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Do "Accidents" Happen? An Examination of Injury Mortality Among Maltreated Children

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Do “Accidents” Happen?
An Examination of Injury Mortality Among Maltreated Children

by

Emily Putnam Hornstein

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ABSTRACT

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Professor Jill Duerr Berrick, Chair

This dissertation is based on a unique dataset constructed by probabilistically linking records across three independent sources of data from California: 1) vital birth records, 2) administrative child protective service records, and 3) vital death records. The final dataset captures 4.3 million children born in California between 1999 – 2006 and includes maltreatment allegation information for over 500,000 children who were reported to child protective services (CPS), as well as death reports on 2,000 children who were fatally injured before age five. Three research questions were examined in the context of a prospective birth cohort analysis: *1) Is a referral to child protective services an independent risk factor for injury mortality? 2) Is allegation disposition associated with injury fatality risk? 3) Does injury fatality risk vary across maltreatment allegation types?* To answer these three questions, a series of multivariate survival models were specified. Separate models were estimated for *overall risk of injury death*, risk of *unintentional injury death*, and risk of *intentional injury death*.

Findings indicate that a prior, non-fatal report to CPS is the strongest predictor of a child's injury death during the first five years of life. Children previously reported for maltreatment died from accidental injuries at twice the rate of their unreported, demographically similar peers, and from intentional injuries at five times the rate. After adjusting for other characteristics, children whose report of maltreatment was evaluated out without an in-person investigation by CPS died of injuries at significantly higher rates than children who had never been reported. Children with a substantiated allegation of maltreatment and no foster care placement died of intentional injuries at over 10 times the rate of children who had not been reported. Placement in foster care for even a single day was protective. Children with a prior allegation of physical abuse died from injuries at rates that were notably higher than not only unreported children, but also children reported for reasons of sexual abuse, neglect, or other forms of maltreatment. When only intentional injury fatalities were modeled, a prior allegation of physical abuse was associated with a rate of death that was 38 times that of children who had not been reported.

This study represents the most rigorous longitudinal analysis of mortality outcomes following a report to CPS to date, with several key implications for practice and policy emerging. First, these data underscore that a child's report to CPS is not random, nor is it simply a function of poverty. Rather, a report to CPS signals a level of risk, including a risk of death, that is greater than sociodemographic factors would alone predict. A second and related point is that children

evaluated out after a CPS hotline call reflect a group whose risk of injury death is far greater than their unreported sociodemographic peers. The decision to screen these children out without an investigation, under the logic that these children were assessed to be at no greater risk of harm than other demographically similar children, is not supported by the empirical evidence generated from this study. Third, these data highlight that although there has been a recent emphasis on the unmet service needs of children reported for neglect, it is young children reported for physical abuse who face the greatest risk of death. Given that physical abuse allegations represent a minority of reports received by CPS, these data suggest that a different protocol for investigating and intervening in cases in which physical abuse is alleged may be justified. Finally, the finding that a prior allegation of maltreatment is the single greatest predictor of not just intentional injury death, but also unintentional injury death, lends support to calls that have been made for child welfare services to be pursued under a broader, public health-oriented agenda, focused on the prevention of all manners of injury death.

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I am indebted to all five members of my dissertation committee. Before ever even applying to Berkeley, I flew to California to meet with Jill Duerr Berrick, Neil Gilbert, and Barbara Needell. My first meeting confirmed what brilliant scholars I had identified as hopeful mentors, but their unwavering support and continued investments in me as a doctoral student have exceeded even my most rose-colored expectations. Meanwhile, I came to know Nick Jewell and Sophia Rabe-Hesketh in the context of several methodology courses I took at Berkeley. Their reputations as statisticians precede them and need no comment here, but less widely known may be just how skilled each is as an exponent of quantitative methods not easily grasped by non-statisticians, or their commitment to students. I benefitted greatly from their instruction.

This dissertation would not have been possible were it not for the tremendous collaborative arrangement that exists between the California Department of Social Services (CDSS) and the Center for Social Services Research (CSSR), with funding support from CDSS and the Stuart Foundation. What Barbara Needell has built here in the basement of the School of Social Welfare is truly unique. Her ability to have successfully navigated the politics of data sharing and public data for over a decade is a feat in and of itself. Her reputation as a respected and trusted researcher throughout the state, and nationally, is beyond compare. Meanwhile, the commitment CDSS and all 58 counties in California have shown to transparency and data informed performance improvement is a model to be emulated by the rest of the nation. The fact that I was able to conduct this study is a testament to California's desire to better understand its practices and policies in the context of the children and families it serves.

I wish to thank several individuals from whom I have cumulatively learned a tremendous amount over these last few years. Each individual has informed my perspective, my research, or my writing, in some critical manner. These individuals include: Eileen Gambrill, Joan Hollinger, Maureen Lahiff, John Leventhal, Joseph Magruder, Mary Ann Mason, and Jane Mauldon. Joe Magruder, in particular, served as a wealth of child welfare knowledge (as well as SAS code critical to my analyses). I am incredibly appreciative of his generosity.

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Finally, I wish to thank my three children, Jacob, Benjamin, and Solomon. Although my younger two were largely oblivious to my dissertation, Jacob asked many thoughtful questions and even offered to contribute a chapter as deadlines loomed. While the writing in the pages that follow is mine alone, included below are four lines written by Jacob. In many ways his words innocently

capture the delicate balance the child welfare system struggles with every day. How do we help parents to parent, while at the same time protecting children? I hope this research moves the field one step closer to meeting these dual objectives.

Parents should be nice to their babies and take care of them. If the mommy and daddy don't know how, we should teach them. But if they are still mean, and don't keep matches away, and don't know where the baby is, we should call the police or the fire department and find the baby new parents.

Jacob Putnam Hornstein, age 5
August 13, 2010

CHAPTER 1
INTRODUCTION

Over a decade ago, the National Research Council concluded that the scientific study of child maltreatment was in its infancy.[1] Since then, a burgeoning body of research has helped extend the knowledge base through the identification of child, parent, and community factors associated with maltreatment.[2-8] The emerging picture suggests that even after abuse or neglect ends, the consequences are often far-reaching. Adverse effects spanning a child's physical, cognitive, and social development are commonly observed in victims of abuse and neglect.[9-13] Research has amassed strong and consistent evidence of increased rates of substance use, delinquency, and poor academic performance.[14-16] In addition, abuse and neglect frequently present against a backdrop of severe family poverty, drug dependency, and disorganized communities, meaning that the negative sequelae of abuse or neglect are likely to collect alongside or exacerbate ancillary problems.[17-19]

A more refined understanding of child abuse and neglect undoubtedly exists today. Yet, the inherent limitations of child welfare data continue to pose a very basic problem: data collected by child protective services (CPS) are incomplete as these data reflect only those children officially reported for abuse or neglect. A common analogy used to describe child abuse and neglect is that of an "iceberg". Those children who come to the attention of CPS represent the tip that emerges above the water, while a much larger population of maltreated children remain below the surface. The actual size of the iceberg – the population of children harmed, or at risk of harm – is unknown. Unknown is the extent to which those who are referred comprise a representative or biased sample of all maltreated children. And uncertain is whether or not the children who most need services ultimately receive them.

This uncertainty leads to speculation as to several different scenarios. The first is a scenario in which only a small proportion of maltreated children in need of protection come to the attention of child protective services, and an even smaller proportion receive the services needed. In fact, a majority of intentionally inflicted child deaths – the most extreme result of child maltreatment – occurred in families with no prior CPS contact; community gathering efforts suggest that the number of maltreated children is far larger than the subset reported to CPS; and only a small minority of all children who are referred for abuse or neglect, actually receive services.[20-25]

The second scenario is one in which an overzealous child welfare system unnecessarily investigates and removes children in the absence of compelling evidence of risk or harm. This may be due to ambiguous and inconsistently applied definitions of what constitutes maltreatment; the seeming inability of trained professionals to agree upon whether or not a child has been maltreated; class and race biases in decision making; or funding streams that incentivize child removals as a means of service provision.[26-32]

Finally, a third scenario encompasses the prior two. It is a scenario in which there are many more maltreated children in need of protection and services than are correctly identified by CPS *and* a scenario in which the child welfare system is unnecessarily removing children. In effect, in this third scenario the child welfare system is missing a large share of children at risk of harm at the

hands of their parents, while simultaneously harming a large number of children by removing them when the risk is not there to justify it.

Unfortunately, data collected by child protective service agencies cannot be used to sort through these various scenarios. Beyond the fact that CPS data capture only those children who are officially reported for possible maltreatment, these data suffer from other notable limitations. Because CPS databases were designed for administrative reporting purposes, the variables available are typically limited to those associated with billing and other management tasks. Absent are more descriptive measures of case characteristics, such as family-level variables, that may confound apparent associations. Also missing is information on etiological risk factors that predate CPS contact, or subsequent outcomes that could be used to assess decision-making surrounding child risk.

1. Study Overview

A recently published article posed the question: "Is it time to consider a public health approach, using population-based measures of child abuse and neglect to accurately describe the epidemiology of population risk and protective factors".[33] The current study attempts to do exactly this. In an effort to overcome the limitations of CPS data and contribute information relevant to better understanding the relative frequency of the three scenarios cited above, child-level linkages were established between administrative child protective service records, vital birth records, and vital death records. All told, this study captures information on over 4 million births, 500,000 children referred to CPS, and 25,000 decedent children. Linkages with birth records allowed for a prospective birth cohort study design, providing universally collected data on risk factors present at birth for all children in the study. Linkages with death records permitted fatality outcome comparisons to be used as a population-based indicator of child harm and unrealized child welfare service needs among both those children who were, and were not, referred to CPS.

1.1 Research Questions and Hypotheses

The record linkages described above were pursued with the broad goal of augmenting administrative CPS records with population-based data. Although a wealth of information was generated from these linkages, three research questions were examined in this study:

1. *Is a referral to child protective services an independent risk factor for injury mortality?*

2. *Is allegation disposition associated with injury fatality risk?*

3. *Does injury fatality risk vary across maltreatment allegation types?*

The first research question explores a referral to child protective services as an independent source of information regarding child well-being (both current and future) and child welfare service needs. *It was hypothesized that, controlling for sociodemographic factors and with time adjustments made for exposure risk, the likelihood of sustaining a fatal injury would be elevated for children with a prior non-fatal allegation of maltreatment made to child protective services.* This hypothesis was based on research indicating that although children referred to CPS generally comprise a poorer and less healthy sub-population of children – two factors which are

associated with a child's risk of injury mortality – a report to CPS serves as a signal of latent familial disorganization or dysfunction and is an independent risk factor for injury death.[16,34-39] In other words, it was hypothesized that a report to CPS was not a random event, but a meaningful indicator of a child's risk.

1.1.2 Research Question Two

The second research question examines whether case disposition is associated with subsequent injury fatality risk. After a report of maltreatment is received by CPS, each allegation included in that report is assigned a "disposition" or finding. In this research, the use of report disposition was treated as proxy of likely child welfare service involvement (if multiple allegations were recorded for a given child, the most severe allegation was coded for this analysis).

It was hypothesized that injury mortality risk would not vary across disposition types. This hypothesis stemmed in part from a body of literature highlighting the fallibility of correctly ascertaining whether a child has been maltreated, which is supported by a lack of distinguishable differences in subsequent behavioral measures between children with a substantiated versus unfounded allegation of maltreatment.[40-44] But this hypothesis was also based on an assumption that the child welfare system is best equipped to assess risk and intervene in those most egregious cases of abuse and neglect. In these circumstances, a child's removal from the home and placement in foster care ensues, which largely removes the child's exposure to a given threat. Since it is the most severe disposition (substantiation) that would result in this action, the removal of these children will offset any heightened fatal injury risks otherwise exhibited by this group of children.

1.1.3 Research Question Three

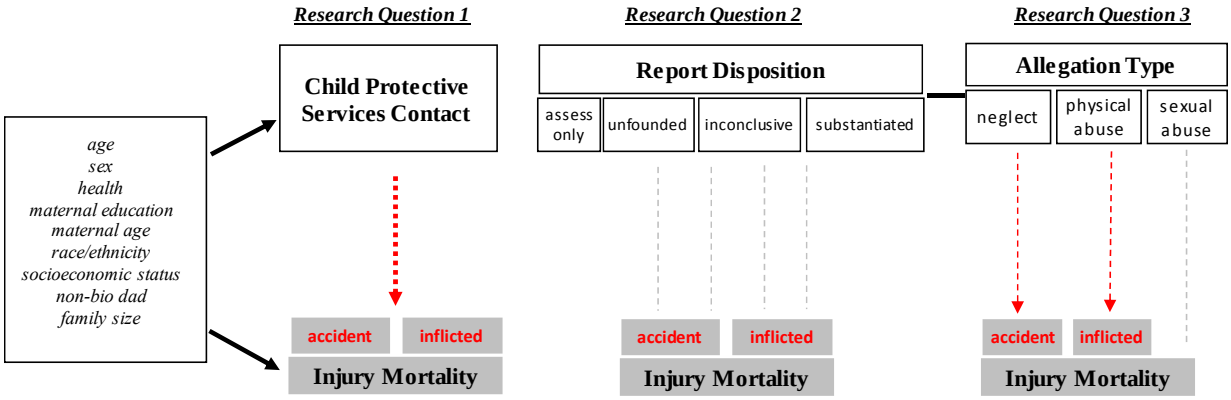
The third research question explores possible associations between the maltreatment allegation type and subsequent injury fatality risk. *It was hypothesized that, controlling for other factors, the likelihood of sustaining a fatal injury would be greatest among children referred for a maltreatment allegation of neglect.* It was posited that because neglect is the form of maltreatment that is most recurrent, chronic, and yet often given lower response priority than those cases involving physical or sexual abuse, it would be a significant predictor of an injury fatality (regardless of whether that fatality is classified as intentional or unintentional and independent of the report disposition).[45-47]

It was also hypothesized that child homicides would be more commonly observed among children referred for physical abuse, with no associations observed for children referred for sexual abuse. These latter two hypotheses are loosely supported by prior literature,[39,48] and were forwarded with some caution due to death misclassification concerns as described in the sections that follow. Associations between allegation type and mechanism of death (e.g., falling, drowning, fire) although not central to this research, were pursued through descriptive tabulations.

Figure 1 depicts the variable associations explored for each research question. Sociodemographic control variables are presented in the leftmost box. Arrows indicate their association with both CPS contact (the key independent variable) and injury mortality (the dependent variable).

Moving from left to right across research questions, red arrows are used to identify expected associations; grey lines are presented when no association is anticipated.

Figure 1. Research Questions



1.2 Chapter Organization

The remainder of this chapter is divided into three sections. Section 2 seeks to justify the use of both unintentional and intentional fatal injuries as population-based indicators relevant to the study of child maltreatment. Research is presented that indicates: 1) both unintentional and intentional injuries are highly preventable and manifest against a common backdrop of child, parental, and environmental risk factors; 2) inadequate supervision is a key causal factor in fatal unintentional injuries, just as "neglect" is the allegation for three-quarters of maltreatment referrals; and 3) attempts to distinguish between unintentional (accidental) and intentional (homicide or maltreatment-related) are highly fallible. This section also reviews prior studies that have examined associations between a prior report to CPS and mortality. Finally, Section 3 serves to conclude this chapter with a summary of the material covered and an overview of Chapters 2 through 5.

2. Background

When the term *accident* is used, it is generally understood to be both an unintended and chance event.[49,50] Yet, this lay definition of an accident in the context of an early childhood injury is misleading far beyond a discussion of semantics. Implicit in this understanding of an accident that strikes individuals at random is a conceptualization of an event that occurs without cause. Yet, research demonstrates that accidents resulting in injuries are not chance or random events; accidents are nearly always preventable; and for young children, negligent caregiving often plays a role.[51-54]

As a result of such findings, the research and public health communities have increasingly advocated use of the term *injury* as an alternative.[55-58] Injury reflects that there was some damage or harm to the body, while making no claims as to the preventability or intentionality of actions leading to that bodily harm. Injuries can then be discussed in terms of those that were fatal vs. nonfatal (i.e., led to death or did not), preventable vs. unpreventable (i.e., could have been reasonably foreseen and thus prevented or not), and intentional vs. unintentional (i.e., deliberately inflicted or not).

