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Accidents will happen? Unintentional childhood injuries and the effects of child care regulations

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Abstract

Accidents are the leading cause of death and injury among children in the United States, far surpassing diseases as a health threat. We examine the effects of child care regulation on rates of accidental injury using both micro data from the National Longitudinal Survey of Youth, and Vital Statistics mortality records. Estimates from both data sources suggest that requiring day care center directors to have more education reduces the incidence of unintentional injuries. An auxiliary analysis of the choice of child care mode confirms that these regulations are binding and that higher educational requirements tend to crowd some children out of care, as do regulations requiring frequent inspections of child care facilities and lower pupil–teacher ratios. Thus, regulation creates winners and losers: Some children benefit from safer environments, while those who are squeezed out of the regulated sector are placed at higher risk of injury.

JEL classification: J13; I12; I28

Keywords: Accidents; Child care regulations; Childhood injuries

1. Introduction

Over the last half of the 20th century, accidents have emerged as the leading cause of death among American children over 1 year of age. Table 1 shows the six leading causes of death for children of ages 1–3, and 4–5, based on mortality data in 1996. As these figures make clear, unintentional injuries are a much more important cause of death among children than any form of infectious disease. Among very young children (1–3 years old), unintentional

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Table 1
Six leading causes of child death in the US (1996) by age

	1–3 years old		4 and 5 years old	
Ranking	Cause	No. of deaths	Cause	No. of deaths
1	Unintentional injuries	1798	Unintentional injuries	1162
2	Congenital or perinatal problem	636	Cancer	384
3	Homicide or assault	362	Congenital or perinatal problem	194
4	Cancer	362	Disorders of nervous and sense organs	182
5	Disorders of nervous and sense organs	349	Infectious and parasitic diseases	158
6	Infectious and parasitic diseases	327	Homicide or assault	149

The number of deaths to US born children. We estimate that in 1996 there were 11,751,692 US born children between 1 and 3, and 8,092,613 between the ages of 4 and 5.

injuries accounted for 1798 deaths in 1996 compared to 636 deaths due to congenital problems, the next leading cause of death. The incidence of deaths due to accidents relative to other causes is even greater for older children. Moreover, deaths represent only the tip of the accidents "iceberg." It is estimated that between 1987 and 1995, while 6600 American children died annually from preventable injuries, 246,000 children per year were hospitalized due to injuries, and injuries resulted in almost 9 million emergency room visits and 12 million physician visits each year (National SAFE KIDS Campaign, 2000).

A commonly held view is that childhood accidents just happen. For example, a 1999 Institute of Medicine Report on injury prevention remarks, "for centuries, human injuries have been regarded either as random and unavoidable occurrences ('accidents' or 'acts of God') or as untoward consequences of human malevolence or carelessness. From this perspective, the main strategies for prevention are prayer and human improvement" (Bonnie et al., 1999). This characterization contrasts with a view that accidents are the result of choices made by parents, family, supervising adults and society about the extent to which children are exposed to risk of injury. For example, parents make choices about whether to place their infants and toddlers in car seats, whether to use safety caps on the containers of hazardous materials and where their children can play.

And, as more and more mothers of young children have entered the labor force,[1] parents have increasingly made choices about the supervision that their children receive, and a corresponding risk of injury. Tabulations from the 1995 Survey of Income and Program Participation suggest that 42% of children between 1 and 3 years old are in some form of organized care, and that almost a third of these children are in formal center-based care rather than more informal family homes (US Census Bureau, 1997). The fraction of children in child care is even higher among 4 and 5 years old. Thus, there appears to be considerable

[1] In the United States, the participation of women with children less than 6 years of age rose from 46.8% in 1980 to 62.3% in 1996 (US Committee on Ways and Means, 1998). Despite the magnitude of these changes, we know little about their consequences for the well-being of children. Existing work has focused largely on effects of maternal employment on children's test scores (cf. Desai et al., 1989; Parcel and Menaghan, 1994; Blau and Grossberg, 1992; Neidell, 2000; Ruhm, 2000), with often inconclusive results. Accident rates may be more directly related to maternal employment at a point in time than test scores.

scope for reducing childhood injury rates by improving the safety of child care settings by their regulation.

In this paper, we examine the relationship between accidental injuries among young American children and child care regulation. As with other consumer products and services, government imposes regulation on child care providers with the goal of reducing the risk of harm to children. Potential risks include harm from injury as well as from disease and developmental impairment (Morgan and Azer, 1997). Regulations stipulate such things as the educational requirements for child care providers, the maximum number of children per child care staff member and the frequency with which facilities are inspected. Most of these regulations are set at the state-level and vary across states in the US as well as within states over time. We exploit this variation in order to assess the impact of regulation on the incidence of accidents among children during the 1980s and 1990s.

Information on state child care regulations was collected by Hotz and Kilburn (1997, 2000) and updated for this research. To measure childhood accidents and mortality due to accidents, we use two sources of data. First, we use individual-level data on accidents requiring medical attention drawn from the National Longitudinal Survey of Youth's Child Mother (NLSYCM) file. Second, we analyze state-level, time-series data about accident rates constructed from the Vital Statistics Detail Mortality (VSDM) data, and Census Population estimates. Data on other characteristics of states are constructed from the March Current Population Surveys (CPS) and merged to the VSDM.

We find that regulations requiring directors of child care centers to have more education significantly reduce the risk of both fatal and non-fatal injury. However, these regulations are not without their costs. Evidence from an auxiliary analysis of the choice of child care mode confirms that child care regulations are binding and suggests that the imposition of stiffer educational requirements crowds some children out of regulated care by making this care more expensive. Requiring inspections of child care facilities and lowering pupil–teacher ratios have similar consequences. As a result, some children in states with more stringent regulations are crowded, or priced, out of formal care, which tends to be safer than other child care arrangements. Thus, the use of regulations to improve the safety of child care settings can end up creating winners and losers, depending on whether the higher costs of regulation outweigh their direct quality-enhancing effects.

The rest of the paper is laid out as follows. Section 2 provides some background information about child care and injury risk. Section 3 describes our data sources. Section 4 provides an overview of our empirical model. Results appear in Section 5 and Section 6 concludes.

2. Background regarding injury risks, child care and child care regulations

Over the last 30 years, there has been a substantial decline in the incidence of deaths to children due to unintentional injuries in the US.[2] From 1979 to 1998, death rates due to accidents declined by 52.1, 51.3 and 45.1% among children ages 1–4, 5–9 and 10–14, respectively; 31.0, 17.5 and 11.9 per 100,000 children for these same age groups (US

[2] A similar trend has occurred in other developed countries (UNICEF, 2000).

National Center for Health Statistics, 2001). These declines in accidental deaths to children exceeded the reductions in death rates to children from all causes (46.1, 43.1 and 30.5%, respectively). Furthermore, we note that childhood accidental deaths rates declined for all racial and ethnic groups (US National Center for Health Statistics, 2001). At the same time, important and persistent differences exist in rates of accidental deaths, and the incidence of injuries, to children in the US by race, ethnicity, socio-economic status, and residential location. Accidental death rates among white children declined by 51.9, 53.5 and 46.9% compared to 47.9, 46.7 and 35.1%, respectively, for African–American children for the age groupings noted above (US National Center for Health Statistics, 2001). As of 1998, childhood accidental death rates for African–American children remained 1.7 times higher than those for white children (National SAFE KIDS Campaign, 2000).[3]

Disparities in accidental deaths also exist by poverty status, with children from low-income households being twice as likely to die in a motor vehicle accident, four times more likely to drown and five times more likely to die in a fire than non-poor children (National SAFE KIDS Campaign, 2000). We note that these disparities in accidental death rates to children, aged 1–14, exist, even though there are relatively small and narrowing differences by race, ethnicity and income in death rates due to congenital anomalies and cancer (NCHS, 2001).

With respect to the relationship between non-parental child care and injury risk, the evidence suggests two things. First, licensed, regulated, day care centers are fairly safe places for children relative to other settings. Sacks et al. (1989) estimate that the risk of an injury requiring medical attention is 14.3 per 100 children annually in day care centers, compared to 35 per 100 children in the community at large. Other researchers have found similarly low rates of injuries in day care (cf. Briss et al., 1994). However, a second finding is that even regulated child care centers are often not as safe as they could be. Surprisingly, most states do not keep detailed information about deaths that occur in child care. However, projections based on states that do report suggest that 12% of the 2260 accidental deaths to children 1–4 years old in 1995 may have occurred in child care settings. This figure rises to 20% if we exclude deaths to children who were automobile passengers from the denominator (authors' calculations based on data in US News and World Report, 1997). Thus, deaths in child care account for a large fraction of total deaths, even if the majority of accidental deaths to children in this age range occur elsewhere. A recent report from the US Consumer Product Safety Commission found that many licensed child care centers had safety hazards including unsafe equipment, a failure to use safety gates, window blind cords within children' reach, and allowing children to wear clothing with drawstrings (US Consumer Product Safety Commission, 1999).

These findings suggest that there may be scope for reducing injury rates in licensed childcare settings through stricter regulation. In principle, imposing more stringent minimum standards on child care arrangements should reduce the incidence of accidents and deaths due to unintentional injuries to children. But this conclusion presumes that: (1) these standards are binding on the existing practices in child care settings; (2) these regulations are enforced; (3) parents do not "avoid" these regulations by the child care arrangements they choose. But the tightening regulations can have "unintended" consequences with respect to the safety of young children. To the extent that higher quality, and safer, child care

[3] Currie and Hotz (2003) offer considerably more detail about trends in black–white gaps in mortality rates.

arrangements are costly to produce, imposing binding child care regulations on child care providers could increase the price of such regulations and "price," or "crowd," some parents "out" of regulated care. As a result of this "crowd-out" effect, it is unclear whether imposing more stringent standards on regulated child care will necessarily increase the quality of care, including safety, to which children are exposed.

