University, a researcher with the Rockwool Foundation Research Unit in Copenhagen, and an affiliate at the Centre for Stratification Research at the Department of Sociology, University of Copenhagen. His current research covers the causes and consequences of foster care entry, the impact of medical treatment of ADHD on children, and the effect of psychiatric treatment on patients' later life outcomes. His research has appeared in *Child Abuse and Neglect, Journal of Adolescence, Child and Youth Services Review*, and *PLoS One.*

Christopher Wildeman is an associate professor of policy analysis and management at Cornell University and a senior researcher with the Rockwool Foundation Research Unit in Copenhagen. His current research considers the prevalence, causes, and consequences of contact with the child welfare system and the criminal justice system for family life. His first book, *Children of the Prison Boom: Mass Incarceration and the Future of American Inequality*, which is coauthored with Sara Wakefield, was published by Oxford University Press in 2013.