The degree to which there is the possibility of exerting some control over the likelihood that an injury will occur can be conceptualized as a continuum of preventability, with entirely unpreventable (and therefore random) injuries falling at one extreme (e.g., an infant drowns in a flood), entirely preventable injuries at the other extreme (e.g., an infant is intentionally submerged and subsequently drowns in a bathtub), and all other injuries falling somewhere in between. [59] Likewise, one can envision a similar continuum of parental intentionality, but how does one accurately ascertain and define the "intent" of another?

One way to overcome the inherent difficulty of discerning intent is to focus instead on the question of preventability: did the injury result from a single lapse in supervision or a pattern of inadequate care? Continuing with the example of drowning, assuming an equal risk of death for each instance in which an infant is left unattended in the bathtub, while a drowning death can certainly occur during a single lapse in surveillance, a death is *more likely* to be the product of repeated exposures to the risk factor. A central premise of this research is that a significant proportion of nonfatal and fatal childhood injuries – classified as unintentional – result from parental care in which the child was repeatedly exposed to risk factors prior to the eventual injury event. In other words, unintentional injuries sustained by young children are often the result of negligent caregiving and negligent caregiving is defined as that which consistently exposes a child to age-inappropriate risks. It must be noted that this is not meant to suggest that all injuries sustained by young children are the result of parental negligence, nor that negligence means the action or inaction was criminal. Only that the fracturing of injuries on the basis of intent is a suspect classification and, as such, unintentional injury data should be assumed to include many injury events where negligent parental caregiving played a role.

2.1 The Role of Parental Caregiving in "Unintentional" Injuries

The literature indicates that nearly all injuries are preventable and, excluding car crashes, injuries suffered by infants and young children almost always occur in the home.[54,60] Of course, even if preventable, establishing a causal link between inadequate supervision and an injury event is difficult. Still, the research that exists supports claims that unintentional injuries, as is true of intentional injuries, frequently result from the direct actions (or inactions) of caregivers, and often fall along a neglect-spectrum of parental supervision.

One child injury study found that "inadequate supervision" accounted for 43% of fatal injuries sustained by children under the age of 6.[51] The proportion of injury deaths resulting from deficient caregiving rose to 55% when additional injuries coded as a "failure to provide appropriate food, shelter and medical care"; "inflicted physical abuse"; and "supervision by persons impaired by alcohol or drugs" were included. Another study examining injury deaths of young children found that 59% died from an inflicted injury or an injury that constituted a severe enough violation of age-appropriate norms of supervision the researchers labeled it "maltreatment-related".[37] In the sections that follow, literature is reviewed that documents the preventable nature of several leading causes of unintentional childhood injuries and highlights the key role of parental caregiving.[61-63]

2.1.1 Motor Vehicle Injuries / Deaths

Although motor vehicle crashes are typically referred to as car accidents, insurance companies are well aware that the burden of driving risk is not distributed evenly throughout the population

(e.g., teen drivers pay higher insurance premiums than do adults since the likelihood that the former is in a crash is substantially greater). Similarly, research suggests that there exist distinct risk profiles among parents: some drive only while unimpaired by alcohol and drugs, safely securing children in the vehicle, while others do not.[64]

One study found that children injured in motor vehicle crashes in which they were completely unrestrained (i.e., no seat belt and no child safety seat) were also more likely to be in vehicles with less safety conscious drivers: police records indicated that the driver was more likely to have been found at fault in the crash and more likely to have been involved in a single-vehicle crash.[65] In a study of alcohol-related traffic crashes with child passenger fatalities, researchers found that 64% of the children died in the car with the driver who was drinking (i.e., it was not the driver of the other car who was at fault).[66] In two-thirds of these cases, the driver was old enough to make it probable that he or she was a parent or functioning in a caregiver status. In a study of a similar vein, researchers examined whether two contributors to crash-related injuries sustained by children – riding with a driver who had been drinking and failure to use restraints – were related to various driver characteristics.[67] Findings indicated that a child was 44% less likely to be restrained when in a car with a driver who had been drinking and that significant group differences in safety behaviors remained after controlling for socioeconomic status. In yet another motor vehicle fatality study, it was found that 82% of children who died were either unrestrained or inappropriately restrained in the vehicle.[54]

2.1.2 Fire Injuries / Deaths

Parents and caregivers play a key role in preventing fire injuries and deaths through two modes of action: 1) supervision of the child and environment so as to avert fires from starting, and 2) serving as a potential rescuer in the case of a fire (crucial for non-ambulatory and very young children who will not otherwise have the wherewithal to escape). If the adult caregiver is incapacitated due to alcohol or drug use, that caregiver's ability to act in either a supervisory or rescue role is severely compromised. If the caregiver is absent entirely, neither role is filled. Perhaps not surprisingly, research points to alcohol consumption as one of the strongest correlates of fire fatalities.[52,68-71] Best estimates of the role adult intoxication plays in fire fatalities involving a child – which are hard to come by as it is often the case that no alcohol or drug tests are conducted – conservatively suggest that 15-30% of child fire fatalities occur in fires in which the adult present was impaired by alcohol or drugs.[52,69]

Research also indicates that nearly all fire deaths are classified as house fires,[52,68,72,73] raising questions of supervision given that roughly 30% of fires resulting in child fatalities are started by children,[52] with this number jumping up to 40% when considering only those fatalities of children ages 0 to 5.[63] While no one would expect a child to be in the constant company of an adult caregiver, the simple presence of a potential rescuer in the home (defined as an adult unimpaired by alcohol or drugs and without any physical or cognitive disabilities) has been estimated to lower the fire fatality rate of children under the age of 5 by a full 10 percentage points.[69] Yet, the complete absence of an adult caregiver is not uncommon. One study examined a sample of child fire deaths and found that 85% (29 out of 34) children died while left at home alone.[74] The median age of children in the sample was 4.5 years. Parental behaviors are also related to child fire fatalities in the form of unsafe home environments, including the infrequency

with which working fire alarms are present in fatal fires and the independent risk factor of smoking.[52,63,68-71]

2.1.3 Submersion Injuries / Deaths

Nearly all infants who drown do so at home, in the bathtub.[75-77] As infants age into ambulatory toddlers, the risk of drowning shifts from inside, to outside, the home. Over three-quarters of one to two year olds and nearly 90% of three to four year olds who drown, do so in either an artificial pool or freshwater setting.[76] Yet, regardless of whether the submersion occurs inside or outside the home, or whether it is deemed intentional or unintentional, it is hard to argue that a lapse in adult surveillance wasn't a key factor in the injury event. Researchers examining child bathtub drowning and near-drowning events have consistently found that incidents involving infants and young children occur when the child is left completely unattended or in the supervision of a pre-school aged child.[77-81] The drowning of toddlers and young children, which tend to involve falling into a body of water, also usually occur in the absence of any supervision.[54]

A review of the literature did not return any studies that examined whether the eventual submersion incident was preceded by a history of leaving the infant or young child unattended. It bears noting, however, that in retrospective studies researchers have estimated that 20-29% of young children who drown or nearly evidence signs suggestive of child abuse, despite the event's classification as unintentional.[78,79,82] In one case study that examined children who survived a near-drowning bathtub submersion, researchers found that one quarter had been previously referred to CPS for maltreatment.[82] Further, the influence of alcohol or drugs on a caregiver's ability to effectively supervise young children has already been established as a significant risk factor for vehicular and fire-related childhood injuries, and in other research was associated with a more than two-fold increase in a child's risk of injury.[83] It seems only likely that adult impairment due to drug/alcohol use would also be implicated in a good number of child submersion events.

2.2 Classification of Manner (or Intent) of Injury

While intentional or maltreatment-related injuries are recognized as preventable, the above literature was cited in order to underscore the similarly preventable nature of most unintentional or accidental injuries, and to highlight the contributory role played by parental behaviors. Yet, even if one rejects the notion that most unintentional injuries are preventable, or the role of parental caregiving in reducing the incidence of injuries, the profound difficulty of determining the manner or intent of an injury (and the real potential for bias), would seem to largely preclude its utility as a means of injury classification. The literature surrounding the validity of the three key sources of manner of death – death certificates, NCANDS figures, and Child Death Review Team counts – is reviewed below.

2.2.1 Death Certificates

In the United States, a death certificate is the "official" record of death. This record is structured to contain both the determination of manner (e.g., unintentional, intentional, suicide) and the mechanism of death (e.g., fall, submersion, poisoning). Although it is estimated that more than 99% of all fatalities are included in death records, death certificates have been well-documented to severely undercount the number of child deaths due to maltreatment.[24,84-87] Setting aside the fact that for infants and young children it may be difficult or impossible to differentiate an

unnatural intentional death, from a natural unexplained death, or an unnatural unintentional death,[88] the legal nature of the death certificate means that medical examiners must be certain their finding will stand-up to legal scrutiny before they label a death intentional:

> Unless the physician, medical examiner, or coroner is absolutely certain that a death is attributable to abuse and unless they feel that there is sufficient evidence that their certification of the cause of death could stand up to a potential legal challenge, they may be unwilling to report child abuse as the cause of death. [89]

In addition, there is evidence (especially in rural areas) that local politics and funding may play a role in which cases are autopsied in order to identify maltreatment.[90] All told, estimates suggest that 52 to 90% of fatalities due to maltreatment are incorrectly coded as deaths due to accidents, natural causes, or other factors and 7-27% of supposedly unintentional injury deaths of young children are actually due to abuse or neglect.[84-86]

2.2.2 Maltreatment Estimates from NCANDS

Fatality data published annually by the National Child Abuse and Neglect Data System (operated by the federal Children's Bureau) is similarly plagued by methodological issues.[87,91] Differing legal standards for the substantiation of abuse or neglect as a cause of death coupled with a lack of standard definitions of what constitutes abuse or neglect hinders valid comparisons across states and aggregate estimates.[92] Further, most states submit data to NCANDS that includes only child deaths from families known to the child protection agency, even though it is estimated that a majority of child deaths from maltreatment occurred in families that had no prior child welfare contact.[23,24,54]

2.2.3 Child Death Review Teams

In order to overcome the shortcomings realized in both death certificate and published NCANDS estimates, reliance on Child Death Review Teams (CDRT) has grown tremendously in the more than three decades since inception. [93] Originating in California in 1978, CDRTs represent a systematic, multidisciplinary, and multiagency effort to investigate child deaths by integrating available data and resources from coroners, law enforcement, courts, child protective services, and health care providers. These teams operate with the goal of better understanding how and why children die, using findings to take actionable steps toward improving child safety and reducing child deaths.[94] At last count, all but one state was reporting that it had teams in place to review child fatalities; several states have now moved to investigating all causes of child death.

Despite being heralded by the United States Advisory Board on Child Abuse and Neglect as "…the greatest hope of finding the underlying nature and scope of fatalities from child abuse and neglect",[93] a recent examination of the identification of deaths due to abuse or neglect in three states found that Child Death Review Teams were little better situated to serve as an accurate source of deaths attributable to maltreatment than were either death certificates or child welfare agencies.[91] The authors found that no single data source provided a comprehensive count of child maltreatment deaths. Ascertainment was most effective when multiple data sources were utilized to identify all unique instances of death – yet the most useful sources differed from state to state – making uniform policy recommendations difficult. An unpublished review of a reconciliation audit of child deaths conducted in California supports these findings and argues that death review

teams have quite limited functionality due to a lack of resources and restricted access to sources needed to complete the task it is charged with.[95]

2.2.4 Potential for Systematic Bias in the Identification of Maltreatment Fatalities

An ample body of research indicates the skepticism with which intentional death counts must be viewed and suggests that official reports capture a mere fraction of the true count of inflicted injuries. Yet, also concerning is that there is evidence to support claims of a systematic over- and under-inclusion of certain groups in these already suspect counts.[24] With all states but one relying on a CDRT functioning in some form or another, and with increasing resources devoted to linking various sources of death data, the discovery of maltreatment fatalities will undoubtedly rise. Yet, the possibility for racial bias by systematically over or under-coding child deaths as maltreatment fatalities is quite real. For example, it is standard practice for CDRTs to link child death cases with the states' child protection registry in order to identify any prior contacts between the child's family and CPS. While this is certainly a crucial source of information, if Black children represent a group of children who are disproportionately likely to have had contact with child protection, then it seems only likely that Black children who die will also be disproportionately likely to have their deaths reviewed with greater scrutiny and suspicion than the deaths of children of other races. In effect, the same biased dynamics that may falsely elevate rates of CPS reporting for Black children, may also impact the rate of Black deaths classified as maltreatment fatalities.

2.2.5 Implications

The true incidence of child maltreatment is unknown. Children who come to the attention of CPS for child maltreatment may well represent a biased sample of victims. Further, fatality rates due to maltreatment – which could signal per death rates of less extreme maltreatment across groups – are notoriously unreliable. Yet, we do know that unintentional injuries in infants and children are nearly always preventable and research lends support to claims of inadequate parental caregiving as a primary cause of these injuries. This research utilizes injury mortality (both unintentional and intentional) as an objective measure of the risk faced by children reported to CPS, compared with those who are not. At a population-level, the utilization of preventable injury deaths is forwarded as a possible means of identifying and quantifying the risk faced by different subpopulations.

2.3 Studies Based on Child Welfare and Vital Death Record Linkages

Also salient to the study at hand are those studies that have longitudinally examined mortality among children reported to CPS. From the research that has been conducted, divergent findings have emerged. In some instances this appears to be due to differences in the control variables that were employed; in other cases the design and inclusionary criteria may have impacted conclusions drawn. Since a limited number of studies were identified, those most relevant to this study are described in some detail below.

2.3.1 Deaths Subsequent to a Substantiated Maltreatment Report

Sabotta and Davis published one of the earliest large scale research studies utilizing administrative child welfare data and vital records to track mortality.[96] In their paper, children who had a substantiated allegation of maltreatment between 1973 and 1986 were matched – on sex, birth county, and birth year – to non-reported children. The authors found that children who

had been abused or neglected faced a nearly threefold greater risk of death before the age of eighteen, and twenty times greater risk of homicide, than did non-maltreated controls. However, as acknowledged by the authors, they were unable to match maltreated and non-maltreated children on either race or socioeconomic status – two of the most established risk factors for childhood mortality and CPS contact. Additionally, this study lacked information as to the type, duration, or intensity of service interventions provided by child protective services.

A decade later, White and Widom published research findings that raised questions as to any claims that maltreated children face a heightened risk of early mortality.[97] In this study, children identified as abused or neglected before the age of 12 were matched to a control group of non-maltreated children of the same age, sex, and race/ethnicity. As a rough proxy for family social class, cases and controls were also matched on residential neighborhood, as well as the school attended, and prospectively followed into young adulthood. Contrary to the authors' hypotheses, there was no significant difference in the overall rates of mortality for the two groups and those children who were victims of abuse and neglect were not more likely to experience a death due to violent means. Although White's paper extended earlier research through the inclusion of race and a proxy for socioeconomic status as matching variables, it still lacked the power for any type of multivariate analysis

2.3.2 Deaths Subsequent to a Maltreatment Report

More recently published research originates from Jonson-Reid and colleagues and is most closely analogous to the study at hand.[98] In the research conducted by Jonson-Reid, death rates for children who were less than age 7 and survived a first report of non-fatal maltreatment were compared with a matched comparison group of non-reported children (both groups were low-income). Propensity scores were used to construct a conditional logistic regression model based on parent age, high school completion, maternal alcohol use at the time of birth, parent history of foster care as a youth, number of moves, and an exit from poverty (as measured by a transition from the federal poverty assistance programs AFDC or TANF). Findings from Jonson-Reid's study were profoundly limited by the low base rate of death and a small sample (only 29 of the 7,433 children in this study died). Yet, cautioned findings suggested higher rates of "preventable deaths" for children reported to CPS and a heightened risk of subsequent death among children reported for physical abuse, as well as those whose allegation of maltreatment was substantiated.

2.3.3 Deaths Following a Placement in Out of Home Foster Care

Barth and Blackwell also examined associations between child maltreatment and mortality, although the scope of their research was somewhat narrower: they focused on children whose maltreatment had resulted in an out-of-home foster care placement.[39] The results of their study (also based on data from California) suggest a heightened risk of preventable death among children who had spent time in foster care. An allegation of neglect was most strongly associated with a preventable death. Children reported for sexual abuse were found to have lower preventable death rates than the general population. The authors also found that a foster care placement was protective against preventable death among Black children (both while in care, and after exiting).