There is mixed evidence with respect to the crowd-out effect of child care regulations. Chipty and Witte (1997), using data from a national sample of child care centers, find that lower required child/staff ratios for pre-school children reduce the probability that child care centers care for pre-school children rather than school age children, and vice versa. Blau and Currie (forthcoming) considers a more comprehensive set of child care regulations and finds, using data from the Survey of Income and Program Participation, that child care regulation does affect the type of child care that is chosen (we provide some additional evidence on this effect below). Blau (2001) examines the effects of child care regulations on the factor inputs, price and quality of child care using data from a 1993 sample of child care centers in four states (the cost, quality and outcomes study). While he finds that more stringent regulations do affect the inputs (i.e., the number and skill levels of center staff) of child care centers, his findings with respect to regulation effects on the price and quality of the specific forms of child care services are not conclusive.[4]

We note that a potentially important consideration in the market for child care services is the informational problems parents may face with respect to the quality and safety of child care services provided. It is possible that imposing minimum quality and safety standards on day care centers may solve parent's lack of information about the quality of particular child care settings, at least to the extent that these standards are enforced. With respect to this "quality assurance" effect of regulations, Chipty (1995) use individual-level data from the National Child Care Survey and find that increasing the number of mandatory inspections increases both the price of child care and the number of hours that children spend in care. This finding is consistent with the idea that minimum quality standards may encourage consumers to purchase more child care.

In summary, regulating the child care market by imposing minimum standards on some segment of that market can be a two-edged sword. While children in child care settings subject to binding regulation may receive higher quality care, regulation is also likely to drive some children out of the regulated sector. Thus, the overall effect of regulations on child safety is ambiguous with the potential crowd out effect balanced against the quality assurance effect.

3. Data

This study merges state-level data about child care regulations with individual-level data from the NLSYCM files as well as from the VSDM data. These two sources of individual-level data are complementary. On the one hand, the NLSYCM has information

[4] Blau finds that the estimated effects on price and quality are sensitive to whether he controls for state fixed effects. However, these fixed effects models are estimated using a single cross-section of data by exploiting the fact that many states set different regulations depending on the ages of children being cared for in a center.

about all medically attended injuries, rather than just the small fraction of injuries resulting in death. This is one of the very few national surveys of non-fatal injuries among children that exists, and to our knowledge, this data has not previously been exploited. Moreover, the NLSYCM has a great deal of demographic information about mothers and children, as well as repeated observations on the same child. On the other hand, the NLSYCM data is reported by the mother, and is likely to be subject to reporting biases, as discussed below.

The VSDM is a census of all deaths, so selective reporting is not an issue. While the demographic information available is limited, data is available about both accidental and non-accidental deaths. In addition to analyzing the effects of child care regulations on accidental deaths, we also estimate their effects on other causes of death to children. We consider the latter estimates in order to assess our ability to isolate the effects of regulations on child care settings, since one would not expect such regulations to affect deaths due to cancer, for example. We also have information about the type of accident, so that we can identify at least one important type of accidental death that should not be directly affected by the regulation of child care centers, deaths to children riding as car passengers. Of course these deaths may be indirectly affected by child care regulation if regulations result in significant changes in commuting patterns but we expect this type of indirect effect to be smaller than the direct effects of regulation. The remainder of this section gives further details about child care regulation, the NLSYCM, and the VSDM data.

3.1. Data about child care regulation

Most states have two types of child care regulations, those that apply to day care centers, and those that apply to less formal child care setting referred to as "family homes." We look at regulations in both settings. The regulations we focus on include ratios of children to care givers; the number of mandatory inspections of child care facilities per year; and the education required of child care center directors or of providers in family homes. As Blau (2001) emphasizes, there are literally dozens of different child care regulations, many of which tend to be highly correlated with each other. For example, education requirements for child care center directors are correlated with education requirements for teachers and aides, as well as requirements specifying minimum experience levels and ages. Requirements on child-staff ratios tend to be highly correlated with maximum group sizes. Rather than attempting to identify the effects of all of the individual regulations, we have chosen to focus on selected measures which are representative of different regulatory approaches, and which have been examined frequently in other studies. One potentially important type of regulation that we do not consider in this study is whether states require child care providers to carry liability insurance. Over our sample period, only Alaska and Louisiana changed insurance regulations for day care centers and only Arizona and Wisconsin changed them for family homes.

Table 2 provides a summary of the national trends in the child care regulations we examine in this study over the period 1987–1998. The means, taken over the 50 states plus the District of Columbia, shown in Table 2 suggest that at the national level, there was relatively little change in the mean number of inspections required in day care centers and family homes. These averages mask many changes within individual states, however. Twenty-two states changed the number of inspections required in family homes, and 14 states changed the number of inspections required in day care centers over our sample period. Some states

Table 2
Variation in child care regulations (1987–1998)

Year	Number of annual inspections, day care centers	Number of annual inspections, family homes	Minimum educational requirements (years of school), day care center directors	Minimum educational requirements (years of school), family home providers	Child-to-staff ratio, day care, child 1–3	Child-to-staff ratio, day care, child 4–5	Child-to-staff ratio, family homes, child 1–3	Child-to-staff ratio, family homes, child 4–5
1987	1.00	1.05	10.92	0.00	8.2	14.1	5.6	6.6
1988	0.97	1.07	10.94	0.00	8.3	14.3	5.5	6.5
1989	0.95	1.04	10.94	0.29	8.3	14.3	5.6	6.7
1990	0.95	1.00	11.26	1.00	8.3	14.3	5.6	6.7
1991	0.95	0.98	12.27	1.24	8.3	14.4	5.6	6.8
1992	0.97	0.98	12.30	1.00	8.2	14.4	5.6	6.8
1993	0.98	0.98	12.41	1.00	8.2	14.4	5.7	6.9
1994	0.96	0.90	12.41	1.24	8.2	14.4	5.7	6.9
1995	0.91	0.90	12.41	1.24	8.2	14.3	5.7	6.9
1996	0.91	0.90	12.41	1.24	8.2	14.3	5.7	6.9
1997	1.01	0.89	12.29	1.94	8.2	14.3	5.7	6.9
1998	1.11	0.90	13.04	2.43	8.2	14.4	5.7	6.9

increased inspections while others decreased them. For example, Illinois changed the required number of annual inspections of family homes from 1 to 0.5 between 1993 and 1994, and then increased the number back to 1 in 1997. Alabama decreased the number of inspections of day care centers from 2 to 1 between 1987 and 1988, while Pennsylvania went from having no inspections of day care centers to having annual inspections between 1991 and 1992.

Changes in minimum education requirements are more evident in Table 2. Over our sample period, the average state began requiring high school diplomas from day care center directors. However, once again, the average masks considerable heterogeneity. For example, seven states went from having no requirements on the education of day care center directors to requiring more than a high school degree (usually 13 or 14 years of education) and Nevada, South Carolina and Utah moved to increase their requirements for center directors from 12 years to 14. But not all states followed this general trend. Over this same period, nine states that had required some college actually reduced their requirements for center directors to having only a high school diploma. With respect to the imposition of education requirements for family home providers, the statistics in Table 2 indicate that this is comparatively uncommon, although we do note that 10 states began imposing some sort of minimum education requirements (usually high school) on this type of child care providers over our sample period.[5]

Finally, Table 2 suggests that there was not much change in average maximum child-staff ratios over our sample period, but again, there is more variation within states than these averages would suggest. For example, if we look at regulations for 3 years old, we see that 10 states increased child-staff ratios in family homes, while seven states decreased them. In day care centers, three states increased maximum child-staff ratios covering 3 years old, while four states decreased them.

In summary, there is a good deal of within-state variation in the measures we are examining. While many states were tightening regulations, some states relaxed them over our sample period. In the analysis, we attempt to exploit this within-state temporal variability to identify the effects of these regulations on accident rates and death rates due to accidents.

3.2. Individual-level data

The National Longitudinal Survey of Youth, 1979 began in 1979 with approximately 6000 young men and 6000 young women. These individuals have been followed up every year since. In 1986, the NLSY began assessing the children of the female respondents of the NLYS79 every 2 years. These data offer a unique and previously untapped source of information about medically attended, non-fatal injuries among children.

Questions about accidents were asked biennially, beginning with the 1988 survey. Mothers are asked: (1) whether the child had an accident in the past 12 months that required

[5] These figures are broadly consistent with what is known about differences in education levels between teachers in centers and family homes. Teachers in day care centers are well educated on average, with almost half (47%) having a 4-year degree, 39% with some college, 13% with a high school diploma or GED, and virtually no high school dropouts (1%). Operators of regulated family day care homes are much less educated, with only 11% having graduated from college, 40% with some college, 34% with a high school diploma or GED, and 16% high school dropouts. Specialized training in early education, child development, or child care is also more common among center staff than in family day care homes (see Blau and Currie, forthcoming, for more discussion).

medical attention; and (2) whether the child ever had an accident (not necessarily in the past 12 months) requiring hospitalization. If the mother answered yes to either of these questions, she was asked the specific month and year of the *three most recent* accidents regardless of when they occurred.[6] Because of the way that the questions were asked, we have information on accidents for different windows of time for different children. For example, if the mother was surveyed in June 1990 and the child had had no accidents since June 1989, all we would know was that the child had not had an accident in the past 12 months, and we would not know whether she had had any accidents between June 1989 and June 1988. However, if the child had an accident in July 1989, then the mother would be asked about the three most recent accidents, regardless of the time they occurred. For example, she might report that there were accidents in July 1989, December 1988, and June 1988. We use all quarters in which we know whether or not an accident occurred for each child. Since there are few reports of accidents before 1987, we limit our sample period to 1987–1998.

We limit our analyses to those periods when the children were between the ages of 1 and 5. Hence, the youngest mother in our sample would have been 22 at the time of the birth, a fact that should be kept in mind when considering our results. We excluded infants under 1 year because unlike older children, they are much more likely to die from essentially medical causes such as congenital anomalies. All children in our sample were surveyed at least once and some up to five times over this period. We have information about 6702 children. Organizing our data into quarters—because of the seasonal patterns in accident rates noted above, and so that we can more precisely measure the mother's work status—yields an average of 7.3 quarters of accident data per child.

We obtained data on maternal and child characteristics from the main NLSY and NLSYCM files. These variables include: the child's age, race, and gender; whether or not a spouse was present; whether there were older or younger siblings in the household; whether the maternal grandmother and grandfather worked when the mother was aged 14; the mother's score on the armed forces qualifications test (a test of job skills); and the mother's education. Some of these variables are likely to have a direct effect on accident rates. For example, the presence of an older sibling may mean that a child is more likely to be exposed to age-inappropriate toys. Other variables such as those describing the maternal grandparents and AFQT have been shown in previous work using the NLSY to be important correlates of maternal employment and socio-economic status and may also be related to accident propensities.