2.4 The Current Study's Contribution to the Research Literature

The current dissertation research is unique in that it examines not just children placed in foster care, or children whose maltreatment allegation had been substantiated, but *all* children who were included in a report of possible child maltreatment. Even those who did not receive an in-person investigation as their allegations were screened out over the phone. Although this was attempted in one prior study, small sample size severely restricted the analyses that could be conducted.[98] The sheer size of California, a state with a population of over 10 million children, allowed this study to avoid many of the base rate issues of prior studies. Unlike earlier studies which were unable to control for socioeconomic status and were forced to rely on general population samples, my study includes covariates for maternal education and birth payment method as measures of social class.[39,96] This research also restricts the cohort of children followed to those who were referred and also died during the first five years of life in an attempt to reduce non-parental environmental confounds. When Barth and Blackwell published the results of their study over two decades ago, they wrote "We do not, yet, have data to determine the mortality for children who are victims of child abuse and who remain at home rather than enter foster care."[39] The current study contributes these data to the body of literature.

3. Summary

The maltreatment of children, including neglect and various forms of physical, sexual, and emotional abuse, endures as a societal problem of significant scope. And among victims of maltreatment, the nation's youngest children are disproportionately represented: 33% of all victims in 2008 were under four years of age; the highest rate of maltreatment was observed during the first year of life (21.7 per 1,000). The profound vulnerability of these youngest children cannot be understated. Not only are these children at greatest risk of death from maltreatment,[22,99] but research suggests that the negative developmental consequences of non-fatal maltreatment manifest in multiple domains of later life functioning, with outcomes often observed to be most severe and intractable for children with an onset of abuse or neglect occurring during the first few years of life.[16,100-10225,101]

Unfortunately, correctly ascertaining maltreatment among the millions of children reported to CPS agencies each year is no easy task. And data collected by these agencies, in isolation, is poorly suited to tracking outcomes that might shed light on decisions made for each child at various points of system contact. The current study contributes population-based data to the study of infant and child maltreatment. Through record linkages between child protective service records, eight years of vital birth records, and nine years of vital death records, the characteristics of over half a million children reported for maltreatment in California were examined on the day they were born and compared with their non-reported counterparts. These children were then prospectively followed and estimates of injury mortality risk were computed as a population-based indicator of child harm and unmet service needs

Dissertation Structure

The remainder of this dissertation is organized into four chapters. Chapter 2 describes the framework, theory, and model that serve as the foundation for the research conducted. A public health framework is used to incorporate population-based data into the surveillance of child maltreatment. Socio-biological theory is proposed to explain dynamics that might account for parenting behaviors that fail to protect children from injuries and harm, despite the seeming

contradiction of these behaviors with genetic fitness. Finally, a model that posits unintentional and inflicted injury fatalities are falsely dichotomized serves as the justification for this line of research.

Chapter 3 covers this dissertation's methodology. The first section of this third chapter is devoted to describing the three data sources that were linked in order to construct the final dataset for analysis. The processing of source files, record clean-up, variable standardization, and record de-duplication are all thoroughly described. In addition, information is provided concerning the protection of human subjects and the security protocols followed. The second section explains the record linkages completed through an overview of the linkage strategies employed, a description of blocking and matching variable decisions, and also reports linkage results. Finally, the analysis of the linked data is outlined. The coding of dependent and independent variables is detailed and justification is offered for the statistical models specified. Chapter 4 is devoted to reporting all study results. Chapter 5 brings the study to its conclusion with a discussion of the results; a summary of the study, including strengths and limitations; and implications for practice, policy, and future research.

CHAPTER 2
FRAMEWORK, THEORY AND MODEL

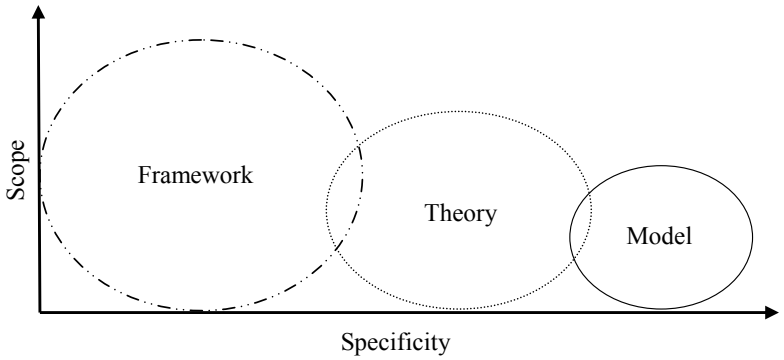
Child maltreatment has been a largely atheoretical area of inquiry, reflecting its practical orientation and fairly recent origins as a recognized problem. Although "unitary theories" have been applied to the study of child abuse and neglect – psychoanalytic theories of parental pathology; social learning theories of intergenerational family violence; environmental theories of stressful life events – none have emerged as dominant since each explains only a small part of what amounts to a highly complex phenomena.[103-108] Interactive or ecological theories – those that explore child maltreatment as a manifestation of dysfunction in a broader ecosystem – have also been applied and provide a better conceptual method for organizing empirical findings.[105,108-110] Yet, these ecological theories are frequently employed without offering a causal understanding of individual, group, or environmental dynamics as they relate to child maltreatment. As such, these interactive models tend to do little more than highlight what practitioners and researchers have long known – that child maltreatment is a dynamic and multifaceted event subject to influences from a variety of sources operating via a number of pathways.

For decades, the lack of a dominant theoretical orientation and the insufficient attention paid to the construction of theory has been cited as a major impediment to the development of successful child abuse and neglect interventions.[103,105,111] Yet, given that "observations and theory develop together" is an inadequate theoretical foundation to blame, or an inadequate empirical base?[112] Do we really have the information necessary to develop successful, theory-driven strategies for the reduction of child abuse and neglect? The fact is, most studies of child abuse and neglect have been: 1) limited in scope, examining only those children who are reported to child protective services; 2) missing key variables, especially important confounders related to socioeconomic status and family-level traits; and 3) focused on a narrow set of short-term and system-related decisions (e.g., substantiated or not). These limitations severely constrain theory development and testing.

The present study sought to broaden the surveillance of child maltreatment, overcoming at least some of the limitations noted above. It is epidemiological in nature, contributing empirical observations that might later inform and promote theory development. It draws upon and integrates data from population-based and administrative data sources in order to better describe the risks of injury mortality faced by children previously referred to child protective services for abuse or neglect.

Despite the epidemiological nature of this research, and the caveat that its contribution falls in the realm of observations rather than theory production or testing, an attempt was made to apply guidelines and definitions proposed for conducting theoretically driven population health research.[113] As such, this study adopts a schematic organization in which framework, theory, and model are conceptualized as existing on a continuum of abstraction: a framework provides the broadest scope and least specificity; a model the narrowest scope and greatest specificity (see Figure 1).

Figure 2. Conceptual Continuum for Population Health Research (Carpiano & Daley, 2005)



This study was undertaken with a goal of expanding the surveillance of child maltreatment and clarifying risk factors for injury mortality. Therefore, a *public health framework* was employed as a means of conceptually organizing the research. Since surveillance and risk factor identification are two key features of a public health approach, this framework was well-suited to the study at hand. In addition, recent calls for the inclusion of child maltreatment in public health research agendas and prevention programs made this an opportune time to demonstrate the applicability of this framework.

Theory from the field of evolutionary psychology was drawn upon in an attempt to logically connect etiological risk factors to the outcome of interest. Specifically, *parental investment theory* was cited as a possible explanation of dynamics that might account for parenting behaviors in which children are injured (or not protected from injury), despite the seeming contradiction of such parenting actions with an evolutionary perspective on genetic fitness.

Finally, this study relied on a unified *model of unintentional and intentional injuries* as first proposed by Peterson. This model served as the foundation for examining all-manners of injury death (rather than only maltreatment fatalities), consistent with her view of unintentional/intentional and non-fatal/fatal injuries as a single field of inquiry.

The remainder of this second chapter is organized into four sections. The first three sections describe the respective manner in which a public health framework, parental investment theory, and unified injury model informed the study. The fourth section serves to summarize and conclude.

1. Research Framework

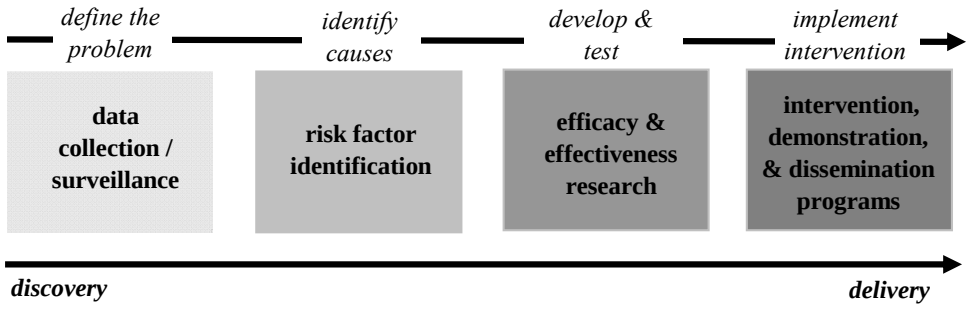
A public health framework served as the highest level tool for organizing the current study. There are many definitions of public health, but all incorporate a focus on the protection and promotion of health and well-being at a population-level, with prevention prominently figuring into strategies.[114-116] Epidemiology, focused on the distribution and determinants of a disease, is the primary scientific method for studying the health of a population within a public health framework.[117,118] In this section, I describe how the classic public health approach to the epidemiologic study of communicable disease transmission was adapted for the study of unintentional injuries; cite recent extensions of this framework to the examination of violent

injuries, including child maltreatment; and describe the application of a public health framework to this line of research.

1.1 The Public Health Framework

A public health approach is conceptualized as a four-step process: 1) define the problem through data collection and surveillance efforts; 2) uncover possible causes through the identification of risk and protective factors; 3) develop and test interventions in order to discover the most efficacious means of addressing the problem; and 4) implement and monitor prevention and control strategies (see Figure 3).[119,120] Upon widespread adoption of a prevention program, the cycle returns to surveillance to assess its efficacy across the full population.

Figure 3. Public Health Approach (adapted from Sleet, Hopkins, & Olson, 2003)



1.1.1 Surveillance

In a public health framework, surveillance serves as the first step toward the control and prevention of disease (or injury). Surveillance is defined as the ongoing collection, analysis, and interpretation of outcome data for use in the planning, implementation, and interpretation of population health.[121] Described not as "an end unto itself, but rather a tool," public health surveillance efforts are typically initiated for the purposes of detecting/describing a problem and monitoring geographic and temporal trends in disease occurrence.[122]

1.1.2 Identification of Risk and Protective Factors

Surveillance provides ongoing information as to the scope and magnitude of an identified health problem. The next step in a public heath framework involves identifying those factors that both place individuals at risk of the problem, and that serve to protect them. Public health tends to rely on ecological models, allowing risk and protective factors to be considered at both the individual and contextual levels.

1.1.3 Development and Testing of Interventions

After surveillance efforts have been used to define and parameterize the problem, and risk and protective factors have been identified, the third step involves the development and testing of prevention strategies. Although public health is focused on the health of the entire population, prevention programs are targeted at different segments of the population. Primary prevention programs are directed at the general population in a universal fashion. Secondary prevention programs are more narrowly targeted towards populations identified as having one or more risk factors associated with the problem. Tertiary prevention efforts focus on individuals where the problem has already occurred, with the goal of minimizing negative effects and preventing its recurrence.

1.1.4 Implementation of Effective Prevention and Control Strategies
Steps one through three contribute to the development of comprehensive evidence-based, prevention programs. The final step involves the implementation of effective programs at the community level. Dissemination features heavily into this step and continued surveillance is required over time.

1.2 Public Health in an Historical Context
Historically, public health efforts were focused on the study and prevention of disease transmission. The application of the public health disease model to injuries occurred only in the latter half of the 20th century and was driven by underlying shifts in the public health burden from communicable and chronic diseases to injury.[57] In the early part of the last century, mortality reductions from medical advances and public health-related efforts had been concentrated among the young.[123] Between 1900 and 1940, 80% of the improvements in life expectancy resulted from reduced mortality for people below the age of 45, with the greatest reductions occurring for infants and children.

But mortality reductions have since shifted and are now increasingly concentrated in older, adult populations. Over the last four decades, roughly two-thirds of the reductions in mortality were realized for those over the age of 45. This trend has been attributed to "medicalization": health improvements and mortality reductions are increasingly ascribed to advances in medical treatment, rather than improvements to the social environment or in health-promoting behaviors. In terms of child health and mortality, this medicalization has meant that many more infants born prematurely survive, while at the same time injury morbidity and mortality stand out as areas subject to lesser gains.

1.2.1 Recognition of Injuries as a Public Health Problem
This shift in health threat has not been lost on the country's "doctor", the U.S. Surgeon General. Nearly twenty years ago, Surgeon General C. Everett Koop testified before the U.S. Senate, noting that, "if some infectious disease came along that affected children [in the proportion that injuries do], there would be a huge public outcry and we would be told to spare no expense to find a cure and to be quick about it."[56] In 2005, Surgeon General Richard H. Carmona focused more narrowly on the problem of inflicted injuries when he stated, "I can think of no terror that could be more devastating than child maltreatment, violence, abuse, and neglect perpetrated by one human being upon another…I believe it is time for critical thinking to formulate a new national public health priority, preventing child maltreatment and promoting child well treatment."[124] Echoing these sentiments, the National Academy of Sciences has identified injuries as one of the most under-recognized public health threats of the day and the Center for Disease Control and Prevention's National Center for Injury Control has identified child maltreatment as one of three priority areas for prevention.[125]

What threat is posed by injuries to infants and young children? In the United States, in 2005, over 2,700 children under the age of five died as a result of what was classified as an "unintentional" injury.[126] Unintentional injuries accounted for over 1,000 deaths of children less than one year of age, a single-year injury death rate far exceeding that observed during all subsequent years of life. Unintentional injury was the *leading cause of death* among children 1

to 4 years of age and accounted for 35% of all deaths in this age group, exceeding death counts from disease, cancer, and congenital anomalies combined. Also in 2005, an estimated 1,460 children died as a result of what was deemed an intentional injury; more than three-quarters of these children were under the age of four.[45]

While death during childhood is both tragic and presents a tremendous social cost in terms of total years of life lost, child deaths amount to just a small share of the total number of children impacted by injuries. In 2005, an estimated 2 million children under the age of five suffered a nonfatal unintentional injury that resulted in emergency care; referrals involving approximately 6 million children believed to have been harmed or at risk of harm were made to CPS agencies.[45,126] Of these children, an estimated 3.6 million were included in an investigation and 900,000 were found to have been maltreated. On any given day over the last several years, over 500,000 children were in out-of-home foster care, with infants and young children comprising an increasing share of children referred to CPS and entering care.[45,127]

Of course, child injuries need not be physical to negatively impact a child's long term health and well-being. As the Centers for Disease Control and Prevention has noted, "Not all injuries that result from child maltreatment are visible. Abuse and neglect can have lasting emotional impact as well."[128] William Haddon Jr.[1] recognized that "frostbite was a type of injury…caused by the absence of a necessary factor, the ambient heat needed for normal health." [129] Analogously, many of the injuries suffered by children may result from an absence of parental nurture, care and supervision.

1.2.2 Child Maltreatment: A Public Health Approach

Recent calls, originating from all corners of the globe, have been made for child maltreatment to be studied in the context of a public health framework. In 1998, the World Health Organization's (WHO) Regional Office for Europe concluded that "it is essential to consider child abuse and neglect from a comprehensive public health perspective" and argued that "child protection strategies need to be incorporated into mainstream health and health-related services at all levels."[130] Less than a year later, WHO issued a press release in which they stated, "abused children suffer a wide variety of physical, emotional and developmental problems which can hamper their ability to live healthy and productive lives…it is a public health issue of vital importance for WHO, and it represents a challenge for the next millennium."[131] A recently published article published by Australian researchers posed the question: "is it time to consider a public health approach, using population-based measures of child abuse and neglect to accurately describe the epidemiology of population risk and protective factors."[33] And the Centers for Disease Control and Prevention has identified child maltreatment as a "critical" and "significant" public health problem that warrants a comprehensive prevention strategy.[128,132]

1.2.3 Why Utilize a Public Health Framework?

If the history of public health reads as "successive redefinings of the unacceptable," then the fact that child maltreatment is finally being incorporated in its folds is a step in the right direction.[2]

[1] William Haddon Jr. is widely considered to be the father of modern injury epidemiology. He is most famous for his development of the "Haddon Matrix": a conceptual framework for the study of injury vectors.

[2] This is an unverified quote attributed to George Vickers of the Open Society Institute.

Child protection service systems in the United States were developed in a manner largely consistent with a traditional medical model of case identification, assessment, and treatment. While CPS agencies are crucial to ensuring the well-being of children, it is increasingly clear that the child welfare system is not capable of addressing the broader social and economic causes of child maltreatment, nor is it easily adapted to prevention-focused efforts.

A number of compelling arguments exist as to why child maltreatment should be included under the public health umbrella.[133] First, there is a growing-body of scientific evidence suggesting that preventing child maltreatment is an effective strategy for promoting health and reducing disease later in life.[12,134] Second, public health agencies fall within a large health infrastructure with ready access to a broad population of young children and their families. In contrast, child protective service agencies have been shown to have contact with only a fraction of children affected by abuse and neglect.[21,135] Finally, although public health has been most effective in promoting health through passive campaigns targeting environmental changes (e.g., child safety tops on toxic substances), it also has an established track record in reducing harm to children through the employment of education, policy, and intervention programs focused on behavior modifications (e.g., use of bike helmets, anti-smoking campaigns).

1.3 The Application of a Public Health Framework to This Study

The lack of reliable information as to the number of children affected by child abuse and neglect has been identified as a serious limitation in lodging an effective public health response.[136] Incomplete data prevent the threat of child maltreatment from being considered in the context of other, more easily measured, public health problems. Inadequate surveillance data also limit the identification of those groups who are at greatest risk and stand to benefit the most from targeted services. Although a majority of children reported to CPS come from poor families, most children in poor families are not reported for maltreatment. Poverty itself is a weak method for targeting services. Additionally, an absence of population-level surveillance data restricts the public health community from tracking changes in the incidence and prevalence of maltreatment over time, which limits the ability to then monitor the effectiveness of child maltreatment prevention and intervention activities.

The current study is conceptualized within the broader four-step public health framework: it contributes information concerning both surveillance and risk/protective factors. Through record linkages between child protective service records and vital death records – with injury death serving as the dependent variable of interest – this study offers child maltreatment surveillance information meeting Thacker's specification that the surveillance data be "outcome" focused.[121] By also linking all CPS and death records with vital birth records, this study provides population-level data used to explore whether children reported to CPS should be identified as a distinct group facing a heightened risk of injury mortality, suggesting unmet service needs despite their earlier identification as at risk of harm. Finally, maltreatment information gleaned from CPS records provide a preliminary examination as to the possible protective functions of child welfare service activities.

2. Research Theory

While a public health approach provided a framework for this study's focus on population-level surveillance and the identification of risk factors associated with injury mortality, an

evolutionary understanding of parental investment theory was employed to explain dynamics that might account for parenting behaviors in which children are either injured, or not protected from injury, despite the seeming contradiction of such parenting actions with an evolutionary perspective on genetic fitness. At a most intuitive level, parent-perpetrated child maltreatment and homicide, as well as a failure to provide the supervision necessary to protect a child from an "accidental" injury, seem to run counter to all evolutionary logic: how could parental genetic fitness be improved by a child's death? Surely both must represent maladaptive parental pathology.

Yet, variations in parental investments in children can be considered "rational" from a strictly genetic perspective in resource constrained parenting environments. This is not to suggest that parents actively calculate the losses and gains of caring for a child. Rather, over the course of human evolutionary history, individuals may have been selected to: 1) make investments in their children that improved the child's chances of survival, and 2) adaptively alter that behavior in response to adverse parenting conditions. Parenthood is an onerous commitment. It stands to reason that humans, as other animals, display patterns of parental investment reflecting sensitivity to the availability of material and nonmaterial resources. A brief overview of parental investment theory is offered as a relevant and informative theoretical orientation for considering childhood injury risk across intent classifications.

2.1 Parental Investment Theory

Arising from an evolutionary framework is the concept of parental investment, defined as any activities on the part of the parent that increase a child's chance of surviving (and then reproducing, thus passing along the parents' genetic material) while simultaneously decreasing that parent's ability to make investments in other children.[137] As such, parental investments are conceptualized by sociobiologists as a "zero-sum game" in which one individual's gain necessitates another's loss: as a parent expends energy and devotes limited resources towards feeding, nurturing, and protecting one child to increase its well-being, those investments decrease the parent's ability to make investments in other children, both present and yet born.

An investment of parental time and energy is critical to the survival of offspring throughout the animal kingdom, but none more so than human children. As S.R. Johansson described,

> Total maternal rejection will lead to infant death within hours or days. But there are many forms of lowered biological, social, and emotional support that will not kill an infant so soon; instead the infant will be placed in a category that renders it more vulnerable to the risk of dying from disease, accidents, or violence.[138]

The anthropologist Sarah Hrdy states point blank that over the course of history, "Many millions of infant deaths can be attributed directly or indirectly to maternal tactics to mitigate the high cost of rearing them." [139]

But what might explain variations in the adequacy and commitment of parental, specifically maternal, caregiving? Why might a mother commit less than the full resources necessary to ensure a child's survival, especially after she has devoted nine months to its creation? Common sense would lead us to believe that any human traits associated with tendencies towards

abandonment, infanticide, or simply poor caregiving would not have withstood pressures of natural selection. The children of individuals displaying these traits would have either not survived to reach their reproductive years, or upon surviving, would have been low quality partners (because of poor caregiving) and would have therefore fared reproductively unsuccessful. Genes would not have been passed forward.

2.1.1 "Early Terminations" of Parental Investments

Those working in the field of evolutionary biology and psychology have long been interested in behaviors that seem contrary to withstanding the pressures of natural selection – the process of differential reproduction. And because there is no more explicit a seeming violation than parent-perpetrated infanticide, it has been the subject of a good deal of study in both animals and humans.[138,140-142] Under similar logic, explorations of child maltreatment have also been conducted within evolutionary frameworks of parental investments.[140,142-145]

Although morally unpalatable, scenarios have been identified in which an "early termination" of parental care can be considered "rational" from a strictly genetic perspective.[144,146] Among these are parenting conditions where: 1) paternity is uncertain or the caretaker is not genetically related to the child; 2) the child has low "reproductive value" as a result of poor health; and 3) there are severe resource constraints.[142,144,146] It should not be lost on the reader that these three conditions have been shown to be among the most consistent and strong predictors of both unintentional and intentional childhood injuries. I next discuss what an evolutionary framework has to say about parental investments in children, and how each of the above scenarios might impact the quality of parental care provided.

2.2 Protection as a Form of Parental Investment

As the earlier reviewed literature highlights, injuries are not randomly distributed throughout the child population. Among infants and young children, risk differences manifest in the home environment and are often related to the quality of parental supervision provided. At one end of the spectrum are those children who are nurtured and protected. At the other end are children subjected to chronic abuse or neglect. Falling in the middle are children who receive caregiving that may not be wantonly harmful, but may still place them at a heightened risk of harm across a number of health and well-being domains, injuries among them.

In this study, protection from harm is examined as a crucial form of parental investment. Infants and young children depend on their parents not only to not inflict harm, but also to protect them from threats posed by the physical and social environments encountered. The energy and time expended in rearing and supervising young children is tremendous and amount to valuable and limited resources that parents possess and conditionally allocate based on the needs of the child and the circumstances of the parenting environment. Parental investment theory suggests that there are three basic scenarios in which high rates of parental "underinvestment" can be expected. This underinvestment heightens a child's risk of both unintentional and intentional injury.

2.2.1 Non-Related Caregivers and Injury Risk

Evolutionary theories of parental investment extend from kin theory, which holds that relatedness explains and predicts altruistic behaviors.[147,148] That is, altruistic behaviors are most

likely to be observed in scenarios where the overall inclusive fitness benefits to the actor are greater than the individual fitness costs incurred. A conceptual example involves two siblings – sibling A and sibling B. Sibling A chooses to forego the opportunity to have children in order to assist sibling B bear and raise children. In determining whether or not this behavior is adaptive, one must consider the number of children sibling A could have had (cost incurred), the number of additional children sibling B is able to raise to sexual maturity since she has her sibling's help (indirect benefit to a relative) and the coefficient of the relationship (degree of relatedness).

In terms of child-caregiver interactions, kin theory posits that the degree of relatedness between a child and his or her caregiver should be predictive of the quality of care provided. Daly and Wilson coined the term "discriminative parental solicitude" to describe a model of kinship-driven variability in parental care.[140] Using data to demonstrate that children raised in stepparent families were subjected to inferior care as compared to children in biologically intact families, Daly and Wilson proposed that natural selection has resulted in behaviors that make it advantageous to favor one child over another. They argue that, in allocating scarce resources (e.g., food, investments in education) it is only rational for parents to make choices between children, and to favor those children who are the closest biological relatives.

Despite the controversy with which it has been received, a robust body of research documents reduced investments in children cared for by non-genetic caregivers.[149-153] In the studies cited, researchers examined whether biological relatedness to a parent/caregiver (and the degree of that relatedness) influenced various aspects of life, everything from survival to educational opportunities. Relatedness consistently demonstrated significant independent effects on the care a child received and was sensitive to the closeness of the genetic relationship. Consistent with these findings are studies demonstrating that children in homes with non-biological caretakers face a heightened risk of unintentional and intentional injury fatalities.[37,99,153-155]

2.2.2 Poor Child Health/Condition and Injury Risk

Beyond selection pressures favoring individuals who discerningly invested in genetic relatives, individuals who selectively invested in offspring with the greatest reproductive potential would have also been favored. From an evolutionary standpoint, a child's reproductive potential can be measured as the number of offspring that child will produce as part of the next generation.[156] Reproductive prospects are low when children are young since they are further from sexual maturity and require greater resources to fulfill their reproductive potential. Reproductive prospects are also low for those in poor health as a child's reproductive value is dependent on his or her ability to attract mates: the physical condition (health) of an offspring has historically been an important signal of future success in this domain.

As such, children falling in either (or both) of these categories are the "riskiest" recipients of parental investments. An evolutionary framework of variable parental investments predicts that if a parent is going to terminate investments, it should be done early in the child's life. It also predicts that, in the face of resource constraints, children in poor health should be disproportionately targeted for underinvestment. Consistent with these predictions, humans have a long history of using "viability tests" such as subjecting young infants to ice baths, "in order to

let die, as not worth rearing, one that cannot bear the chilling."[3] The abandonment of infants in poor health or with deformities are cross cultural phenomena that have more than stood the test of time. And just as infants in nineteenth-century Europe were accidentally smothered in their parents' bed through "overlying", one wonders the extent to which "sudden infant death" syndrome is nothing more than its 21st century equivalent.[90,139,157]

In the unintentional and intentional injury literatures, infants, as well as young children with disabilities or suggestions of poor health (e.g., low birth weight), are consistently identified as high risk.[8,158] Parental investment theory suggests that such findings may jointly stem from an evolved parental psyche in which it was adaptive to underinvest in those children who were least likely to fulfill their reproductive potential.

2.2.3 Resource Constraints, Conditional Investments, and Injury Risk

Within a evolutionary framework of parental investments, natural selection would have favored parents who made greater investments based on the degree of shared genes, as well as those who discriminated against offspring suffering from poor health. Of course, parents who were able to provide for *all their children*, including more distantly related relatives and even those for whom a genetic connection was possible, even if not certain, would have experienced the greatest reproductive success in the next generation.

But to invest in a child, a parent must have resources available. I conceptualize resources possessed by parents for possible investment in children as falling in three classes: material, human, and social. *Material resource*s comprise those that are physically needed to ensure a minimum level of child well-being, such as shelter and food. *Human resources* encompass the parent's ability to competently manage parenting tasks that protect a child from harm. Resources in this class include cognitive problem-solving skills, good mental health, an ability to delay gratification, and age-appropriate understandings of child development. *Social resources* relate to the support system available to a parent and may include an engaged parenting partner or extended network of "alloparents". Social resources can be thought of as those resources that meet a parent's interpersonal needs, thus allowing them to attend to a child's well-being.

Although qualitatively different, all three resource classes are critical to the creation of a parenting environment in which investments are made in children. Unfortunately, it is often the case that limited parental resources in one domain are strongly associated with limited resources in other domains. Also unfortunate is the fact that, as is true with other mammals, a mother's emotional commitment to her infant or young child can be highly variable based on the environmental circumstances in which she is parenting.

Research from the animal world documents that the adequacy of the parenting an offspring receives is contingent upon the resources available to the parent.[139] In other words, *parental investment in children is conditional upon the availability of both material and nonmaterial resources that allow for investments to be made.* This is not to suggest that cost-benefit calculations are consciously made. Only that, as with other mammals, a mother's emotional commitment to her infant can be highly variable, and that this "differential parental solicitude"

[3] This quote is from Hrdy's book, *Mother Nature* (1999), attributed to Soranus who was a doctor during Roman times.

may reflect "an evolved intolerance or reduced solicitude toward particular kinds of infants (e.g., unrelated; poor quality), or toward infants under certain conditions (e.g., insufficient resources) rather than selection for abusive behavior." [159] In short, throughout evolutionary history, parenting in the context of a resource-deprived environment was not good for a child's likelihood of survival to the age of reproduction. Individuals who were able to adapt their reproductive investment strategies in the face of those conditions were likely to have been naturally selected.

2.3 The Application of Parental Investment Theory to This Study

In the context of this research, the strong association between the presence of a non-biological (usually male) caretaker in the home and a child's risk of both unintentional and intentional injury is thought to uniformly stem from lower levels of parental investments received from unrelated caregivers. This underinvestment in caretaking may manifest in less vigilant supervision, or as physical abuse. Both can be thought of as failures to protect a child from harm. As the evolutionary psychologists Wilson and Daly summarized,

> Little children are annoying, after all: they cry and soil themselves and sometimes refuse to be consoled. A caretaker with a heartfelt, individualized love for a squalling baby is motivated to tenderly alleviate its distress, but a caretaker who is simply playing the part without emotional commitment – and who might even prefer that the child had never been born – is apt to respond rather differently." [155]

Parental investment theory also identifies children with the lowest reproductive value – based on young age and poor health – as those who can be expected to be selectively targeted for underinvestment in the face of parental resource constraints. As such, the high rates at which infants and children of poor health fall victim to injuries, both inflicted and unintentional, may reflect tangible displays of underinvestment, rather than simply heightened physical fragility.

Finally, most germane to this study is the concept of conditional parental investments based on resource constraints.[4] Children at risk of unintentional and intentional injuries are disproportionately born into environments defined by limited material, human, and social resources. In the face of these resource constraints, parental investment theory predicts that early terminations of investments, or underinvestment, may reflect psyches that were selected through evolutionary processes. In other words, the ability of an individual to differentially invest in children based on cues originating with the child (e.g., health) and in the environment (e.g., resources) may well have been adaptive to a parent's overall reproductive success.

To be clear, this is in no way meant to suggest that selective pressures have created different "groups" with greater or lesser predispositions to commit infanticide, or to underinvest in the next generation. As Richard Dawkins would argue, this would not have been an "evolutionary stable strategy".[160] Rather, this is to suggest that all humans have evolved with capacities for

[4] Recent research lends support to a contingent model of parental investments based on the material and nonmaterial resources possessed by the parent, which interact with characteristics of the child (Bugental, Beaulieu, & Silber-Geiger, 2010; Beaulieau, Bugental, 2008). Mothers of high-risk children who possessed low-levels of human capital, as well as low-levels of material resources, pursued a reproductively safe strategy by differentially investing in low-risk children. In contrast, parents in possession of greater resources, selectively invested in high-risk rather than low-risk children.

variable investments in children. Calculations made are not conscious, nor appealing, but because they have been adaptive over time, they remain. I close this section by borrowing the words of Daly and Wilson: "In suggesting how parents 'should' or 'are expected to' behave, [I am] not making value judgments. Rather [I am] suggesting what characteristics of parental psychology might be anticipated insofar as that psychology is a product of evolution by natural selection."[140]

3. Research Model

This study has been presented in the context of a public health framework for its focus on surveillance and risk factor identification. Parental investment theory has been employed as a means of explaining injury mortality in the context of established etiological risk factors. I now turn to a working model proposed by Peterson for the unified study of unintentional and intentional injuries. Injury mortality is an outcome in which there is no "one" risk factor that is either a necessary or sufficient antecedent condition to produce the outcome. Yet, these factors may still be considered causes as they contribute to the likelihood of an injury event's occurrence. This working model was developed to organize antecedent factors observed in instances of both unintentional and inflicted injuries. Thus, the working model serves to place CPS contact in the context of potential confounds, treating it as a surrogate indicator of some unmeasured, more proximate stressor.