Information about the mother's employment was obtained from the NLSY Work History file. The work history file has information about every mother's labor force status and usual hours of work for every week beginning with the first week of 1978. Mothers who reported working for at least 1 week during the quarter were coded as having worked during that quarter. After excluding children with missing information, we have a total of 49,255 quarters of child life data.[7] The NLSYCM surveys also included questions about child care

[6] If there was an accident requiring medical attention reported in the same month and year as an accident requiring hospitalization, then we assumed that these were one and the same accident. While it would be interesting to look at accidents requiring hospitalization separately, the sample size is too small.

[7] We include dummy variables for such things as missing maternal education in order to minimize the number of observations excluded for missing data. We lose some observations from the beginning of our sample period because of missing regulation data. For example, there are 798 quarterly child observations missing data on education requirements for day care directors.

in the 1986 and 1988 surveys which applied to the last month prior to the date of interview. Starting in 1992, questions were asked about child care in the first 3 years of each child's life. Because so little data was available about the child care of children 3 years and over, we restrict this part of our analysis to children 1 and 2 years old. Our "child care" sample covers 13,654 quarters of child life. We use this subset of the sample to examine the effect of regulation on the choice of child care mode.

Descriptive statistics for the NLSY data are presented in Table 3. In panel A, we display the means for all of the variables we use for the entire NLSYCM sample, and by race, maternal education category, and child age. As one can see, the overall accident rate is 2.9% per quarter of child life, with a rate of 1.9% for blacks and 3.3% for whites. These accident rates seem too low, given the epidemiological evidence cited above. For example, if 35% of children have medically attended injuries in any given year, then approximately 9% of children should have such injuries in each quarter. Moreover, if black children are 1.7 times more likely to die from accidents than white children, one might expect to see substantially higher rather than lower rates of medically attended injuries among black children. Patterns of accident rates by maternal education also suggest that there are systematic biases in the reporting of medically attended injuries since reported accident rates increase slightly with the education of the mother even though you would expect actual injury rates to fall.

In summary, white mothers and more educated mothers are more likely to report medically attended injuries than their non-white and less educated counterparts, even though we would expect their children to have lower actual injury rates. These reporting differences may either be because white/educated mothers are more likely to seek medical attention for an injury of a given severity to their child or because they are less likely to "forget" to report injuries. These differences in reporting provide important rationales both for allowing the estimated effects of regulation to differ by race and education, and for including child fixed effects in our models as a means of controlling for maternal propensities to report accidents.

Maternal employment rates are high for all groups except high school dropouts, and increase with education. The other variables in Table 3 show largely the patterns that one would expect. For example, black children and children of high school dropouts appear to be disadvantaged in terms of maternal education and absence of a father-figure.

Panel B of Table 3 displays rates of unintentional injuries, maternal employment, and child and family characteristics by reported type of child care, for those mothers and children for whom we have child care information. This sample is much younger on average than the "accident" sample because of the way it is selected. Child care regulations generally distinguish between child care centers and licensed family homes. The NLSY data do not allow us to make this distinction. Unfortunately, the NLSY asks only whether a child was cared for in someone else's home, and not whether that home was a licensed child care setting. Given this limitation, we split the data into three groups: (1) nursery schools, day care centers, and pre-schools; (2) other types of child care; and (3) no non-maternal child care.[8] The first category is one that is very likely to be subject to regulation. The second category includes both licensed family homes, and other forms of non-maternal child care.

[8] A small number of children who are reported to be in "group homes" are also included in the preschool/nursery school/daycare category.

Hence, it is difficult to tell whether children in the second category are affected by the regulation of family homes, though some children in this category must be.

There are several noteworthy patterns in the accident rates by mode of child care in panel B of Table 3. First, the overall use of child care seems to be under-reported relative to what national surveys of child care use suggest. Recall that the Census bureau reported that about a third of 1–3 years old children were in child care centers in 1995. Second, 43% of the mothers who report "no care" in a given quarter also report employment for at least 1 week in that quarter. It is possible that some of these mothers work shifts, have siblings care for younger children, or perhaps do not report father care as "child care."[9] However, there is likely to be some measurement error in responses to questions about the timing of work and child care decisions, as the information about these two sets of variables were gathered in two different parts of the survey. Fortunately, the rates of maternal employment are much higher for mothers who do report using child care, suggesting that there is some signal here. Third, accident rates do appear to be slightly lower among children in the most regulated child care settings and in the no-care category compared to in less regulated child care settings.

3.3. Vital Statistics data

The Vital Statistics Detail Mortality files contain information about every death in the United States. The file has information about race, the state of birth, state of residence, age at death, and cause of death. We use data from both the 1987 and 1998 sample period (for comparability with our NLSY data) and for 1983–1998 since this is the full period for which we have data about child care regulation. In order to calculate a denominator to use in the computation of death rates, we use census projections of the numbers of children in each state, year, race, and age group. Unfortunately, these data are not available over the entire period by single year of age.[10]

The age group that corresponds most closely to that used in our analysis of the NLSY data, is 0–4. We also will examine deaths among children, ages 5–9, since we expect children in this age range to be much less affected by child care regulation than younger children. Census bureau figures from the 1995 SIPP suggest that only 8% of children 5–13 were in any kind of organized child care facility, including family homes (Smith, 2000).

Calculating rates separately for 51 states, 16 years, two races and two age groups gives us 3264 possible cells. In practice, there are 1632 cells for whites, and 1284 cells for African–Americans because for some states and years, no estimate of the number of black children is available, presumably because the numbers are so small. Hence, there are a total of 2916 possible cells of data.

[9] Scott et al. (2001) and London et al. (2000) provide ethnographic evidence that suggests that many "welfare to work" mothers do in fact work non-standard shifts, and that very young children are frequently left in the care of somewhat older siblings.

[10] In a previous version of this paper, we constructed rates for each single year of age by combining information from the Detailed Natality files with information from the Detail Mortality files. Briefly, given the number of children born in a state, and the number of children who die in a state, one can come up with a rough estimate of the number of children of each age in each state and year. The limitations of this method are that: (a) it ignores immigrants; and (b) it assumes that children are born and die in the same state.

Table 3
Sample means for NLSY data

Variable	All	Black	White	<HS	HS	Any college	Children ages 1–3	Children ages 4–5
Panel A: by race and education								
Accident rate	0.029	0.019	0.033	0.025	0.029	0.030	0.031	0.026
Mother's employment	0.612	0.601	0.617	0.338	0.588	0.709	0.604	0.622
Child age	3.16	3.23	3.13	3.29	3.21	3.07	2.04	4.54
Child male	0.509	0.500	0.512	0.525	0.502	0.511	0.510	0.507
Hispanic	0.203		0.279	0.363	0.191	0.170	0.199	0.207
Black	0.274	1.0		0.325	0.281	0.254	0.262	0.289
Mother's age	31.1	30.6	31.3	29.7	30.6	31.9	30.8	31.3
Mother single	0.306	0.588	0.200	0.520	0.345	0.212	0.280	0.339
Younger sibling	0.225	0.222	0.226	0.280	0.218	0.216	0.144	0.325
Older sibling	0.467	0.529	0.443	0.622	0.499	0.395	0.495	0.432
Grandma worked when mother 14	0.512	0.561	0.493	0.411	0.503	0.547	0.513	0.511
Grandpa worked when mother 14	0.740	0.560	0.808	0.586	0.728	0.793	0.746	0.733
Maternal grandma education	10.6	10.6	10.7	8.1	10.1	11.7	10.7	10.5
Mother's education	13.0	12.8	13.1	9.3	12.	15.0	13.1	12.8
AFQT score	37.6	20.6	44.0	10.9	29.2	52.7	38.8	36.1
No. of observations	49255	13502	35753	6048	20917	22290	27242	22013
No. of children	6702	1800	4902	913	2891	2898	5411	5531

Variable	No child care	Day care centers and pre-schools	Other non-parental child care modes
Panel B: by child care mode (selected variables)			
Accident rate	0.029	0.029	0.032
Mother's employment	0.43	0.89	0.93
Child's age	1.52	1.51	1.46
Child is male	0.51	0.54	0.51
Hispanic	0.20	0.16	0.21
Black	0.26	0.36	0.26
Mother's age	30.24	30.39	30.13

Mother single	0.29	0.28	0.25
Younger sibling present	0.11	0.06	0.07
Older sibling present	0.56	0.42	0.48
Grandma worked when mother 14	0.49	0.61	0.55
Grandma worked data missing	0.02	0.05	0.01
Grandpa worked when mother 14	0.74	0.72	0.79
Grandpa worked data missing	0.20	0.25	0.15
Maternal grandma's educational attainment	10.62	11.36	10.75
Mother's educational attainment	12.86	13.79	13.52
AFQT percentile test score	36.34	44.32	42.11
No. of observations	8958	1087	3609

Means for spouse present and maternal grandfather's work status when mother aged 14 are taken over all non-missing observations.

Following Glied (1999), these cells are matched to additional demographic data obtained from the Current Population Survey's March files. The Current Population Survey samples approximately 60,000 persons per year. We use these data to calculate, for each state and year, the fraction of children less than 16 who are in poverty, urban, black or Hispanic, as well as the median family income of the children, the fraction of children whose mother's have less than a high school education, the fraction of children in one parent families, and the fraction of children whose mothers were working for at least 20 h per week. These variables are included in our analysis of accidental deaths in an attempt to control for time varying characteristics of states that might be correlated both with the passage of child care regulation legislation and with accident rates. Including the state and year dummies in our models will control for fixed characteristics of states and national trends. Of the 2916 cells in the Vital Statistics data, some are missing information about child care regulations. These cells come primarily from the early years of our data and in many cases it was not possible to tell whether there was, in fact, a regulation or not. Thus, we conduct our analyses of accidental deaths using a maximum of 2497 cells over the period 1983–1998.

Table 4 provides descriptive statistics for these Vital Statistics data. The first column shows the weighted mean computed over all cells, while the minimum and maximum counts across cells are shown in columns 2 and 3. We divided accidental deaths into three categories: those to children riding as car passengers, those to pedestrians from automobiles, and those not due to accidents involving an automobile. We also consider death rates due to cancer. We focus on these causes of childhood deaths for several reasons. First, all of them are quantitatively important. At the same time, we suspect that they differ with respect to their connections to child care arrangements. For example, we do not expect deaths to automobile passengers to occur primarily while children were in child care settings (though it is not impossible that such deaths could occur while children are in care). We expect that childhood deaths due to cancer are even less likely to be influenced by the nature of child care arrangements and, thus, by the stringency of child care regulations. At the same time, accidents to children who are pedestrians are more likely to occur in unregulated child care settings—for example, if children are brought along while someone does errands—than in regulated care. Thus, examining the latter may give us a sense of the potential crowd out effects of child care regulations on childhood injury rates.