3.1 Connections Between Unintentional and Intentional Injuries

Lizette Peterson began her career in a pediatric hospital setting, studying methods of stress reduction for children about to undergo medical procedures.[161,162] It was her reported dissatisfaction with helping children only post-injury event that led to a shift in her research focus: she wanted the impact of her work to be realized in the prevention of childhood injuries, believing that finding ways to avoid childhood injuries was quite preferable to addressing its after effects.[163] With this goal in mind, she began to explore the role that parental supervision played in averting injuries among young children.[164-166]

Thereafter, Peterson's research was concerned with the relationship between levels of parental supervision and unintentional injuries. But that changed when her colleague, Bernard Ewigman, published his landmark study of child deaths in which he documented that maltreatment fatalities were vastly underreported on death certificates.[163] Peterson began to explore parallels between unintentional and inflicted injuries and spent the latter part of her career studying what she viewed as a single field of inquiry – non-fatal and fatal injuries among children, independent of intent classification.

3.2 Childhood Injuries: An Unified Model

Peterson's unified framework of childhood injuries was summarized in her 1994 article entitled, *Integrating child injury and abuse-neglect research: Common histories, etiologies, and solutions*. In this article, she sought to conceptually link the preventive work and research of accidental (or unintentional) injuries with the corresponding literature in intentional (or maltreatment related) injuries.[167-170] Peterson argued that for reasons partly political in nature – including funding turf wars and the lack of a common constituency – injuries had been artificially dichotomized. This "split" resulted in the claiming of unintentional injuries by

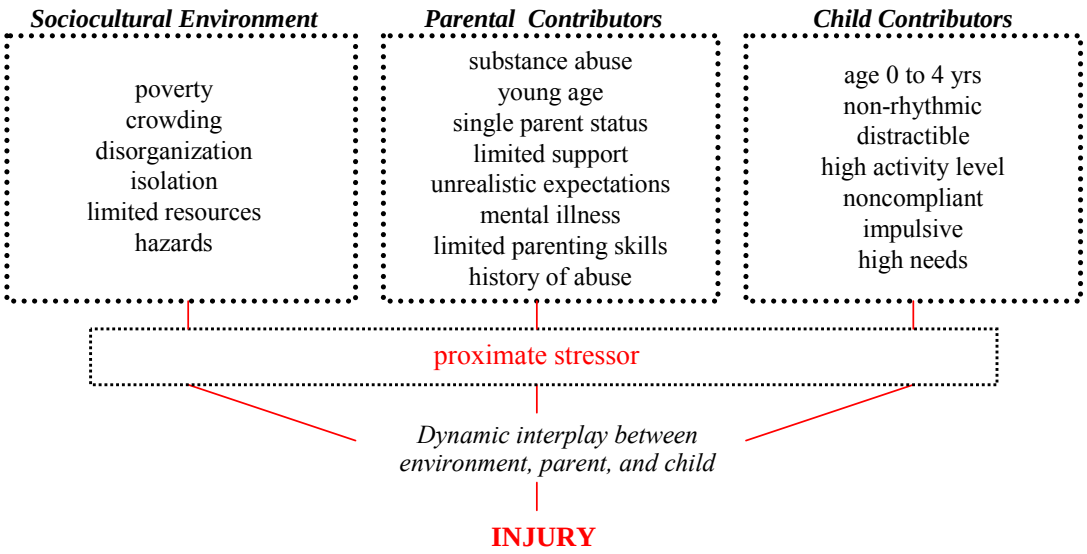
epidemiologists in public health and intentional injuries by those in sociology and social work. Peterson explained that, beyond sharing a common outcome of interest (i.e., child harm):

> …the literature on what has been termed unintentional injury and the study of what has been labeled child abuse and neglect have similar histories, have used similar definitions, have documented similar etiologies for injury, are likely to be influenced by similar preventive efforts, currently face similar challenges, and probably address a single, albeit multidimensional, phenomenon.[168]

She was careful not to dismiss "important differences in the study of unintentional injury and injury due to abuse and neglect," but noted that she was choosing to focus on the "similarities that exist despite the differences" because "uniting efforts to prevent all injuries in children makes more sense than continuing to respond as though it is possible to differentiate injuries that are unintentional from those due to abuse and neglect."

As such, Peterson outlined a working model for organizing risk factors common to both unintentional and intentional injuries which is represented below (Figure 4) in a slightly modified form.[168] In essence, a classic ecological model was offered as a means of providing a parsimonious description of "child injuries as a single entity regardless of source." In this framework, environmental, parent, and child factors are assumed to be "background contributors which exist as historical or ongoing continuous influences." These contributors interact with a proximate stressor, leading to an unintentional or intentional injury.

Figure 4. Peterson's Model of Etiological Risk Factors for Child Injury



3.3 The Application to the Present Study: A "Proximate Stressor"

Garbarino argued that it is the unmanageability of stress that is the most immediate antecedent to child abuse or neglect: a mismatch between the level of stress encountered and the availability and strength of available support systems and resources.[108] There is no one environmental, parent, or child factor that is either a necessary or sufficient condition for an inflicted or

unintentional injury. As such, some proximate stressor may be the one constant to be found. Of course, "stress" amounts to an ill-defined and almost always unobservable factor. That which proves a critical stressor under one set of conditions, for one parent, may be entirely different than for another parent under the same set of conditions. Still, I would contend that this makes the consideration of a proximate stressor all the more conceptually useful in a model of injury events. To borrow a term from statistics, it serves as the model's "random effect". And in this study, a referral to CPS is included as the individual family's error term. A report to CPS serves as a surrogate measure of one or more prior instances in which an unmeasured stressor led to a child's harm, or suspected harm. As such, it is posited to be associated with an increased likelihood that the same confluence of background factors will again interact with a proximate stressor, and that in a future instance, the result may be fatal rather than nonfatal.

4. Summary

The profile of a child at risk of an unintentional (or accidental) injury is virtually indistinguishable from that of a child at risk of an intentional (or maltreatment related) injury. This was likely true throughout human evolutionary history; was true in the second half of the 20th century when the public health approach was selectively applied to the study of unintentional injuries; and was true a decade and a half ago when Peterson's unified model of childhood injuries was first proposed. It should be no surprise that it remains true today. Young age, low birth weight, and behavioral or health problems are child level factors associated with both unintentional and intentional injury risk.[16,34,38,171-174] Parental and familial contributors such as low income, a single-parent home, limited maternal education, depression or mental illness, young maternal age, and a non-biological caregiver in residence are cited in both injury literatures.[35,36,61,158,172,174-187] Research also indicates that neighborhood poverty and a proximate crisis or stressor provide a common backdrop against which both unintentional and intentional injuries typically manifest.[61,174,177,188 4,176,189-192]

Yet, by and large, unintentional and inflicted child injuries are still studied and treated as distinct. This conceptualization suggests different child populations at risk, exclusive risk factors, disparate outcomes, and the necessity of unique prevention efforts. The research reviewed in Chapter 1, however, would suggest this misreads the literature. In this second chapter, I have outlined a public health framework for the surveillance of child maltreatment which incorporates the use of population-level birth and mortality data. Since there is no more easily observable manifestation of harm than the premature and preventable loss of a child's life, injury deaths were studied.

The non-random distribution of injury fatalities suggests that children are differentially exposed to hazards related to the fatal injury event. As noted earlier, a central premise of this line of research is that the differential exposure to hazards among this youngest group of children is largely explained by variability in the quality of parental care and supervision provided. To explain variable parenting, I rely on an evolutionary theory of parental investments, highlighting protection from harm as a critical investment parents make in children. I discuss three child/environment scenarios in which under-investments might be understood by considering selection pressures that would have favored conditional parenting when faced with resource-constraints.

Finally, I turn to Peterson's working model of unintentional and intentional injuries as the only example I could find that attempted to present a unified picture of antecedent risks. Using this model, I treat her inclusion of a "proximate stressor" as an opportunity to examine a report to child protective services as a proxy for some aspect of otherwise unmeasured family-level dysfunction or risk. On this basis, I assume that, on average, a prior non-fatal report to CPS is associated with a future risk of injury mortality.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

This study linked child-level administrative and population-based data sources to create a unique dataset for analysis. These record linkages – Child Welfare Records, Vital Birth Records, and Vital Death Records – were used to assess the risk of death among children referred to child protective services (CPS) for maltreatment, compared to sociodemographically similar children for whom no such allegation of abuse or neglect was made.

As covered in the review of literature, associations between CPS contact and death have been explored in prior research.[39,96-98] Earlier studies, however, were limited in the level of statistical analysis that was possible (and therefore the findings reported) because both CPS contacts and child deaths are rare events. This study overcomes limitations of prior studies through its analysis of eight full birth cohorts of children born in California. This translates into a study capturing over four million children, a disproportionately high share of whom have been reported to CPS relative to other states.[193] Not only does this methodology allow many rare-event and base rate issues to be overcome, but it also allows for a longitudinal birth cohort study design, reducing biased or distorted findings, and from which greater causal inference can be derived.

Additionally, this research is unique as it examines not only children who had a substantiated allegation, or who spent time in foster care, but incorporates the full universe of children reported for possible abuse or neglect. This further increased the number of children experiencing the key independent variable event (a referral for maltreatment) while also allowing some preliminary explorations of CPS decision-making and service interventions. Finally, this dissertation research helps fill gaps in the injury literature by examining both inflicted fatal injuries and unintentional fatal injuries. The extent to which children who sustain an intentional or violence-related fatal injury, differ from those who are unintentionally injured, remains a largely unanswered question.

The remainder of this chapter is divided into three sections. Section 1 details the three data sources that were linked in order to create the final dataset for analysis. The construction of all datasets is described, including the processing of source files, record clean-up, variable standardization, and record de-duplication. In addition, information is provided concerning the protection of human subjects and the security protocols followed. Section 2 covers record linkages. Linkage methodologies are described and information for the linkage software is presented. This section also details the linkage strategies employed, explains blocking and matching variable decisions, and reports linkage parameter estimates and results. In Section 3, the analysis of the linked data is outlined. Coding of both the dependent and independent variables is detailed and justification is offered for the statistical models specified. Finally, Section 4 serves to conclude this chapter with a brief summary of the topics covered.

1. Data for Linkages

Historically, administrative data were maintained as paper records and their utility for purposes of research were quite limited. Paper records were burdensome to compile, expensive to share, and frequently fraught with clerical errors. Technological advances in computing, however, have made administrative records an increasingly popular (and reliable) source of data for research.[194]

The strengths of administrative data are numerous. They offer complete coverage of a given population, can often be configured longitudinally, and cost relatively little when compared with survey data. Yet, an inherent limitation of administrative data is the scope of the information contained in any one database. Since administrative data are collected during the normal course of agency operations, with recorded information typically confined to only that which is directly relevant to that agency's administration of programs and services, key variables of interest are frequently missing.

Fortunately, just as computers have streamlined the once onerous process of compiling and managing administrative records, computers have also allowed for the labor intensive process of record linkage, and the low match rates between databases, to be largely overcome. Information captured for individuals in one database can be extended with information captured for those same individuals in another database, allowing much more to be gleaned about a given population than can be found in independent databases.

In this section, general record linkage methodologies are explained, the administrative data sources that were linked in this dissertation research are described, and the steps that were undertaken to prepare each data file for linkage are detailed. Information regarding human subjects security protocols to ensure the confidentiality of all records is also provided.

1.1 Data Sources

Three independent California data sources were linked to create the analysis dataset:

1) Vital Statistical Birth Records,
2) Vital Statistical Death Records, and
3) Administrative Child Welfare Records.

Each data source is described below.

1.1.1 Vital Statistical Birth Records

Confidential Birth Records in two different configurations – Cohort Files and Master Files – were purchased from the California Department of Public Health for the years spanning 1999-2006. Although these two file types contain the same base birth variables, and can be purchased for research purposes with personal identifiers, some variables are exclusive to each file. The Birth Cohort Files are unique in that they contain a death record locater indicating if the child died during the first year of life, while the Birth Master Files are the only files that contain parent Social Security Numbers (SSNs). Since this research involved birth to death record linkages, the Cohort Files allowed for this study to build upon already completed matches which served to streamline the linkage process, while also providing a means of confirming linkage methodologies. Meanwhile, although parent SSNs are not captured in the Death Files, they are present in approximately 60% of the Child Welfare mother records and 40% of the Child Welfare father records: gaining access to parent SSNs available in the Master Files was also important to successful linkages. Therefore, both file types were purchased and individual birth records were merged in order to utilize both the infant death record linkages in the Cohort Files and the parent SSNs in the Master Files.

1.1.2 Vital Statistical Death Records

Confidential Death Master Files for the years 1999-2007 were purchased from the California Department of Public Health. Each annual death file contains data concerning all deaths that occurred in California during the year. The Death Master Files contain personal identifiers such as the decedent's name, mother's name, date of birth, and SSN.

1.1.3 Child Welfare Records

This study utilized individual and case-level data from California's statewide child welfare information database: Child Welfare Services/Case Management System (CWS/CMS). Through a longstanding interagency agreement between the California Department of Social Services (CDSS) and the Center for Social Services Research (CSSR), confidential administrative data from CWS/CMS are hosted at the Data Center located within CSSR where they are configured into a longitudinal database. Personal identifiers, including names and SSNs, are maintained on a private workstation and were extracted for the purposes of linkages with birth and death records.

1.2 Protection of Human Subjects

The current study did not involve any direct contact with human subjects. Rather, it was based on the secondary analysis of data collected during the normal course of agency operations as required by state and federal laws pertaining to registering births, deaths, and child abuse and neglect. Because personal identifiers were used to link individual-level records across multiple data sources, however, approvals from two separate Committees for the Protection of Human Subjects were required: California's Health and Human Services (HHS CPHS) and the University of California at Berkeley (UCB CPHS). Additionally, permission for linkages was sought and granted from the California Department of Public Health's Vital Statistics Advisory Committee and the California Department of Social Services.

1.2.1 Human Subjects Approvals

Human subject approval for the use of child welfare data from California's CWS/CMS system fell under a longstanding interagency agreement between the California Department of Social Services (CDSS) and the Center for Social Services Research (CSSR) in the School of Social Welfare at the University of California at Berkeley (HHS CPHS# 04-12-09 and UCB CPHS# 2004-05-09). The interagency agreement with CDSS allows data to be used for research purposes by CSSR staff and graduate student affiliates with the proper clearances.

The above-referenced CPHS approvals for the use of child welfare data were modified to allow for the addition of vital birth and death records to the data archive maintained at CSSR for ongoing analysis of child maltreatment and child welfare services. CPHS revisions were approved under an expedited review by HHS CPHS and UCB CPHS, and were then endorsed and accepted by the Vital Statistics Advisory Committee (VSAC). Further revisions to allow for the addition of parental SSNs available in the Master Birth Files were approved by Human Subjects Committees in November 2009 and VSAC in January 2010. Approval was also received for this dissertation research, inclusive of all data linkages (UCB CPHS# 2009-6-2).

1.2.2 Data Security

All data used in this research were hosted at CSSR, which is located in a basement suite within the School of Social Welfare at the University of California at Berkeley. CSSR is kept locked during all hours when a receptionist is not on duty; an alarm is set during evening and weekend hours. All CSSR personnel require a key and a numeric code to disarm the alarm to gain admittance during non-traditional hours. All unencrypted computer media containing confidential child welfare data and confidential birth and death records is stored in a fire and theft protected vault located in Room J within CSSR. Room J is keyed separately from the other offices in CSSR and is kept locked when unattended.

A private server (also located in Room J) was used to stage, process, and link confidential child welfare and vital statistics data. This private server has been operational since 2005 and has nodes that are configured so that even if the computer is plugged in, they will not operate within the University of California at Berkeley's campus subnet. Upon completion of record linkages, all confidential personal identifiers were purged from the resultant data files and data were transferred to a restricted-access server via encrypted computer media. This restricted-access server is maintained by CSSR for authorized users to work with encrypted data for research and analysis purposes.

1.3 Pre-Linkage Record Preparation

A well-established reality of record linkage is that the preparation and management of the individual data files for subsequent linkage is the most difficult, time consuming, and important stage of the research.[195-197] This project proved no exception. The sheer number of records being linked, coupled with the fact that not two, but three, data sources were being combined, meant that several weeks were devoted to the coding and processing of *each individual data source* before any linkages were undertaken. The details of pre-linkage data management are described below.

1.3.1 Processing of Vital Record Source Files

Each of the eight Birth Cohort files (1999-2006), eight Birth Master files (1999-2006), and nine Death Master files (1999-2007) were read into Stata (v.11, StatCorp) from encrypted ASCII-text files received from the California Department of Public Health. A data dictionary was written in Stata based on the file documentation accompanying each annual data file and was used to read and code the data. Since the formatting of files has changed over time – variables have been added and dropped, value codes have changed, column allocations have shifted – it was necessary to construct a separate dictionary file for each single year data file.

Single year birth cohort datasets were created in Stata from the Cohort files, with parental SSNs (uniquely available in the Birth Master files) added to each dataset by conducting a one-to-one merge using the 6-digit state birth file number assigned to each birth record and common to both the Cohort and Master files. Since state birth file numbers are unique only within a given calendar year, and this analysis spans multiple years, a unique identifier was assigned to each child (child identifier: BID) incorporating both the last two digits of the birth year and the 6-digit state birth file number. Birth records created in response to a fetal death were dropped from each birth cohort, nonresident births occurring in California were maintained. As such, the final cohort dataset contained all live births occurring in California. To decrease data processing time, the

overall dataset size for each birth cohort file was reduced by dropping all variables except those personal identifiers that were to be used to perform a linkage. The annual counts of birth records meeting the above criteria are reported in Table 1. Live birth counts are slightly larger than those published by the California Department of Public Health as the statistics they report exclude non-resident births (amounting to roughly 2,500 births each year). For the purposes of this research, the decision was made to retain all birth records for possible match. *A total of 4,317,738 births met all study criteria and were retained for linkages with death and child welfare records.*

Table 1. Birth files, *by year of birth*

birth year	*full file*	*live births*
1999	522,621	519,596
2000	536,077	532,964
2001	532,178	529,089
2002	533,992	531,035
2003	545,489	542,610
2004	549,567	546,615
2005	554,241	551,153
2006	567,707	564,676
total	**4,341,872**	**4,317,738**

In similar fashion, single year death datasets were also created in Stata and each death record was assigned a unique identifier based on the death year and the official state death file number (decedent child identifier: DID). Each annual death dataset was then restricted to decedents who were born between 1999 and 2006. If the birth year was missing, as it was in 982 records, those deaths were maintained in the final file for possible linkage. The only exceptions were 299 cases where the 'age group' variable was not missing and suggested the decedent was broadly defined as an adult over the age of 18. These records were dropped. As was the case when birth datasets were created, all variables except those employed in performing record linkages were dropped to improve processing time. Annual death record counts are reported in Table 2. *A total of 25,987 deaths met all study criteria and were retained for linkages with birth records.*

Table 2. Death Files, *by year of death*

death year	*death count*	*dob '99-'06*	*born/died CA*	*death < age 5*
1999	231,033	2,530	2,391	2,391
2000	231,528	3,213	2,964	2,964
2001	235,805	3,300	3,063	3,063
2002	236,181	3,417	3,215	3,215
2003	242,301	3,492	3,252	3,252
2004	235,300	3,518	3,306	3,273
2005	239,228	3,718	3,594	3,518
2006	239,417	3,644	3,533	3,391
2007	236,377	1,177	1,091	920
total	**2,127,170**	**28,009**	**26,409**	**25,987**

1.3.2 Processing of CWS/CMS Extract File

A dataset consisting of all unique children reported to California's child welfare system between January 1, 1999 and December 31, 2007 was created by downloading a child-level file from the Quarter 1, 2009 CWS/CMS data extract.[198] These data were then restricted to include only those children born between 1999 and 2006 and for whom the first allegation of maltreatment occurred before their fifth birthday. The initial dataset was downloaded in SAS (v.9.1, SAS Institute) and then converted to Stata using StatTransfer (v9, Circle Systems). The CWS/CMS encrypted identifier already assigned to each child in this dataset was maintained as the unique identifier (FKCLIENT_T). Attached to each unique child were possible mother and records as identified through the CWS/CMS Client Relationship Table.

While some unknown fraction of these children were born outside of California, and therefore did not meet the study criteria, the field capturing the state or country of birth contained data in only 1% of all cases. For the 7,324 children for whom it was explicitly coded that the child was born outside of California or outside of the United States, that information was treated as reliable and those records were dropped. In addition, for those records with a child SSN recorded (54%) the first three digits of the SSN were examined and the record was flagged if the numbers indicated it was a non-California birth according to published state digit assignments (see: http://www.ssa.gov/employer/stateweb.htm). These records were not dropped at the outset due to concerns that there might be some children whose SSN contained an entry error making it appear that they were not born in California, when in fact they were. After linkages were completed, however, 5,182 of the records flagged as non-California births had not been matched to a birth record and were subsequently dropped from the final analysis. The total count of children meeting the above criteria is reported in Table 3 by year of birth. *A total of 596,692 children met all study criteria and were retained for linkages with birth records.*

Table 3. Child Welfare Records, *by year of birth*

birth year	*total records*	*referral '99-'07*	*referral < age 5*	*unique children*	*study eligible*
1999	534,148	445,979	249,296	90,150	85,823
2000	493,900	401,387	256,071	91,100	86,777
2001	441,191	346,738	260,137	91,021	86,693
2002	389,629	294,214	265,572	91,526	87,232
2003	341,517	246,479	246,479	85,998	82,295
2004	287,435	194,890	194,890	72,182	69,474
2005	240,462	147,452	147,452	58,807	56,881
2006	195,621	98,232	98,232	42,922	41,787
total	**2,923,903**	**2,175,371**	**1,718,129**	**623,706**	**596,962**

1.3.3 Data Cleaning

Prior to performing any linkages, all variables were systematically reviewed, cleaned, and standardized. Data reviews were conducted by running frequency distributions in to identify clearly errant values in both numeric and string variables. For example, a quick scan of the frequency tabulation for the 'middle name' variable in the birth datasets returned multiple instances in which the text field had been entered as 'UNK', 'UNKNOWN', 'UKNOWN' or

'MISSING'. Similarly, these same entries appeared with some regularity in the death and child welfare datasets. Since 'middle name' was used as one of the matching variables when a linkage was performed between birth and death files, in the absence of data clean-up for these entries (i.e., re-coding the errant values to a blank field), Link Plus would have treated the values as valid middle names and sought to match records across these two files based on a middle name of 'MISSING'.

Clean-up was also undertaken for numeric variables which had values that fell outside of clearly defined bounds on the set of admissible values. For example, in all three data sources missing SSNs were sometimes entered as '999999999' or '000000000'. These values clearly fall outside of the published set of possible SSNs, but would have been treated as valid values by Link Plus absent a re-code to missing.

1.3.4 Variable Standardization

Format standardization of all variables used in the matching process was also completed. For example, the 'sex' variable was coded numerically in the Birth datasets (e.g, 1, 2), as abbreviated text in the Death datasets (e.g., M, F), and as full word text in the Child Welfare datasets (e.g., MALE, FEMALE). In order for Link Plus to successfully match variables across data sources, variables must be coded and formatted according to the same conventions. As such dates were consistently formatted as 'YYYYMMDD' across all data sources, variables such as 'sex' and 'race' were comparably formatted as text fields, and where applicable, missing values were recoded as blank fields.

1.3.5 Deduplication of Parent Records in Child Welfare Data

Of all the children included in the child welfare data extract, approximately 10% (64,384) were attached to more than one mother or father in the CWS/CMS database. Although record linkages were made at the child-level, parent variables were crucial to establishing correct matches and efforts were made to glean as much information from the possible parent records as possible. In many cases children had been assigned to more than one mother or father not because of uncertain maternity or paternity, but because a parent who had already been entered into CWS/CMS and assigned a unique identifier was re-entered at some later date and assigned a new identifier.

Efforts were made to locate and drop duplicate mother and father records by grouping parent records by the child's unique identifier and then systematically comparing the first name, date of birth, and SSN of all duplicate mother (or father) records attached to a given child. If any of the above variables matched, then those records were flagged and an assumption was made that the two records captured information for the same person. For example, if a given child was assigned to two different maternal records, but each of these records reported that the mother had been born on 'January 14th, 1977' and was named 'Nicole', the assumption was made that these were duplicates and information from the two mother records was merged into a single record.

Employing this methodology led to the identification of 6,345 duplicate mother records and 9,243 duplicate father records, all of which were dropped. Additional clean-up was also conducted in instances in which there were two mother (or two father) records, and yet the gender of one of the duplicate records suggested that a mother had been incorrectly entered as a

second father (or a father had been incorrectly entered as a second mother). This clean-up led to an additional 880 duplicate mother records and 641 duplicate father records dropped. 478 duplicate parent records where all data except for the assigned parent identifier was missing were also dropped since these were not only duplicate records, but contained no information that could be used for record linkages or analysis.

2. Record Linkages

Record linkage entails "the bringing together of information from two records that are believed to relate to the same entity."[199] The entity may be an individual (or some other unit) appearing across multiple files – or an individual who appears multiple times within a given file (also referred to as 'deduplication' and described in this chapter, section 1.2.5). In either case, the challenge lies in correctly identifying the *same* individual in order to make an exact match.[5,6] When person-level data are involved and individuals are correctly linked across data sources, the quantity of data is literally multiplied. As the U.S. Government Accountability Office highlighted, linkage projects "have many potential benefits, such as informing policy debates, tracking program outcomes, helping local government or business planning, or contributing knowledge that, in some cases, might benefit millions of people." [200]

2.1 Overview

Two basic record linkage methodologies exist for establishing exact matches: *deterministic* and *probabilistic*.[199] In deterministic record linkage, two records are designated a match when the records agree exactly on a set of linkage variables. If a Social Security Number is the sole linkage variable, then a comparison pair will be considered a link if the Social Security Numbers captured in the two records agree exactly on every digit. If multiple match variables that are non-unique are used – for example first name, last name, and year of birth – then a deterministic methodology requires character for character matching on one or more of these variables.

Probabilistic record linkage differs from deterministic linkage in that it does not require perfect agreement between matching variables to link a pair of records, relying instead on a formal statistical model.[201] This statistical model is used to compute a numerical value which captures the similarity of two records based on the probabilities of agreement and disagreement for the specified match variables. Record pairs that are deemed links or matches are those where the ratio of the probabilities of agreement and disagreement – or the degree of difference between files – suggest that it is 'highly likely' the two records capture information for the same individual.

When there exists a unique identification number (e.g., a Social Security Number) that has been 1) assigned to each individual, 2) verified, and 3) is common to all files, record linkages are relatively straightforward and deterministic strategies are often employed.[199] The strength of a deterministic linkage lies in its *specificity*: a deterministic strategy is unlikely to establish a link for comparison pairs that are not actually matches – *false positive matches* are rare. Yet, few

[5] The terms 'linked' and 'matched' are used interchangeably, as are the terms 'linkage variables' and 'match variables'.

[6] There exist two types of matches that can be made: exact and statistical. Although not relevant to this research, a statistical match is one in which records for similar units are matched between two data files. Matched units need only have some relevant attribute in common and are not expected to be exactly the same unit.

linkage projects are so simple. Frequently, files are large, lack unique identifiers, capture information in non-standardized formats, and contain many errant values. The weakness of deterministic strategies is that many true matches are missed, its *sensitivity* is relatively low and it frequently has high rates of *false negative matches*. Table 4 outlines the possible match outcomes for comparison pairs arising from the linkage of two files.

Table 4. Possible Linkage/Match Outcomes for Record Comparison Pairs

File 1	Matched?	File 2	Match Status	Description
JOHN DOE	yes	JOHN DOE	True Positive Match/Link	*A comparison pair* ***correctly accepted*** *as a match.*
JOHN SMITH	no	JOE SMITH	True Negative Match/Link	*A comparison pair* ***correctly rejected*** *as a match.*
JOE SMITH	yes	JOHN SMITH	False Positive Match/Link	*A comparison pair* ***incorrectly accepted*** *as a match.*
JANE DOE	no	JANE DOE	False Negative Match/Link	*A comparison pair* ***incorrectly rejected*** *as a match.*

Since probabilistic methodologies allow for partial record agreement and often utilize information from a greater number of possible identifiers, the number of matched pairs tends to be higher. Yet, because records may be linked based on lesser degrees of shared attributes, this strategy is accompanied by the downside of an increased likelihood of false positive links. Thus, probabilistic strategies trade-off some degree of specificity, but have the advantage of greater sensitivity.

2.2 Linkage Methodology

In this project, probabilistic linkage strategies were employed for all record linkages. This strategy has become increasingly sophisticated over the last decade and has been verified as a superior method for linking files that do not have a common unique identifier.[202] Since the three data sources linked not only lacked a common unique identifier and contained non-unique identifiers that had not been verified, but also consisted of hundreds of thousands of records each, it was arguably the only strategy that could be employed. As described in the sections that follow, however, efforts were made to utilize the strictest criteria for establishing linked pairs. A decision to err on the side of specificity (i.e., minimizing false positives, but increasing the likelihood of false negatives) was based on the particulars of the research questions posed: false negative links may have dampened effect sizes, but should not have biased any of the results reported in Chapter 4.

2.2.1 Linkage Software

All record linkages were completed using Link Plus, an 'open source' (i.e., free and in the public domain) linkage software developed by the Cancer Division of the U.S. Centers for Disease Control and Prevention (CDC). Although Link Plus was written as a probabilistic record linkage tool for cancer registries (as part of the CDC's National Program of Cancer Registries), it can also function as a stand-alone, Windows-based application for record linkage between any two data files. Link Plus was designed by a statistician following a review of the relevant record linkage literature dating back to 1969 and can work with files as large as 4 million records. The software is available for download at: http://www.cdc.gov/cancer/npcr/tools/registryplus/lp.htm. In an evaluation of the linkage algorithms underlying Link Plus it was deemed a powerful linkage tool and outperformed basic deterministic methodologies.[202] Although one of the Link

Plus design goals was "to hide the statistical complexities and linkage technicalities from the user to the extent possible",[203] some of the basic theory guiding its development bears mention and is described below. This is followed by details of the more practical aspects of record linkage.

2.2.2 Theoretical Underpinnings

Link Plus conducts probabilistic record linkages based on the theoretical foundation developed by Fellegi and Sunter, who are credited with developing the formal mathematical models underlying modern record linkages.[199,204,205] The Fellegi and Sunter model extends the pioneering work of Newcombe and associates, who first introduced the use of "machines" to conduct fully automated record linkages based on probabilities derived from the frequency distributions of the matching variables.[195]

Using the Fellegi and Sunter framework, record pairs are partitioned into a true set of matches (M) and a true set of nonmatches (U), with *m-probabilities* and *u-probabilities* estimated as match parameters. Consider $P(B)$ to equal the probability that a given birth record and a given death record refer to the same child. Consider also that A_1 is some matching variable – say, date of birth – that is the same in both the birth file and death file. $P(A_1|B)$ is then the probability that date of birth matches in both files given that the birth and death record refer to the same child. This probability is known as the *m*-probability (*m*) in record linkage terminology. Also estimated is the *u*-probability (*u*), or the probability that date of birth is the same (just by chance) despite the fact that the record pair being compared is not a match: $P(A_1|\overline{B})$.

Accompanying *m* and *u* probabilities are *agreement weights* and *disagreement weights*. An agreement weight is the weight assigned when there is agreement on a given match variable and is computed by taking the base 2 logarithm of the ratio (*R*) of the *m*- and *u*-probabilities described above; a disagreement weight is simply the base 2 logarithm of $[1 - m] / [1 - u]$. This (likelihood) ratio will be large for agreement patterns that are frequently observed among matched records, yet infrequently observed among non-matches. It will be small when the agreement patterns are observed with some frequency among non-matches. These weights are used to assign each comparison record pair a match weight or 'score'. And based on these scores, Fellegi and Sunter proposed a decision rule specified as:

> If $R > UPPER$, then designate the pair as a match or link
>
> If $LOWER \leq R \leq UPPER$, then designate the pair as a potential match or link and conduct clerical review
>
> If $R < LOWER$, then designate the pair as a nonmatch or nonlink.