The summary statistics in Table 4 indicate that deaths due to unintentional injury among children are (mercifully) rare events. The overall rate is 0.169 per 1000, which breaks down to 0.033 deaths per 1000 to car passengers, 0.018 deaths per 1000 attributable to pedestrians/car accidents, and 0.118 deaths per 1000 due to all other unintentional causes. Cancer deaths are similar in importance to car passenger deaths with a rate of 0.037 per 1000. Although it is not shown in the table, mean accident rates are higher for blacks than for whites, and higher for children, ages 0–4, than children, ages 5–9. The variation across cells in our CPS variables is also striking, with for example, poverty rates varying between 6 and 28%. However, small cell sizes in the CPS lead us to have some cells in which the share urban is either 0 or 1.

Information on the number of observations per cell also is provided at the bottom of Table 4. As one can see, there is a good deal of variation in the sizes of cells in the Vital Statistics data we use, with the smallest cell having 199 observations and the largest having

Table 4
Descriptive statistics for Vital Statistics data

Variable	Mean	Minimum	Maximum
Vital Statistics variables			
Non-auto accidents (per 1000 population)	0.118	0.000	7.65
Car passenger accidents (per 1000)	0.033	0.000	2.67
Car-pedestrian accidents (per 1000)	0.018	0.000	5.03
Cancer deaths (per 1000)	0.037	0.000	3.25
CPS variables			
Maternal employment rate	0.580	0.338	0.788
Poverty rate	0.159	0.062	0.277
Urban share	0.785	0.000	1.000
Hispanic share	0.177	0.000	0.574
Black share	0.143	0.000	0.813
Median income (1000s)	25.2	14.4	43.1
Mother <HS education	0.211	0.011	0.397
One parent family	0.256	0.078	0.622
Child care regulations			
Child-to-staff ratio, day care	12.3	3	25
Child-to-staff ratio, family homes	5.87	2	16
Minimum education, day care director	12.2	0	16
Minimum education, family home provider	1.06	0	15
No. of annual inspections, DC	0.818	0	4
No. of annual inspections, FH	0.915	0	4
Distribution of cell sizes			
Number of cells	2497		
Minimum	199		
First percentile	1395		
Median	120579		
Maximum	2622102		

Means are weighted using cell sizes. The CPS variables refer to the fraction of children living in families with the particular characteristic.

2.6 million observations. Given this disparity in cell sizes, all of the estimates we produce below are derived from weighted regressions, where the weights are the cell sizes.

4. Empirical methods and identification strategies

Regulations may be the result of political processes and considerations that reflect, in part, the attitudes of parents and/or the influence of child care providers. As such, the regulations that states set may be correlated with parental child care choices and outcomes such as accident rates.[11] Blau (2001) highlights this issue in a recent study of the effects of child care regulations on parental child care choices and the supply of child care workers.

[11] See Besley and Case (2000) for a discussion of the endogeneity of regulations and the consequences for estimating their impacts on behavioral choices.

He stresses that although many previous studies of the effects of child care regulations on choice of child care mode and other outcomes have relied on cross-state variation in regulations, stable coefficient estimates are obtained only when state and year effects are included in the estimating equations. Hence, we control for differences across states (and their populations) by controlling for state fixed effects in most of our analyses.[12] In our analyses of accident rates using the NLSY data, we also employ child-specific fixed effects to control for differences across parents that may be correlated with their state of residence and thus with regulations, and also to control for potential reporting biases. To our knowledge, our work represents the most extensive effort to date to account for the potential endogeneity of regulation in models of child outcomes.

Data limitations, both in terms of the quality of information and the number of years for which we have information on child care arrangements of children—we only have reliable data for children of ages 1 and 2—limit our ability to implement these strategies in our analysis of the effects of regulations on child care mode choices. For the latter analyses, we limit our specifications to controlling for fixed effects for geographical regions of the country (e.g., New England, Mountain and Pacific states) and do not include child-specific fixed effects. Thus, we consider our estimates of the effects of regulations on child care mode choices to be more susceptible to the endogeneity biases noted above than is the case for our estimates of regulation effects on childhood accidents. On the other hand, we are able to exploit the fact that regulation of day care centers should have its most direct impact on the use of centers, while regulation of family homes should have a greater impact on the use of more informal types of care.

More precisely, for our analyses of accidents in the NLSY data, we estimate models of the following form:

$$\begin{aligned}\text{ACCIDENT}_{it} &= \alpha_i + \alpha_1' \text{CCREG}_{it} + \alpha_2' X_{it} + \alpha_3' \text{SEASON}_t + \alpha_{4t} \text{STATE}_{it} \\ &\quad + \alpha_{5t} \text{YEAR}_t + \varepsilon_{it} \end{aligned} \tag{1}$$

where ACCIDENT is a dummy variable equal to 1 if child i was reported to have had an accident requiring medical attention in quarter t; CCREG a vector of variables describing the regulatory regime; X a vector of child and household characteristics, such as maternal and child age; SEASON a vector of dummy variables for the season of the year; STATE a vector of state dummy variables that is equal to 1 for the state in which the child resides in year t and 0 otherwise; and YEAR is a vector of year dummies. Also note that we allow α to vary across children, i.e., the vector of α_i's represent child-specific fixed effects.

We also estimate variants of this specification that allow for different effects of regulations across various subgroups in our data by interacting the CCREG vector with indicator variables for these subgroups. In particular, we examine how the effects of regulations vary by race, the education of the mother, and the mother's work status. Examining differences in the impacts of regulations across these groups provides an important check on the plausibility of our findings. For example, one might expect that child care regulations should

[12] We have also reestimated our NLSY models using only data on children whose families did not change states over the period for which their behavior is analyzed. This subgroup was 92% as large as the full sample of children. The estimates in this restricted sample were very similar to those reported below.

have a greater impact on the children of employed mothers, than on the children of mothers who are not employed, since the former are more likely than the latter to use child care. Similarly, more educated mothers are more likely to use child care centers, and so may be more likely to be affected by regulations in this sector.

To estimate the effects of regulations on the child care modes chosen by parents for their children, we make use of multinomial logit methods. In particular, we employ the universal logit specification in which we specify the following index functions for the "formal" and "informal" modes of child care:

$$I_{it}^{m} = \beta_{m0} + \beta'_{m1}\mathrm{CCREG}_{it} + \beta'_{m2}X_{it} + \beta'_{m3}\mathrm{SEASON}_{t} + \beta'_{m4}\mathrm{REGION}_{t} + \beta'_{m5}\mathrm{YEAR}_{t} + \varepsilon_{it}^{m} \tag{2}$$

where m denotes the mode choice ($m = 1$ for day care center or nursery school, $m = 2$ for other modes of non-parental care, and $m = 3$ for parental care) and ε_{it}^{m} is a mean-zero, extreme value random error that is independently distributed across modes. It follows that the observed mode choice satisfies the following condition:

$$\text{Observe } m \text{ if and only if } I_{it}^{m} = \max_{j\in 1,2,3}\{I_{it}^{j}\} \tag{3}$$

As is standard in the identification of multinomial logit models, we normalize all of the coefficients for one of the mode choices—$m = 3$ in our case—to 0. Below, we do not present the estimates of the β_m's but rather we present estimates of the marginal effects of the covariates included in the specifications of the index functions in (2) on the probability of choosing a particular mode. This estimate captures the direct and indirect effects of a particular covariate on the likelihood of choosing a particular mode (estimates of the standard errors for these marginal effects are also presented below). As with our analysis of accidents, we examine how the effects of regulations vary across subgroups by also interacting the regulation variables in (2) with subgroup indicators.

We use the combined Vital Statistics and CPS data to estimate models of the following form:

$$\mathrm{ACCMORT}_{gst} = \delta_i + \delta_1\mathrm{YOUNG}_{gst} + \delta_2\mathrm{BLACK}_{gst} + \delta'_3\mathrm{CCREG}_{st} + \delta'_4\mathrm{CCREG}_{st}\cdot\mathrm{YOUNG}_{gst} + \delta'_5\mathrm{CPS}_{st} + \delta_{6s}\mathrm{STATE}_{s} + \delta_{7t}\mathrm{YEAR}_{t} + \xi_{it} \tag{4}$$

where g indexes the demographic group, s indexes the state, t indexes the year, ACCMORT is the mortality rate in the cell, YOUNG indicates that the group is 0–4, BLACK indicates that the group is black, CPS is a vector of other characteristics of states and years constructed using the CPS, STATE is a vector of state dummies, YEAR is a vector of YEAR dummies, and ξ is an error term. All models are estimated by weighted least squares, where the weights are given by the cell sizes.

This model takes a "difference-in-differences" approach to identifying the effects of child care regulations on childhood accidents, where we use children, ages 5–9, as a control group that we hypothesize is less directly affected by these regulations. If there are unmeasured characteristics of states and years that are associated with the passage of child care regulation, then these will be reflected in δ_3, the vector of coefficients that measures the "effects"

of child care regulation on 5–9-year-old children. The true effects of regulation are then given by δ_4, the vector of coefficients on the interaction of YOUNG and CCREG.

5. Estimation results

5.1. Regulation and the choice of child care mode

Table 5 presents results on the effects of state regulations on the parents' choice of child care arrangements. Panel A presents estimates of the marginal effect of a change in these regulations, and those of other variables, on the probability of choosing day care centers and pre-schools and of less formal modes of child care, while panel B summarizes how the estimated effects of the regulation vary by race and mother's educational attainment. The estimates in both panels of Table 5 provide evidence that the child care regulations we examine are binding and affect the child care choices made by parents. These estimates also shed light on the potential crowd out effects of regulations, and on spillovers between regulation of child care centers and family homes. The estimates show that increasing the number of annual inspections of day care centers has a large negative effect on the probability that this form of care is chosen. Increasing the education requirements for day care center directors also has a statistically significant negative effect on the probability that centers are chosen, though the effect is smaller. Increasing the requirements for center directors also increases the probability that other forms of non-maternal care are chosen. Other forms of regulation have no significant effects in the model for all children.