The cutoff thresholds *UPPER* and *LOWER* are determined by a priori errors bounds. Using this decision rule, record pairs with a weight that exceeds the upper cut-off are classified as *designated matches*. Record pairs with a weight that falls below the lower cut-off are classified as *designated nonmatches*. And all remaining pairs are classified as *designated potential matches* and manually reviewed.

2.2.3 Parameter Estimation

Link Plus offers two methods for estimating match parameters. The first is the 'Direct Method' which utilizes default *m*-probabilities derived from the main file to which the other files are linked – in this research, birth files. The second method of parameter estimation is the Expectation-Maximization (EM) algorithm.[206] The EM algorithm is frequently used for parameter estimation in latent models where the data are from unknown subpopulations and subject to latent (unmeasured) factors.[203] In linkage contexts, linked pairs and unlinked pairs can be considered two 'latent populations' since the true status of the record pair is unknown. The EM algorithm utilizes an iterative expectation (E) and maximization (M) process which allows for record linkage parameters to be computed from the dynamic characteristics of the data, rather than relying on *a priori* empirical values.

In the documentation accompanying Link Plus, users are advised to rely on the Direct Method for initial linkage runs because it is "robust and it consumes roughly half of the CPU time needed to have Link Plus compute the *m*-probabilities".[203] But users are also informed that, especially when the files are large and the match variables contain relevant information for identifying linked pairs, "the EM Algorithm may improve results, because computed *m*-probabilities are likely to be more reflective of the true probabilities, since they were computed by capturing and utilizing the information dynamically from the actual data being linked." Based on this guidance and supporting literature, the EM algorithm was utilized for performing the record linkages underlying the analysis dataset.[199,207]

2.2.4 Phonetic System

The Link Plus software offers users two phonetic coding systems: the Soundex System and The New York State Identification and Intelligence System (NYSIIS). Each of these phonetic systems code string or character entries based on pronunciation. As such, these systems serve to reduce missed record matches through accommodations for spelling errors and minor letter transpositions. NYSIIS was used as the phonetic system in this research because it has been shown to have a reported accuracy increase of 2.7% over the Soundex System and because there is research to suggest that NYSIIS is better equipped to handle Spanish names – a particularly salient point since this is California-based research where over 50% of the children are of Hispanic ethnicity.[203] NYSIIS was developed in New York State in 1970 and maps similar phonemes to letters while maintaining relative vowel positioning.

2.2.5 String Comparators

Partial matching in Link Plus is based on the Jaro-Winkler Metric, a string comparator that assesses the degree of agreement between two strings. Because typographical data entry errors often occur in administrative data, matching two records based on exact character-by-character agreement can result in many missed matches.[208] The basic Jaro string comparator accounts for random character insertions, deletions, and transpositions and is considered to be among the most powerful comparators in the computer science literature.[209-211]

2.2.6 Blocking Variables

Blocking is a scheme to reduce the total number of record comparisons required in order to identify a match. Blocking variables serve to "partition the database into a large number of small segments so that the number of pairs being compared is of a reasonable size."[199] Consider the

birth and child welfare record linkages conducted in this research. The 2000 birth cohort file (file *A*) consists of ≈500,000 records. The child welfare file for children born in 2000 includes roughly 90,000 records (file *B*). This means that the total number of possible record pairs (a,b) in which $a \in A$ and $b \in B$ is equal to the product space $A \times B$ or 45 billion. Since the maximum number of matches is equal to the number of records in the smaller file (file *B*), this would mean that in the absence of blocking, billions of comparisons would be required even though (at most) only 0.000002% of those comparisons would result in a match.

Link Plus utilizes an "or" blocking methodology in which record comparisons are made between two files if they contain identical values on at least one of the specified blocking variables. This "or" methodology is equivalent to taking multiple passes of the data in the sense that record pairs are compared if they have identical values on at least one of the blocking variables (versus attempting record linkages based on multiple runs of the data, each of which is based on a different blocking variable).

In performing the birth to death linkages, three blocking variables were specified: NYSIIS code of the child's last name, the child's date of birth, and the death state file number. Use of these blocking fields meant that Link Plus attempted to match only those birth-death comparison pairs in which the two records had the same NYSIIS coded last name, *or* the same date of birth, *or* the same death state file number.

For the birth to child welfare linkages, NYSIIS code of the child's last name, NYSIIS code of the child's first name, the child's date of birth, mother's SSN, and father's SSN were specified as blocking variables. Again, this meant that Link Plus attempted to match only those birth-child welfare comparison pairs in which the two records had the same NYSIIS coded last name, *or* the same NYSIIS coded first name, *or* the same date of birth, *or* the same mother's SSN, *or* the same father's SSN.

In both instances, these blocking variables were chosen based on recommendations outlined in the Link Plus documentation, as well as the criteria outlined by Herzog, Scheuren, and Winkler for efficient matching through the use of blocking variables.[199,203] They describe how a variable such as gender is a poor means of blocking since only two sub-files can be partitioned from this field. More effective blocking fields are those that 1) contain a large number of values, 2) follow a reasonably uniform distribution, and 3) have a low probability of reporting error. Last name, date of birth, and officially recorded death state file number all contained a high number of unique values and were not overly skewed in either a left- or right-tailed distribution. Among the birth to child welfare files similar logic was applied when choosing blocking variables. Although parental SSNs were missing in a large number of child welfare records, the assumption was made that when recorded, these numbers would have lower rates or reporting errors than other fields.

2.2.7 Matching Variables

Beyond exact (character-for-character) matching, Link Plus provides several options for using partial, value-specific, and "fuzzy" matching methodologies. It also includes matching options specifically configured for variables commonly used in record linkage (e.g., Social Security Numbers) which incorporate several different techniques. Table 5 provides a list of fields used

for matching birth to death records, as well as birth to child welfare records; the Link Plus matching method employed for performing each match; and the variable names in each of the respective data sources. Those methods that were used to perform record linkages in this research are described below.

Table 5. Matching Fields and Methods for Record Linkages

Match Field	Match Method	Death Variable	Birth Variable	Child Welfare Variable
Child's First Name	NAME-FIRST	dfname	cfname	com_fst_nm
Child's Middle Name	NAME-MIDDLE	dmname	cmname	com_mid_nm
Child's Last Name	NAME-LAST	dlname	clname	com_lst_nm
Child's Sex	EXACT	sexD	sex	gender_cd
Child's Date of Birth	DATE	bthdateD	bthdate_cd	bthdate_cd
Race	VALUE-SPECIFI	raceD_cd	mrace_cd	ethnic
Death Date	DATE	dthdateD	cdthdate_cd	dthdate_cd
Death State File Number	EXACT	dthsfn	dthsfn	n/a
Mother's SSN	SSN	n/a	momssn	mo_ssn
Father's SSN	SSN	n/a	dadssn	fa_ssn
Mother's First Name	NAME-FIRST	n/a	mfname	mo_fst_nm
Mother's Last Name	NAME-LAST	n/a	msurname	mo_lst_nm
Father's Last Name	NAME-LAST	n/a	flname	fa_lst_nm
Mother's Date of Birth	DATE	n/a	mbthdate_cd	mo_dob_cd
Father's Date of Birth	DATE	n/a	fbthdate_cd	fa_dob_cd

1) NAMES

First names, middle names, and last names were coded as separate fields in each data source and matched using the Link Plus matching method developed for names. This method incorporates partial and value-specific matching (see additional details below), as well as NYSIIS phonetic code (see section 2.2.5), to account for minor typographical errors, misspellings, and hyphenated names. For a hyphenated name, this method compares the sub-strings separated by the hyphen with the other name of the comparison pair. For a comparison pair with the same name, the frequency of this name is incorporated into the computed weight of the pair so that a common name results in a low weight and a rare name results in a high weight. Name frequencies were derived from each annual Birth File.

In addition to the general name methodology, Link Plus incorporates a file of nick names against which unmatched first names within a comparison pair can be referenced. If one of the unmatched first names in a pair falls on the nick name list, it is then checked against an accompanying list of associated full names in order to determine a possible match. Link Plus also includes a middle name methodology which allows for the occurrence of a middle initial rather than a full middle name.

2) EXACT

An exact character-for-character string comparison methodology was utilized for matching child's sex. This methodology was also employed for matching the 5-digit death identification number.

3) DATE

All dates were matched using the Link Plus date methodology which treats day, month, and year as three separate components. If all three components match, the comparison pair is assigned a high weight (*w*). If there is agreement on year and month, but day is missing, the weight (*w1*) will be positive, but less than *w*. If there is agreement on year, but month and day are missing, the weight (*w2*) will be positive, but less than *w1*. The date method also checks for transposition of components (i.e., day and month).

4) VALUE-SPECIFIC

The value-specific methodology is a frequency-based method. It assigns value weights to a given match based on the frequencies of those values in the files being linked. A match on a frequent value is associated with a low-weight, while a match on a rare value is associated with a high weight. This method was used for linkages based on race and is also incorporated into the Link Plus *NAMES* method.

5) SSN

Link Plus includes a matching method that was created specifically for linkages using Social Security Numbers. This method incorporates partial matching to account for typographical errors and transposition of digits, as well as SSNs where only the last four digits are present.

2.3 Study Linkages

Record linkage amounts to messy-data analysis and notwithstanding increasingly sophisticated probabilistic algorithms for automated record linkages, "the only 'gold standard' for whether two records truly match is still the judgment of a human reviewer."[196] The fact is that computers cannot yet beat the power of human pattern recognition. Record linkages remain part 'science' and part 'art' and the best method for establishing linkages between datasets without unique and verified identifiers is a probabilistic method (i.e., the science) followed by a carefully conducted clerical review (i.e., the art).[199,212,213]

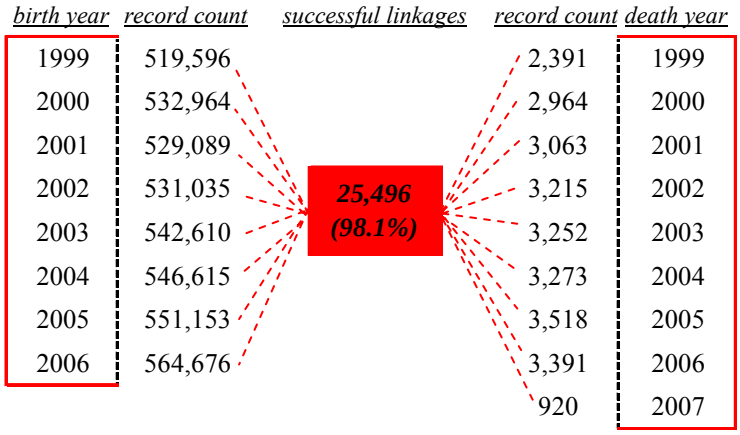
2.3.1 Death to Birth Linkages

A merged death file was created from the nine annual death files described in Section 1.3.1. This merged file, totaling 25,987 deaths, consisted of all deaths of children who were born in California between 1999 and 2006, died by age five, and whose death occurred in California and before January 1, 2008. Of these deaths, 98.1% (25,496) were successfully linked to a birth record.

Linkages were made by running the merged death file against each annual birth cohort file. Per guidelines from Link Plus, the lower cut-off score for possible match consideration was set at a match weight of 10. Two separate reviewers then scanned all comparison pairs above this threshold and independently set an upper cut-off score above which a *match* was automatically assigned and clerical reviews were not conducted. For all remaining comparison pairs falling above 10 and below this upper cut-off (a match 'gray area') a clerical review was completed and a manual assignment of *match* or *non-match* was made. After each reviewer classified all gray area comparison pairs, the Link Plus *double review* feature was used. This feature compares the match assignments made by two reviewers and isolates all discrepant assignments for further examination. For those pairs where the match assignments did not align (less than 1%), the two

reviewers examined the data together to make a final assignment based on the information available. Figure 5 reports the count of death records meeting study criteria, the count of birth records against which death records were matched, and successful matches.

Figure 5. Death Records Linked to a California Birth Record



2.3.2 Unlinked Deaths

After death to birth linkages were completed as described above, there remained 491 deaths (1.9% of all deaths) for which no corresponding California birth record had been located. Of these unmatched deaths, 32% had a missing date of birth; 33% were missing birth place information; and 37% were missing both the child's first name and last name. Certainly, based on the age distribution of the full death file, it is reasonable to assume that a large fraction of the death records with a missing date of birth belonged to individuals who were born outside of the 1999-2006 study window and therefore should have been excluded from the outset. Similarly, an unknown percentage of children with missing birth place information may well have been born outside of California and therefore did not meet study inclusion criteria. Attempts were made to make comparisons between matched and unmatched deaths on basic demographic variables, but unmatched deaths were defined by such high rates of missing variables that comparisons were impossible. For example, race/ethnicity was missing for 81% of unmatched deaths. All told, missing information for the match variables appeared to be the primary common feature among unmatched death records and the loss of such a small amount of death data should not, in itself, constitute a source of bias in this study.

2.3.3 Child Welfare to Birth Linkages

Linkages between child welfare records and birth records required a slightly different linkage strategy. The high count of unique children referred to child protective services during the study period (596,962) meant that the same level of clerical review conducted for the birth/death linkages was not feasible. Instead, an assumption was made that a child's year of birth was one of the most reliably entered data fields and the full child welfare dataset was divided into eight birth year files. Each of these child welfare files was then linked to the corresponding birth file of the same year.

As was done for the birth/death linkages, the lower cut-off score for possible match consideration was set at a Link Plus match weight of 10. To determine an upper-bound cut-off above which all comparison pairs would be deemed a match, both the 1999 and 2006 child

welfare birth files were examined. Link Plus color-codes match variables for all comparison pairs: match variables that match perfectly are shaded gray, match variables in which the field for one or both of the records is missing are shaded yellow, and match variables in which the information does not match perfectly are shaded pink. As such, a reviewer can relatively quickly scroll through thousands of comparison pairs and assess where the match likelihoods begin to fall off based on the increasing presence of pink and yellow shaded fields.

Among comparison pairs receiving the highest weighted scores (60-100), imperfectly matched fields were relatively rare and when present, were clearly minor misspellings in the context of otherwise perfectly matched information (e.g., all match variables aligned except for first name which was spelled 'BRIANA' in file one and 'BRIANNA' in file two). Comparison pairs receiving weights falling closer to the middle of the distribution (30-60) tended to match perfectly on several key identifiers (i.e., first name, last name, date of birth, mother's first name, sex), but were down-weighted due to increasingly frequent missing information in fields such as middle name and parent SSNs, or because of high rates of minor data entry errors spanning several text fields. Finally, those pairs that received the lowest weights (10-30) sometimes matched perfectly on date of birth, first name, and last name, but included common names (given a lower weight) and had missing values for almost all other matching fields.

Other problems arising among records in the lowest scored group included field entry errors. For example, in this study, FIRST NAME, MIDDLE NAME, and LAST NAME were all treated as unique match fields. Yet, a not uncommon clerical error observed was the entry of the LAST NAME in the FIRST NAME field and the FIRST NAME in the LAST NAME field in one of the two records of a comparison pair. These two records were still identified as a comparison pair because information was consistent across other linkage variables, but the pair was usually given a very low weight because so few letters overlapped between the first name fields and last name fields for the two records. It was errors such as these that Link Plus proved least well-equipped to handle, yet a superficial clerical review was able to quickly resolve.

Based on detailed reviews of both the 1999 and 2006 files, which included a close manual examination of a 1% random sample of comparison pairs falling within each 10-point weight strata, an upper bound cut-off score was set at 30 and applied to all child welfare to birth linkages. All comparison pairs falling above this score in each file were automatically assigned match status. For the remaining comparison pairs with a score in the established gray area between 10 and 30, a clerical review was completed. Among pairs falling toward the upper end of this gray area, the review conducted was relatively cursory and merely involved a scan of the fields to ensure that the information generally aligned. As the scores dropped, the reviews became increasingly thorough and included manual searches in the full birth file to confirm that there were no other possible matches. Linkage results for all child welfare birth years are reported in Table 6.