Panel B of Table 5 shows that there are some interesting differences in the effects of regulation by race and maternal education. More stringent regulations regarding the inspection and education requirements in day care centers have significant impacts on white women, and on more educated women (rather than high school dropouts). Increasing the child-staff ratio in day care centers also appears to encourage white women to use centers. Increasing the education requirements for providers in family homes encourages black women to substitute out of other forms of care and into child care centers. While at first blush one might expect women of lower socio-economic status to be most affected by crowd-out, these results make sense when one considers that women of higher socio-economic status are more likely to be using center-based care to begin with.

Turning to less formal care, the bottom half of panel B of this table shows that increasing the frequency of inspection in family homes has a strong positive effect on the usage of such care by college educated women. Minimum education requirements for day care center directors encourage the use of other forms of care among women with high school educations, while minimum education requirements for family home providers discourage the use of other modes of non-parental care among black women. Finally, higher maximum child-staff ratios in day care centers encourage women to use other sources of non-maternal care, while higher maximum child-staff ratios in family homes have the opposite effect. These latter results suggest that women who are likely use other forms of non-maternal care (besides day care centers) do not like large child-staff ratios.

The coefficients on other variables are broadly consistent with what one might expect given the existing literature on choice of child care modes. More educated mothers are more

Table 5
Choice of child care mode from multinomial logit analysis, children, ages 1 and 2 (1987–1998)

Variable	Estimate	Variable	Estimate	Variable	Estimate
Panel A: estimated effects for full sample					
Day care centers and pre-schools					
No. of annual inspections, DC	−0.0193** (0.0091)	Single mother	0.0080 (0.0092)	1987	−0.0990*** (0.0263)
No. of annual inspections, FH	−0.0025 (0.0054)	AFQT percentile test score	0.0709*** (0.0185)	1988	−0.0701*** (0.0242)
Minimum educational requirement of DC directors	−0.0018** (0.0009)	Mother is HS graduate	0.0387** (0.0182)	1989	−0.0733*** (0.0259)
Minimum educational requirement of FH providers	0.0010 (0.0012)	Mother has some college	0.0569*** (0.0187)	1990	−0.0650*** (0.0238)
Child-to-staff ratio, DC	0.0009 (0.0012)	Mother has college degree	0.0432** (0.0206)	1991	−0.0850*** (0.0250)
Child-to-staff ratio, FH	0.0006 (0.0015)	Maternal grandma HS graduate	0.0160* (0.0087)	1992	−0.0518** (0.0231)
Younger sibling present	−0.0331*** (0.0126)	Maternal grandma some college	0.0070 (0.0137)	1993	−0.1026*** (0.0258)
Older sibling present	−0.0376*** (0.0078)	Maternal grandma college graduate	−0.0135 (0.0155)	1994	−0.0396* (0.0235)
Child is male	0.0076 (0.0070)	Maternal grandma's education missing	−0.0048 (0.0178)	1995	−0.0986*** (0.0255)
Hispanic	0.0113 (0.0114)	Mother 20–29 years old	0.0004 (0.0306)	1996	−0.0662** (0.0262)
Black	0.0377*** (0.0110)	Mother 30–39 years old	−0.0060 (0.0299)	1997	−0.0842*** (0.0208)
Grandma worked when mother 14	0.0202*** (0.0075)	Child 2 years old	−0.0015 (0.0067)	Constant	−0.1391*** (0.0467)
Grandma worked data missing	0.0816*** (0.0179)	Fall quarter	0.0193*** (0.0070)		
Grandpa worked when mother 14	0.0327* (0.0175)	Summer quarter	0.0187*** (0.0065)		
Grandma worked data missing	0.0462** (0.0189)	Spring quarter	0.0055** (0.0026)		
P-values (test of all regulation variance = 0)	0.0108				
Other modes of non-parental child care					
No. of annual inspections, DC	−0.0104 (0.0166)	Single mother	0.0039 (0.0181)	1987	0.0268 (0.0673)
No. of annual inspections, FH	0.0065 (0.0114)	AFQT percentile test score	0.1181*** (0.0396)	1988	0.0356 (0.0644)
Minimum educational requirement of DC directors	0.0043** (0.0020)	Mother is HS graduate	0.1288*** (0.0303)	1989	0.0465 (0.0668)
Minimum educational requirement of FH providers	−0.0006 (0.0027)	Mother has some college	0.1874*** (0.0321)	1990	0.0691 (0.0634)
Child-to-staff ratio, DC	0.0040 (0.0032)	Mother has college degree	0.1797*** (0.0372)	1991	−0.0282 (0.0656)

Table 5 (*Continued*)

Variable	Estimate	Variable	Estimate	Variable	Estimate
Child-to-staff ratio, FH	−0.0041 (0.0030)	Maternal grandma HS graduate	−0.0445** (0.0179)	1992	0.0172 (0.0630)
Younger sibling present	−0.1100*** (0.0224)	Maternal grandma some college	−0.0775*** (0.0273)	1993	−0.0725 (0.0671)
Older sibling present	−0.0881*** (0.0157)	Maternal grandma college graduate	−0.1666*** (0.0350)	1994	0.0405 (0.0636)
Child is male	−0.0049 (0.0140)	Maternal grandma's education missing	−0.0304 (0.0373)	1995	−0.1573** (0.0672)
Hispanic	0.0331 (0.0227)	Mother 20–29 years old	0.3530** (0.1588)	1996	−0.1309* (0.0685)
Black	0.0292 (0.0222)	Mother 30–39 years old	0.3884** (0.1584)	1997	−0.1831*** (0.0592)
Grandma worked when mother 14	0.0363** (0.0142)	Child 2 years old	−0.0488*** (0.0156)	Constant	−0.6821*** (0.1666)
Grandma worked data missing	−0.0428 (0.0583)	Fall quarter	0.0123 (0.0153)		
Grandpa worked when mother 14	0.0152 (0.0299)	Summer quarter	0.0107 (0.0142)		
Grandma worked data missing	−0.0441 (0.0336)	Spring quarter	−0.0014 (0.0058)		
P-values (test of all regulation variance = 0)	0.2601				

Variable	White	Black	<HS	HS	Any college
Panel B: estimated effects of regulations by race and mother's educational attainment					
Day care centers and pre-schools					
No. of annual inspections, DC	−0.0189* (0.0108)	−0.0128 (0.0134)	−0.0197 (0.0367)	−0.0042 (0.0149)	−0.0258** (0.0107)
No. of annual inspections, FH	−0.0042 (0.0069)	−0.0060 (0.0086)	0.0013 (0.0269)	−0.0140 (0.0086)	0.0041 (0.0069)
Minimum educational requirement of DC directors	−0.0028*** (0.0010)	−0.0001 (0.0014)	0.0029 (0.0042)	−0.0026** (0.0013)	−0.0017 (0.0011)
Minimum educational requirement of FH providers	−0.0001 (0.0014)	0.0028* (0.0016)	0.0003 (0.0054)	0.0028* (0.0017)	0.0003 (0.0014)
Child-to-staff ratio, DC	0.0029** (0.0015)	−0.0013 (0.0019)	0.0011 (0.0048)	0.0020 (0.0017)	0.0002 (0.0016)
Child-to-staff ratio, FH	0.0004 (0.0019)	0.0014 (0.0022)	−0.0062 (0.0058)	−0.0032 (0.0029)	0.0025 (0.0017)
P-values (test of all regulation variance = 0)	0.0018	0.2495	0.9114	0.0237	0.0630
Other modes of non-parental child care					
No. of annual inspections, DC	−0.0058 (0.0199)	−0.0047 (0.0268)	−0.0123 (0.0502)	−0.0297 (0.0261)	−0.0102 (0.0211)

No. of annual inspections, FH	0.0178 (0.0129)	−0.0233 (0.0206)	0.0072 (0.0451)	−0.0096 (0.0162)	0.0277* (0.0149)
Minimum educational requirement of DC directors	0.0041* (0.0024)	0.0043 (0.0033)	0.0033 (0.0061)	0.0059** (0.0029)	0.0039 (0.0027)
Minimum educational requirement of FH providers	0.0024 (0.0031)	−0.0089** (0.0045)	−0.0005 (0.0084)	−0.0035 (0.0040)	0.0017 (0.0033)
Child-to-staff ratio, DC	0.0028 (0.0038)	0.0072 (0.0044)	0.0030 (0.0070)	0.0126*** (0.0040)	−0.0050 (0.0040)
Child-to-staff ratio, FH	−0.0014 (0.0034)	−0.0118* (0.0064)	0.0031 (0.0099)	−0.0074 (0.0048)	−0.0020 (0.0041)
P-values (test of all regulation variance = 0)	0.5067	0.0559	0.9859	0.0130	0.2552

NLSYCM data: marginal effects of variables on probability of mode choice reported. Models in panel A also includes regional (i.e., New England, Mid Atlantic, Mountain, etc.) fixed effects. The models in panel B also included all of the variables included in panel A. Asymptotic standard errors in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

likely to use center-based care, and within education groups, higher AFQT mothers are also. Children with either older or younger siblings are less likely to use any form of child care, suggesting that *only* children are more likely to be in such care. Black children are more likely to use center-based care than other children, and Hispanic children are more likely to use such care than other whites.

In summary, while small sample sizes preclude the use of state or child fixed effects, these estimates appear to be very reasonable in that more stringent regulation of day care centers reduces the use of centers and encourages the use of other forms of non-maternal care, while more stringent regulation of family homes tends to encourage the use of day care centers, or no care. These estimates suggest that child care regulation does bind, at least in terms of choice of child care mode, and that stricter regulation is associated with children being squeezed out of regulated care.

5.2. *Results for accidents requiring medical attention*

Tables 6 and 7 present results for the effects of regulations on the likelihood that a child experiences an accident requiring medical attention in a given quarter. The regression specifications used to produce the estimates in Table 6 included state and time fixed effects, while those in Table 7 included fixed effects for each child in the sample. Each table includes three panels: panel A displays estimates for the entire sample and panels B and C display estimates of the effects of regulations for different demographic groups. Consider first the results in panel A of Table 6. There we find that minimum education requirements for day care center directors have a significant negative effect on accident rates. Comparing the coefficient estimate of -0.0012 to the means in Table 3 suggests that increasing the education requirement by 2 years would reduce accident rates by 8%. None of the estimates for the other regulation variables are statistically different from zero.

Most of the coefficient estimates for the other variables displayed in panel A of Table 6 follow the patterns one might expect on the basis of the epidemiological literature. These results are of interest given that the epidemiological literature seldom looks at the effects of covariates in a multivariate context. We find that, other things being equal, children with younger siblings are 6% less likely to have accidents, while boys are 9% more likely to have accidents than girls. Children of single mothers are also more likely to be at risk. The risk of accidents varies considerably by age, being significantly greater for toddlers than for older or younger children. We also see the seasonal pattern that has been noted by others, with the lowest accident rates being in the winter quarter and the highest in the summer.

There are however, some coefficients that suggest the possibility of systematic differences in either the propensity to seek medical attention or in reporting between groups. For example, black mothers are less likely to report accidents requiring medical attention, even though we know that black children are at much higher risk of accidental deaths than white children. And we find no statistically significant effect of maternal education, even though we expect true accident rates to be lower for more educated mothers.

Panels B and C of Table 6 show how the estimated effects of regulations on the probability of an accident vary with race, maternal education, age of child and maternal employment. It is striking that although there is some variation, the effects of minimum

Table 6
Estimates of the effects of child care regulations on accidents, children, ages 1–5 (1987–1998) includes state fixed effects

Variable	Estimate	Variable	Estimate	Variable	Estimate
Panel A: estimated effects for full sample					
No. of annual inspections, DC	−0.00002 (0.0027)	AFQT score missing	−0.0066 (0.0043)	Spring quarter	0.0314*** (0.0026)
No. of annual inspections, FH	−0.0036 (0.0058)	Mother is HS graduate	0.0007 (0.0027)	1987	−0.0905*** (0.0077)
Minimum educational requirement of DC directors	−0.0012** (0.0005)	Mother has some college	0.0008 (0.0031)	1988	−0.0062 (0.0060)
Minimum educational requirement of FH providers	−0.0001 (0.0004)	Mother has college degree	−0.0035 (0.0039)	1989	−0.0857*** (0.0079)
Child-to-staff ratio, DC	0.00002 (0.0003)	Mother's education missing	−0.0145 (0.0233)	1990	−0.0154*** (0.0057)
Child-to-staff ratio, FH	−0.0008 (0.0005)	Maternal grandma HS graduate	0.0009 (0.0021)	1991	−0.0863*** (0.0074)
Younger sibling present	−0.0063*** (0.0021)	Maternal grandma some college	−0.0033 (0.0031)	1992	−0.0038 (0.0057)
Older sibling present	0.0020 (0.0021)	Maternal grandma college graduate	0.0025 (0.0045)	1993	−0.0884*** (0.0075)
Child is male	0.0090*** (0.0016)	Maternal grandma's education missing	0.0021 (0.0034)	1994	−0.0188*** (0.0053)
Hispanic	−0.0099*** (0.0028)	Mother 20–29 years old	0.0121 (0.0099)	1995	−0.0775*** (0.0069)
Black	−0.0156*** (0.0025)	Mother 30–39 years old	0.0081 (0.0096)	1996	−0.0015 (0.0060)
Grandma worked when mother 14	0.0019 (0.0017)	Child 2 years old	0.0089*** (0.0030)	1997	−0.0757*** (0.0066)
Grandma worked data missing	0.0021 (0.0066)	Child 3 years old	0.0082** (0.0034)	Constant	0.0248* (0.0134)
Grandpa worked when mother 14	0.0042 (0.0033)	Child 4 years old	0.0026 (0.0038)		
Grandpa worked data missing	0.0031 (0.0036)	Child 5 years old	0.0037 (0.0046)		
Single mother	0.0059*** (0.0020)	Fall quarter	0.0726*** (0.0054)		
AFQT percentile test score	0.0002*** (0.00005)	Summer quarter	0.0797*** (0.0055)		
Observations	49255				
R^2	0.02				
P-values					
Test of inspection regression = 0	0.8053				
Test of education requirement regression = 0	*0.0223*				
Test of child-staff ratio regression = 0	0.3397				
Test of all regulation variance = 0	0.1203				

Table 6 (*Continued*)

Variable	Whites	Blacks	<HS	HS	Any college
Panel B: estimated effects of regulations by race and mother's educational attainment					
No. of annual inspections, DC	−0.0008 (0.0031)	0.0013 (0.0032)	0.0062 (0.0064)	−0.0001 (0.0033)	−0.0014 (0.0031)
No. of annual inspections, FH	−0.0032 (0.0058)	−0.0055 (0.0063)	−0.0026 (0.0064)	−0.0043 (0.0059)	−0.0033 (0.0059)
Minimum educational requirement of DC directors	−0.0013** (0.0006)	−0.0012** (0.0005)	**−0.0002** (0.0006)	**−0.0013***** (0.0005)	**−0.0013**** (0.0006)
Minimum educational requirement of FH providers	−0.0001 (0.0004)	−0.0002 (0.0004)	0.0015 (0.0012)	−0.0002 (0.0004)	−0.0004 (0.0004)
Child-to-staff ratio, DC	0.0001 (0.0004)	−0.0002 (0.0004)	0.0003 (0.0005)	0.0001 (0.0004)	−0.0001 (0.0004)
Child-to-staff ratio, FH	**−0.0016***** (0.0006)	**0.0004** (0.0008)	−0.0019*** (0.0007)	−0.0005 (0.0007)	−0.0007 (0.0007)
R^2	0.02		0.02		
P-values					
Test of inspection regression = 0	0.7883	0.6793	0.6024	0.7455	0.635
Test of education requirement regression = 0	*0.0984*	*0.0151*	0.4351	*0.0173*	*0.0298*
Test of child-staff ratio regression = 0	*0.0178*	0.7306	*0.0298*	0.7887	0.4958
Test of all regulation variance = 0	*0.0455*	0.1541	0.1736	0.1551	0.1329

Variable		Ages 1–3	Ages 4–5	Mother does not work	Mother works
Panel C: estimated effects of regulations by children's age and mother's work status					
No. of annual inspections, DC		0.0012 (0.0031)	−0.0012 (0.0031)	−0.0001 (0.0033)	−0.0002 (0.0029)
No. of annual inspections, FH		−0.0049 (0.0059)	−0.0017 (0.0059)	−0.0045 (0.0058)	−0.0029 (0.0060)
Minimum educational requirement of DC directors		**−0.0017***** (0.0005)	**−0.0008** (0.0005)	**−0.0007** (0.0005)	**−0.0015***** (0.0005)
Minimum educational requirement of FH providers		−0.0004 (0.0004)	0.0002 (0.0004)	**−0.0007** (0.0005)	**0.0002** (0.0004)
Child-to-staff ratio, DC		**−0.0009** (0.0006)	**0.0001** (0.0004)	**0.0004** (0.0004)	**−0.0002** (0.0004)
Child-to-staff ratio, FH		−0.0006 (0.0007)	−0.0012* (0.0006)	−0.0006 (0.0006)	−0.0009 (0.0007)
R^2		0.02		0.03	

P-values				
Test of inspection regression = 0	0.6968	0.8456	0.7144	0.8601
Test of education requirement regression = 0	*0.0017*	0.2788	*0.0696*	*0.0105*
Test of child-staff ratio regression = 0	0.1725	0.1561	0.3622	0.3354
Test of all regulation variance = 0	*0.0192*	0.3498	0.2615	*0.0783*

Data from NLSYCM Models in panel A also includes state fixed effects. Models in panels B and C also included all of the variables included in panel A models. Sets of estimates denoted in bold indicate regulation effects that are significantly different at the 10% level across the specific subgroups. Asymptotic standard errors in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

Table 7
Estimates of the effects of child care regulation on accidents, children, ages 1–5 (1987–1998) includes child and state fixed effects

Variable	Estimate	Variable	Estimate	Variable	Estimate
Panel A: estimated effects for full sample					
No. of annual inspections, DC	−0.0012 (0.0045)	Child 3 years old	0.0131** (0.0065)	1993	−0.0863*** (0.0149)
No. of annual inspections, FH	−0.0032 (0.0081)	Child 4 years old	0.0084 (0.0091)	1994	−0.0108 (0.0119)
Minimum educational requirement of DC directors	−0.0019** (0.0007)	Child 5 years old	0.0129 (0.0118)	1995	−0.0762*** (0.0105)
Minimum educational requirement of FH providers	−0.0003 (0.0006)	Fall quarter	0.0754*** (0.0042)	1996	0.0035 (0.0079)
Child-to-staff ratio, DC	0.000003 (0.0004)	Summer quarter	0.0811*** (0.0036)	1997	−0.0841*** (0.0072)
Child-to-staff ratio, FH	−0.0009 (0.0006)	Spring quarter	0.0309*** (0.0023)	Constant	0.0228 (0.0306)
Younger sibling present	−0.0083** (0.0033)	1987	−0.0768*** (0.0293)		
Older sibling present	−0.0007 (0.0044)	1988	0.0088 (0.0268)		
Single mother	0.0188 (0.0134)	1989	−0.0768*** (0.0243)		
Mother 20–29 years old	0.0159 (0.0129)	1990	−0.0029 (0.0217)		
Mother 30–39 years old	0.0160 (0.0129)	1991	−0.0797*** (0.0193)		
Child 2 years old	0.0101** (0.0042)	1992	0.0060 (0.0167)		
Total no. of observations	49255				
Number of children	6702				
R^2	0.02				
P-values					
Test of inspection regression = 0	0.8678				
Test of education requirement regression = 0	*0.0243*				
Test of child-staff ratio regression = 0	0.3436				
Test of all regulation variance = 0	0.1412				

Variable	Whites	Blacks	<HS	HS	Any college
Panel B: estimated effects of regulations by race and mother's educational attainment					
No. of annual inspections, DC	−0.0021 (0.0057)	0.0013 (0.0067)	−0.0027 (0.0125)	0.0030 (0.0065)	−0.0047 (0.0060)
No. of annual inspections, FH	−0.0034 (0.0083)	−0.0018 (0.0127)	0.0057 (0.0129)	−0.0068 (0.0091)	−0.0006 (0.0100)
Minimum educational requirement of DC directors	**−0.0030***** (0.0010)	**−0.0009** (0.0009)	−0.0007 (0.0018)	−0.0022** (0.0010)	−0.0018* (0.0010)

Minimum educational requirement of FH providers	0.0001 (0.0007)	−0.0010 (0.0009)	−0.0002 (0.0015)	−0.0006 (0.0009)	0.00005 (0.0008)
Child-to-staff ratio, DC	−0.0000001 (0.0005)	0.00001 (0.0005)	0.0008 (0.0007)	0.00001 (0.0005)	−0.0002 (0.0005)
Child-to-staff ratio, FH	−**0.0020**** (0.0008)	**0.0006** (0.0010)	−**0.0014** (0.0016)	**0.0006** (0.0009)	−**0.0025***** (0.0009)
R^2	0.02		0.02		
P-values					
Test of inspection regression = 0	0.8365	0.9793	0.9046	0.7182	0.7036
Test of education requirement regression = 0	*0.0114*	0.2537	0.9081	*0.0349*	0.2038
Test of child-staff ratio regression = 0	*0.0521*	0.8182	0.4238	0.7768	*0.0238*
Test of all regulation variance = 0	*0.0217*	0.7811	0.8972	0.2368	*0.0249*

Variable	Ages 1–3	Ages 4–5	Mother does not work	Mother works
Panel C: estimated effects of regulations by children's age and mother's work status				
No. of annual inspections, DC	−0.0003 (0.0048)	−0.0006 (0.0050)	−0.0037 (0.0056)	−0.0009 (0.0048)
No. of annual inspections, FH	−**0.0033** (0.0083)	**0.0008** (0.0086)	−0.0032 (0.0083)	−0.0021 (0.0083)
Minimum educational requirement of DC directors	−0.0020*** (0.0008)	−0.0019** (0.0008)	−**0.0007** (0.0008)	−**0.0026***** (0.0008)
Minimum educational requirement of FH providers	−**0.0011** (0.0007)	−**0.00007** (0.0006)	−**0.0015*** (0.0008)	**0.0004** (0.0006)
Child-to-staff ratio, DC	−0.0011* (0.0007)	−0.0001 (0.0005)	**0.0005** (0.0005)	−**0.0003** (0.0005)
Child-to-staff ratio, FH	−0.0005 (0.0007)	−0.0019** (0.0009)	−0.0005 (0.0009)	−0.0013 (0.0008)
R^2	0.02		0.03	
P-values				
Test of inspection regression = 0	0.9114	0.9893	0.6873	0.9371
Test of education requirement regression = 0	*0.0034*	*0.0707*	*0.0722*	*0.0039*
Test of child-staff ratio regression = 0	0.2143	0.1025	0.5516	0.2149
Test of all regulation variance = 0	*0.0272*	0.1132	0.3284	*0.0298*

Data from NLSYCM. Models in panel A also includes state fixed effects. Models in panels B and C also included all of the variables included in panel A models. Sets of estimates denoted in bold indicate regulation effects that are significantly different at the 10% level across the specific subgroups. Asymptotic standard errors in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

education requirements are similar across most groups. These estimates suggest that the effects of minimum education requirements for day care center directors are similar for both black and white mothers, but that they are greater for women with at least high school educations. These regulations also have a greater effect on children of working mothers than on children of non-working mothers, as one would expect since the former are more likely to be in care. Higher maximum child-staff ratios are also estimated to have negative effects on accident rates among whites, and among children of high school dropouts. It is possible that looser regulation in this regard reduces accident rates by drawing children into regulated care. Finally, higher education requirements in family homes are estimated to increase accident rates among children of high school dropouts, perhaps by squeezing them out of the regulated sector.

As noted above, child-specific fixed effects offer a powerful way to control for the possible maternal differences in the propensity to report accidents. Coefficient estimates for specifications that control for child-specific fixed effects are displayed in the three panels of Table 7. The results in panel A of this table are qualitatively similar to those found in Table 6, though the estimated effect of minimum education requirements for day care center directors is larger than those found in the former table. Comparing this coefficient to the mean accident rate in Table 3 implies that increasing educational requirements by 2 years would reduce accident rates by 13%. However, since in principle, the child-fixed effects estimates are purged of much maternal reporting bias, it may be more appropriate to compare the estimated coefficient with a baseline from the epidemiological literature. As discussed above, the literature suggests that approximately 9% of children have an injury requiring medical attention in each quarter, which suggests that increasing minimum education requirements on center directors by 2 years would reduce injury rates by 4%.

Panels B and C of Table 7 display the estimates we obtain when we allow effects to vary with race, education, and maternal employment status. The main qualitative difference between these estimates and those obtained using state fixed effects, is that we now find that the effects of minimum education requirements for day care directors are concentrated among whites, and are not statistically significant for blacks. This set of results suggests that black under-reporting of accident rates is greater in states with stricter regulation, generating a spurious negative correlation between strict regulation and low accident rates in models that do not control adequately for the maternal propensity to report accidents.

We also find that lower child-staff ratios in family homes, which were associated with higher accident rates for children of high school dropouts in panel B of Table 6, are associated with higher accident rates only among children of college educated mothers once child fixed effects are included in the model.

Where they are statistically significant, the point estimates in panels B and C of Table 7 are also larger in absolute value than those in the corresponding panel of Table 6. For example, they suggest that among whites, increasing the education required of day care center directors by 2 years would reduce accident rates by between 7 and 18%, depending on whether we take a 9 or a 3.3% accident rate as our base.

In summary, the results so far paint a remarkably consistent picture of the effects of minimum education requirements for day care center directors. These regulations reduce accident rates. Effects are concentrated among whites, and among children of mothers with at least a college education which is perhaps unsurprising that these are the children

most likely to be using day care centers. The estimated coefficients are much larger among children of working mothers than among children of non-working mothers, as one would expect if they measure a causal effect of child care regulation. However, these minimum education requirements tend to crowd white children and children of more educated mothers out of day care centers and pre-schools.

In contrast, regulations requiring inspections crowd children out of day care centers, but do not have any significant effect on accident rates. Regulation of child-staff ratios has more complex effects. Lower ratios in day care centers crowd children out of centers and into less regulated care, while lower ratios in family homes encourage families to use other forms of non-maternal care. However, lower ratios in family homes are also associated with higher accident rates.

5.3. Results using Vital Statistics data

Models based on specification (4) were estimated using the aggregate Vital Statistics data and are shown in Table 8. Our main concern here is to verify whether the patterns we obtained for medically attended injuries in the NLSYCM data are consistent with those derived for the more objectively reported Vital Statistics data. The table shows the determinants of death rates from all accidents that are not car related, accidents to car passengers, car-pedestrian accidents, and cancer. As discussed above, we include cancer deaths as controls as one would not expect them to be affected by child care regulation.

We expect child care regulations to have larger effects on 1–4 years old than on 5–9 years old, since older children are much less likely to be in care. Thus, our main focus is on the interaction between "YOUNG" and the child care regulations. If it were the case that child care regulation had no effect on 5–9 years old, then we could interpret any statistically significant coefficients on the "main effects" of regulation as evidence that regulatory policies were more likely to be adopted in states with higher/lower rates of accidental mortality than in others. However, concerns about policy endogeneity should be less acute for minimum education requirements as these are less likely to be enacted in response to accidents in child care then regulations governing inspections and ratios—instead, minimum education requirements are likely to reflect a desire to provide more developmentally appropriate care.

Estimates for the 1987–1998 sample are shown in panel A of Table 8. The coefficient on the interaction between YOUNG and minimum education requirements is negative and statistically significant for non-car accidents, but is not significant for accidents to car passengers, accidents involving cars and pedestrians, or for cancer deaths, and the main effects are not statistically significant. These estimates indicate that increasing the minimum education required of day care center directors by 2 years would reduce deaths by 1.8 per 100,000. Comparing this reduction to a baseline of 215 accidental deaths (excluding those to automobile passengers) per 100,000 per year in this 0–4-year-old group, and assuming that 20% of these deaths occur while children are in care, implies that minimum education requirements could reduce child care-related deaths by 4%.

We also present estimates of the same specification for the 1983–1988 period in panel B of Table 8. The estimated effect of minimum education requirements for day care center directors is somewhat larger in this longer time period and implies that an increase in these requirements by 2 years would reduce child care-related deaths by 6%. The main effect of

Table 8
Child care regulation and deaths, children ages 1–9

Variable	Cause of death			
	Non-car accident	Car-pedestrian accident	Car passenger accident	Cancer
Panel A: effects estimated over period 1987–1998				
No. of annual inspections, DC	−0.0004 (0.0046)	0.0005 (0.0011)	−0.0040** (0.0016)	0.0014 (0.0016)
No. of annual inspections, FH	−0.0075 (0.0061)	−0.0032** (0.0014)	0.0034 (0.0021)	−0.0007 (0.0022)
Minimum educational requirement of DC directors	0.0011 (0.0007)	−0.0002 (0.0002)	−0.0003 (0.0002)	−0.0001 (0.0003)
Minimum educational requirement of FH providers	−0.0003 (0.0006)	−0.0005*** (0.0001)	−0.0001 (0.0002)	0.0001 (0.0002)
Child-to-staff ratio, DC	−0.0034*** (0.0006)	−0.00005 (0.0001)	−0.0002 (0.0002)	0.00003 (0.0002)
Child-to-staff ratio, FH	0.0004 (0.0011)	0.0002 (0.0003)	−0.0010*** (0.0004)	−(0.0004 (0.0004)
No. of annual inspections, DC × young	**0.0039 (0.0042)**	**−0.0001 (0.0010)**	**0.0032**** **(0.0015)**	**−0.0012 (0.0015)**
No. of annual inspections, FH × young	**0.0113***** **(0.0031)**	**0.0003 (0.0007)**	**−0.0006 (0.0011)**	**0.0008 (0.0011)**
Minimum educational requirement of DC directors × young	**−0.0009*** **(0.0006)**	**0.0002 (0.0001)**	**0.00005 (0.0002)**	**−0.0002 (0.0002)**
Minimum educational requirement of FH providers × young	**−0.0004 (0.0006)**	**0.0005***** **(0.0001)**	**0.0002 (0.0002)**	**−0.0003 (0.0002)**
Child-to-staff ratio, DC × young	**0.0019**** **(0.0010)**	**0.0001 (0.0002)**	**0.0009***** **(0.0003)**	**0.0001 (0.0004)**
Child-to-staff ratio, FH × young	**0.0029*** **(0.0016)**	**0.0001 (0.0004)**	**0.0011*** **(0.0006)**	**0.0001 (0.0006)**
Child black	0.1248*** (0.0030)	0.0167*** (0.0007)	0.0069*** (0.0010)	−0.0009 (0.0011)
Young children (ages 1–4)	0.0605*** (0.0158)	−0.0089** (0.0036)	−0.0157*** (0.0054)	0.0058 (0.0056)
Working mom	0.0203 (0.0391)	0.0034 (0.0090)	0.0028 (0.0135)	0.0086 (0.0139)
Black	0.0020 (0.0640)	0.0082 (0.0146)	0.0264 (0.0221)	−0.0245 (0.0228)
Hispanic	−0.0133 (0.0630)	−0.0065 (0.0144)	−0.0203 (0.0217)	0.0142 (0.0224)
Median income	7.04E-08 (1.16E-06)	4.97E-07* (2.60E-07)	6.56E-08 (4.00E-07)	−5.79E-08 (4.10E-07)
Mother with HS degree	0.0252 (0.0531)	−0.0025 (0.0121)	−0.0067 (0.0183)	−0.0222 (0.0189)
Single parent household	−0.0241 (0.0519)	0.0163 (0.0119)	−0.0078 (0.0179)	0.0118 (0.0185)
Poverty	−0.0088 (0.1049)	0.0138 (0.0240)	−0.0290 (0.0362)	−0.0029 (0.0374)
R^2	0.76	0.41	0.49	0.23

Panel B: effects estimated over period 1983–1998				
No. of annual inspections, DC	−0.0009 (0.0040)	0.0001 (0.0010)	−0.0028** (0.0014)	0.0016 (0.0014)
No. of annual inspections, FH	−0.0098** (0.0048)	−0.0013 (0.0012)	0.0001 (0.0017)	−0.0004 (0.0017)
Minimum educational requirement of DC directors	0.0009 (0.0006)	−0.0003** (0.0001)	−0.0001 (0.0002)	−0.0001 (0.0002)
Minimum educational requirement of FH providers	−0.0004 (0.0006)	−0.0004*** (0.0001)	−0.0001 (0.0002)	0.0001 (0.0002)
Child-to-staff ratio, DC	−0.0030*** (0.0005)	−0.00001 (0.0001)	−0.0002 (0.0002)	−0.0001 (0.0002)
Child-to-staff ratio, FH	−0.0001 (0.0010)	0.0002 (0.0003)	−0.0008** (0.0004)	−0.0005 (0.0004)
No. of annual inspections, DC × young	**0.0026 (0.0036)**	**0.0011 (0.0009)**	**0.0037*** (0.0013)**	**−0.0023* (0.0013)**
No. of annual inspections, FH × young	**0.0090*** (0.0026)**	**−0.0006 (0.0007)**	**−0.0006 (0.0009)**	**0.0004 (0.0009)**
Minimum educational requirement of DC directors × young	**−0.0012*** (0.0005)**	**0.0001 (0.0001)**	**0.0001 (0.0002)**	**−0.0001 (0.0002)**
Minimum educational requirement of FH providers × young	**−0.0006 (0.0006)**	**0.0005*** (0.0001)**	**0.0002 (0.0002)**	**−0.0003 (0.0002)**
Child-to-staff ratio, DC × young	**0.0029*** (0.0009)**	**0.0002 (0.0002)**	**0.0009*** (0.0003)**	**0.00004 (0.0003)**
Child-to-staff ratio, FH × young	**0.0019 (0.0015)**	**0.00004 (0.0004)**	**0.0008 (0.0005)**	**0.0001 (0.0005)**
Child black	0.1273*** (0.0027)	0.0180*** (0.0007)	0.0048*** (0.0009)	−0.0014 (0.0009)
Young children (ages 1–4)	0.0673*** (0.0137)	−0.0091*** (0.0035)	−0.0151*** (0.0048)	0.0054 (0.0048)
Working mom	0.0487 (0.0342)	0.0084 (0.0086)	0.0124 (0.0119)	0.0249** (0.0120)
Black	−0.0118 (0.0521)	0.0094 (0.0131)	0.0267 (0.0181)	−0.0245 (0.0183)
Hispanic	−0.0511 (0.0532)	−0.0180 (0.0133)	−0.0168 (0.0185)	−0.0003 (0.0187)
Median income	−9.39E-08 (1.03E-06)	5.00E-07* (2.60E-07)	2.30E-09 (3.60E-07)	−8.46E-08 (3.60E-07)
Mother with HS degree	0.0227 (0.0430)	0.0029 (0.0108)	−0.0199 (0.0150)	−0.0133 (0.0151)
Single parent household	−0.0052 (0.0463)	0.0152 (0.0116)	−0.0045 (0.0161)	0.0079 (0.0163)
Poverty	−0.0124 (0.0919)	0.0066 (0.0231)	−0.0497 (0.0320)	−0.0039 (0.0323)
R^2	0.76	0.42	0.47	0.24

Data from Vital Statistics Mortality data. Standard errors in parentheses. Models also include state and year dummies. There were 1990 cells (panel A) and 2497 cells (panel B). All estimates weighted by cell size.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

this variable is however, significant and negative in the model for accidental deaths involving cars and pedestrians which suggests that these requirements are more likely to be adopted in states and years where contact between children and cars is more likely (e.g., in states that are becoming more urban over time).

Higher child-staff ratios in day care centers are estimated to increase non-car accident rates among young children, though the main effect of this variable is negative. Thus, although higher ratios increase accidents, they are more likely to be permitted in states and years with low accident rates. A higher number of inspections in family homes is associated with higher non-car accident rates among young children, though again, the main effect suggests that the number of inspections is likely to be higher in areas that have low overall accident rates.

Finally, it is interesting to note that in both sub-samples, higher educational requirements for family home providers are associated with increases in car-pedestrian accident rates among young children. It is possible that this increase reflects children being crowded into less regulated child care settings.

The control variables constructed using the CPS are generally not statistically significant. This result indicates that it is difficult to control for time-varying state characteristics that may be correlated with accident rates using aggregated CPS data. It is for this reason that we emphasize the difference-in-difference results comparing effects on 0–4-year-old children with effects on older children, and comparing results for different types of accidents to those for cancer deaths.

6. Discussion and conclusions

We find consistent evidence that requiring day care center directors to have more education reduces accident rates. In the NLSY, we find that accidents requiring medical attention are reduced for all children, though effects are stronger among white children and among children of mothers with high school education or more. The estimated coefficients are much larger among children of working mothers than among children of non-working mothers, as one would expect if they measure a causal effect of child care regulation. Estimates obtained using the Vital Statistics data indicate that higher minimum educational requirements for day care center directors also reduce accidental deaths.

Our findings are subject to at least two potential caveats. First, our estimates of the effects of regulation across data sets do not always yield a consistent story. For example, while we find that increasing the number of inspections of day care centers appears to crowd children out of day care centers and pre-schools and increase accidental death rates, we do not find any effect of the number of annual inspections on the incidence of reported accidents measured in the NLSY79. Second, despite examining a fairly extensive set of state child care regulations, our estimates of the effects of these regulation on child care crowd-out and childhood accident rates could be biased by the failure to control for a more complete set of state policies related to child care and child safety. For example, although systematic information is not available on the extent of state subsidies for and/or free provision of child care services to low-income populations, we do know that such care has increased over the time period we examine. To the extent that those states that were increasing the

educational requirements of day care center directors were systematically increasing child care subsidies and/or free care to offset the potential crowd-out effects of more stringent regulations, our estimated effects of this regulation might be biased downward. Whether this policy substitution occurred is unclear, but, in future work, it would be useful to look at a broader menu of state child care policies.

Increasing the education of child care workers is likely to be a costly policy. The median hourly wage for women without a high school education was US$ 6.00 in 1998 compared to US$ 8.61 for women with a high school education. We will concentrate on 2 year increments in minimum education requirements for day care center directors in this discussion, since much of the policy debate in recent years has been focused on whether these workers should be required to have 12, 13, or 14 years of education. Our estimates imply that in a group of 100,000 children, increasing this education requirement by 2 years would reduce the number of accidents by 380 per quarter, or 1520 per year and would also reduce the number of deaths per year by 1.8–2.4.

If the average day care center had 40 children, then it would take 2500 directors to look after these children. If it was necessary to raise the wages of all of these directors by US$ 2.61 and they worked 2000 h per year, then implementing the minimum education policy would cost US$ 13 million per 100,000 children. This estimate implies that the cost per life saved through education requirements is between US$ 5.4 and 7.2 million, which is in the same ball park as the costs of other regulations aimed at saving children's lives (cf. Tengs et al., 1995). However, this is likely to be a high estimate of costs, given that there will be some directors who already meet the new educational requirements.

But minimum education requirements also bring other benefits. The private and public costs associated with childhood accidents for surviving children are substantial. In 1998, the total annual costs of unintentional injuries to children under the age of 15 were estimated to be US$ 157 billion, of which US$ 5 billion were medical costs, US$ 3.3 billion were for earnings lost, and US$ 148 billion were for lost quality of life (National SAFE KIDS Campaign, 2000). On a per-injured-child basis, this amounts to annual average costs of US$ 650 for medical care, US$ 1000 in lost future earnings and US$ 11,000 in lost quality of life. Among children between the ages of 5 and 14, the costs of treating accidents exceed those associated with the treatment of any other condition (National SAFE KIDS Campaign, 2000). Even if we take the very conservative approach of discounting reduced quality of life, reductions in the costs of medical care and foregone wages would offset US$ 2.5 million of the US$ 13 million increase in wage costs per 100,000 children.

Moreover, the main impetus for minimum education requirements is concern about children's cognitive development rather than concern with their physical safety. Many studies suggest that more educated care givers give more developmentally appropriate and cognitively stimulating care than less educated care givers (cf. NICHD Early Child Care Research Network, 1999). Thus, a complete cost–benefit accounting would have to place a dollar figure on these benefits.

Our results indicate that when it comes to child care regulation, the "cup" may be regarded as half empty or half full. On the one hand, some forms of regulation such as direct inspections that are aimed at improving child safety crowd children out of regulated care without appearing to have much effect on accident rates. On the other hand, requiring day care center directors to have more education has positive overall effects on child safety,

even though these regulations cause some children to be crowded out of regulated care. These requirements may also have benefits in terms of children's cognitive skills and future development.

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