Table 6. Child Welfare Records Linked to a Birth Record

birth year	*birth count*	*successful linkages*	*child welfare count*
1999	519,596	72,630 (84.6%)	85,823
2000	532,964	73,880 (85.16%)	86,777
2001	529,089	73,721 (85.06%)	86,693
2002	531,035	74,374 (85.27%)	87,232
2003	542,610	71,207 (86.56%)	82,295
2004	546,615	61,582 (88.7%)	69,474
2005	551,153	51,276 (90.2%)	56,881
2006	564,676	38,344 (91.9%)	41,787

2.3.4 Unlinked Child Welfare Records

After all child welfare to birth record linkages were completed as described in the preceding sections, there remained 79,948 child welfare records (14% of eligible records) for which a California birth record had not been located. Some notable differences were observed in the variable distributions of matched versus unmatched records. First, as was true for death records, higher rates of missing data were consistently observed in the records of children for whom no birth record match was established, and these data were not missing at random. The further the child had penetrated the system, the greater the information available in the child welfare record, and the increased likelihood it was successfully linked to a birth record. For example, although this analysis relied on race as it was recorded in the birth record for all multivariate models, race from the child welfare record was used as a matching variable when completing birth to child welfare linkages. In the total pool of eligible child welfare records, race/ethnicity was missing in approximately 12% of the records. Yet, this variable was missing in less than 1% of the records of children who had entered an out-of-home foster care placement, but was missing in almost 30% of records for children whose contact with CPS had moved no further than an uninvestigated hotline call. As such, it was not surprising that report disposition (a measure of a child's level of contact with the child welfare system) differed significantly by match status *($\chi^2(3)=3.5e+04$,* $p<.001$*).* Successfully matched children were much more likely than unmatched children to have had a report substantiated (38% vs. 18%) and much less likely to have been evaluated out (9% vs. 27%), with no differences observed between matched and unmatched children who had unsubstantiated or inconclusive allegations. Likewise, children who were successfully matched to a birth record were more likely to have been reported at least twice during the first five years of life (25%) than children whose records were unmatched (10%). Racial differences also emerged *($\chi^2(4)=1.5e+03$,* $p<.001$*),* with matched children somewhat less likely to be White (27% vs. 33%) and somewhat more likely to be Hispanic (53% vs. 46%). No differences in matched versus unmatched groups were observed for Black (15% vs. 15%) or Asian children (4% vs. 4%). There were also no notable differences between matched and unmatched children based on gender. Children with an allegation of physical abuse were slightly less common among matched records (11%) than those that were unmatched (13%).

3. The Dataset

The unique dataset constructed for this study was based on probabilistic record linkages between Vital Birth Records, Vital Death Records, and administrative Child Welfare Records. Record

linkages underlying this dataset were described in Section 2 of this chapter; Section 3 is devoted to an overview of its analysis.

3.1 Study Design

This dataset consists of records of births and deaths in California, as well as records of children who had contact with child protective services. These data were analyzed as a longitudinal birth cohort study, as outlined below.

3.1.1 Population

This dataset covers the full population of children born in California between 1999 and 2006 (4,317,738 births) and captures both child welfare contacts and deaths occurring (within state) through each child's fifth birthday. Children born out of state who were later reported to CPS or died within California during the study timeframe were excluded. Also excluded were fetal deaths.

3.1.2 Timeframe

The study window spans the years 1999-2007, capturing the full cohort of children born in each year from 1999 through 2006. Because both child welfare contacts and child mortality are rare events, the longest possible time frame was desirable in order to increase the power of this study. 1999 was identified as the study start period because: 1) the current child welfare data collection system in California did not become fully operational until 1998 and choosing the year after its inception reduced issues of data integrity; and 2) the World Health Organization's tool for classifying deaths switched from the *ICD-9* to the *ICD-10* between 1998 and 1999. By starting the study in 1999, all deaths could be uniformly classified. 2006 was the most recent year for which the necessary birth files were available from the California Department of Public Health; death records were available through 2007.

3.1.3 Dependent Variable

The main dependent variable of interest was any theoretically preventable death occurring before the age of five, defined as any unintentional or intentional injury fatality. Injury deaths were identified based on the external cause of death codes (e-codes) found in the International Classification of Diseases, 10th Revision (*ICD-10*).[214] In the latest revision of the ICD, injuries are described using e-codes which incorporate both the mechanism (e.g., fall, poisoning, firearm, drowning) and the manner (e.g., unintentional, homicide/assault, suicide/self-harm, or undetermined) of death into a single ICD code.

Death data in this study were conceptually organized based on the External Cause of Injury Mortality Matrix for ICD-10, a framework for external cause of injury developed by the National Center for Health Statistics and other stakeholders.[215] ICD-10 e-codes used to classify injury deaths are reported in Table 7. Specially designated *U letter codes used to identify victims of terrorism were not included. Also excluded were Y letter codes used to specify deaths stemming from complications of medical or surgical care.

Table 7. External Cause of Injury Mortality Matrix for ICD-10

		Manner				
	all injury	*unintentional*	*suicide*	*homicide*	*undetermined*	*legal intervention*
Mechanism						
all injury	V01-Y36, Y85-Y87, Y89	V01-X59, Y85-Y86	X60-X84, Y87.0	X85-Y09, Y87.1	Y10-Y34, Y87.2, Y89.9	Y35-Y36, Y89.0, Y89.1
cut/pierce	W25-W29, W45, X78, X99, Y28, Y35.4	W25-W29, W45	X78	X99	Y28	Y35.4
drowning	W65-W74, X71, X92, Y21	W65-W74	X71	X92	Y21	
fall	W00-W19, X80, Y01, Y30	W00-W19	X80	Y01	Y30	
fire	X00-X19, X76-X77, X97-X98, Y26-Y27, Y36.3	X00-X19	X76-X77	X97-X98	Y26-Y27	Y36.3
firearm	W32-W34, X72-X74, X93-X95, Y22-Y24, Y35.0	W32-W34	X72-X74	X93-X95	Y22-Y24	Y35.0
machinery	W24, W30-W31	W24, W30-W31				
all transport	V01-V99, X82, Y03, Y32, Y36.1	V01-V99	X82	Y03	Y32	Y36.1

3.1.4 (Key) Independent Variable

A non-fatal allegation of maltreatment served as the key independent variable examined in this analysis. Allegation data were extracted from the child welfare database and used to identify all children who were both born between 1999 and 2006, and reported to CPS before their fifth birthday. This date of first referral was used to establish whether or not a child should be coded as having had prior non-fatal CPS contact. Upon completion of linkages with birth and death records, *those children who were first reported to CPS only on or after the date of death were re-coded as having had no CPS contact. Children first reported to CPS only on or after the date of the injury event associated with death were also re-coded as having had no CPS contact.* There were 1,465 children for whom this was true. Not all of these deaths involved injuries.

3.1.4.1 Allegation Disposition

In addition to the indicator variable capturing whether or not a child was reported to CPS for maltreatment before death or their fifth birthday, allegation disposition was also examined for its possible role as a mediator in the observed association between CPS contact and injury mortality risk. Since some children were reported to CPS multiple times between birth and age five, dispositions were sorted hierarchically, with the most severe disposition recorded.

In California, allegations of abuse or neglect are either *evaluated out*, or assigned one of three dispositions: *unfounded, inconclusive*, or *substantiated*. Children coded as *evaluated out* were included in an allegation of maltreatment that was not investigated by CPS. Children with an allegation classified as *unfounded* received an investigation, but the evidence gathered in the investigation was insufficient to conclude that the child had been maltreated or was at risk of maltreatment. Similarly, a classification of *inconclusive* is used when there is evidence suggesting the child may have been maltreated, or is at risk of maltreatment, but the evidence is still insufficient to declare the child maltreated. In both of these situations, formal child welfare services are unlikely to have been provided, although there may have been a referral for community-based services. Finally, a *substantiated* disposition is the classification used when there is sufficient evidence under state law to make a finding of maltreatment (or risk of maltreatment). There is the greatest range of services provided after an allegation is substantiated than for other dispositions. At one extreme a child and family may receive no follow-up services. At the other extreme a child may be placed in out-of-home foster care.

An adjustment for variable risk exposure resulting from a child's placement into foster was captured using a dichotomous measure of an out of home placement at any time during the first five years of life. Although these children remained at risk of sustaining a fatal injury while in

the foster home, the primary "hazard" presented by the parenting environment and thought to be associated with an increased risk of injury has been largely removed for children while in out-of-home placement settings. In addition to the dichotomous measure, two additional variables capturing a child's time in a foster care placement were examined. The first was a continuous measure of the percent of each child's life spent in out of home care was also constructed in an attempt to assess the duration of this change in exposure status.[7] The second was a dichotomous measure restricted to children whose placement had lasted at least one week. Although all three of these variables provided estimates that were directionally consistent, re-constructing a perfect timeline of a child's placements in and out of various foster care settings is a complicated task using the administrative child welfare data available for this study. Attempts to construct timelines are also compromised by the child's continued contact with the biological parents in the context of scheduled visits of varying lengths of time while still under the supervision of CPS. Since a relatively small percentage of all children reported to CPS in this study actually experienced an out of home foster care placement (6%), the effort of including this additional information, of uncertain quality, was deemed to outweigh its utility. The decision was made use the simplest of the placement measures: any placement in foster care for any length of time.

3.1.4.2 Allegation Type

The type of abuse or neglect allegation was also examined (allegation type). Since a single report to CPS for a given child may include multiple allegations of abuse or neglect, allegations were coded based on a severity hierarchy established by CWS/CMS. In other words, if a child was referred for both physical abuse and emotional abuse, the most severe allegation was recorded (i.e., physical abuse). The severity hierarchy is organized as follows: 1) Sexual Abuse, 2) Physical Abuse, 3) Severe Neglect, 4) General Neglect, 5) Exploitation, 6) Emotional Abuse, 7) Caretaker Absence/Incapacity, 8) At-Risk, Sibling Abused, and 9) Substantial Risk. In recognition that any hierarchy of this sort is inherently subjective, all allegation type models were also run with the first allegation, rather than the most severe allegation, utilized. This alternative specification did not change the findings.

3.1.5 Confounding Risk Factors

As earlier described, the profile of a child at risk of a fatal injury (either unintentional, or inflicted) is virtually indistinguishable from that of a child at risk of being reported to child protective services. As such, identifying any contribution of risk stemming independently from a referral to CPS (a possible proxy of latent harm faced by a child) is no easy task. Failing to control for the multitude of variables that have demonstrated an independent association with both the key independent variable (CPS contact) and the outcome of interest (death) would lead to spurious associations between CPS contact and mortality. Fortunately, the large population of children captured in this analysis provided sufficient power to properly adjust for a number of known confounders.

In an effort to identify appropriate birth indicator proxy variables, capturing the qualitative aspects of established risk factors, prior studies utilizing direct linkages between CPS data and

[7] The code allowing this information to be gleaned from the administrative child welfare data was generously shared with me by Joseph J. Magruder, PhD, a research specialist at the Center for Social Services Research. In this code, Dr. Magruder attempted to create a timeline of a child's movements between placement settings within the foster care system, as well as movements in and out of foster care.

birth records were reviewed.[8,181,216-219] A common set of variables predictive of CPS contact emerged from this literature, proving largely robust across geographies, over time, to a variety of methodologies, and to different inclusionary criteria. Variables modeled and reported in Chapter 4 are listed below. It is worth noting that the rather crude measures used in this study are, at least partially, offset by the large study population. That is, use of a "noisy measures" made it harder to detect associations, but the large sample meant that even small effects could be observed when present.

1. Sex: Child's sex was derived directly from the birth record (*male, female*). This variable was missing in only 0.01% of records.

2. Health: A binary variable indicating that the child faced a health risk at birth based on whether or not the child weighed less than 2500 grams at birth or had one or more birth abnormalities (*health risk, none*). Birth weight data were gleaned from a continuous measure of birth weight with <2500g used as the low birth weight cut-off. The presence of a birth abnormality was identified from a birth record variable that captures up to 10 conditions. Birth weight was recorded in all by 0.01% of records. The field for a birth abnormality was left blank in the absence of any identified abnormalities so its rate of missing values could not be computed.

3. Birth Coverage: The expected source of payment for the birth was used to create a rough proxy for family socioeconomic status based on a dichotomous coding of Medi-Cal coverage, California's Medicaid program (*medi-cal, other*). Approximately .02% of records were coded as "Medically Indigent". These records were included in the Medi-Cal group. The expected source of payment was missing in approximately 0.34% of all records.

4. Maternal Race/Ethnicity: A mother's race/ethnicity was coded into four categories based on the first identified race and a Hispanic identifier variable (*non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic Asian/Pacific Islander*). Race was imputed from father's race/ethnicity in those instances in which the maternal variable was missing, but paternal information was present. Since Native American children were less than 1% of all births, these children were re-coded as race "missing" and excluded from analysis. In total, 1.71% of records in this analysis were missing race.

5. Maternal Age: Maternal age captured at the time of birth was coded into a dichotomous variable (*< 24 years, 25+ years*). Maternal age was missing in 0.03% of records.

6. Maternal Education: A two-level variable for maternal education was constructed based on reported years of school completed. Mothers who reported having completed no more than 12 years of school were coded as *high school or less*. Mothers who identified as having completed 13 or more years of completed education were classified as *some college or higher*. Maternal education was missing in 1.85% of records.

7. Father Information: California Health and Safety Code Section 102425 now prohibits the release of marital status by the California Department of Public Health. Yet, this same

Health and Safety Code specifies that "If the parents are not married to each other, the father's name shall not be listed on the birth certificate unless the father and the mother sign a voluntary declaration of paternity at the hospital before the birth certificate is prepared", the absence of paternal information in the record was used as a lower-bound estimate of non-marital births and a seeming lack of substantial parental partner involvement (*missing, present*). The use of established paternity, as measured by the absence of a father's name on the birth record, has been used in prior studies examining infant mortality.[220,221]

8. Birth Order: The child's position in a maternally-defined birth order was coded based on whether or not the child was first born (*first born, second or higher in birth order*). Birth order was missing in only 0.08% of records, although it is unknown whether children were coded as first births by default.

3.1.6 Miscellaneous Notes Regarding the Final Dataset

After all record linkages were completed and the data coded, a handful of records were dropped from the analysis because of internal inconsistencies identified during data clean-up. Included in dropped records were 415 children who were identified as reported to CPS, but the referral date suggested they were reported before birth. Although theoretically possible (i.e., a report may have been filed prenatally based on maternal drug use or the referral of an older sibling) it was deemed more likely that these were either errant linkages or reflected delinquent date values more generally. The decision was made to maintain these records in the study, but to re-code these children as having not been reported to CPS.

Likewise, 152 children were re-coded as having had no CPS contact after an examination of all linked records showed that they has been first reported shortly after, rather than before, their fifth birthday. This is likely the result of discrepancies between the birth dates recorded in the child welfare data (which were used to identify children eligible for linkages with birth records) and the date of birth as recorded in the birth record (which was treated as the more reliable data source). Perhaps due to similar birth date discrepancies, 11 children were reported to have a date of death that fell before their date of birth. These children were dropped from the count of decedent children. Finally, because no restriction had been placed on the age at which a child died in the birth-death record linkages that were completed at the outset, 406 deaths of children over the age of five were dropped as they fell outside of the study window.

3.2 Statistical Analysis

Beyond descriptive statistics and crude risk ratios, survival or hazard models were also specified to answer the three primary research questions outlined in Chapter 1. Briefly, these questions sought to examine: 1) whether a prior referral to child protective services was associated with a heightened injury mortality risk (controlling for other risk factors), 2) whether the assessment of risk as reflected in an allegation's disposition mediated the overall observed association between CPS contact and injury mortality (controlling for other risk factors), and 3) whether specific allegation types were associated with injury mortality (controlling for other risk factors). For each of these research questions, both bivariate and multivariate hazard models were specified. Robust standard error adjustments were made in all models to account for potential violations of

the assumption of independence. In the subsections that follow, a brief overview of the analytic methods used to compute statistics presented in Chapter 4 is provided.

3.2.1 Descriptive Statistics

Descriptive characteristics of the study population are reported based on various subgroup classifications. First, the distribution of all variables listed in section 3.1.5 (arising from the birth record) were examined for the full population of children eligible for this study (n=4,317,321). These distributions are presented by birth cohort with trends over time tested. These same variables were also examined for the subgroup of children in the study who were reported to child protective services prior to death (n=514,718), stratified by birth cohort, allegation disposition, allegation type, and out-of-home foster care placement. Likewise, variables and cohort trends are examined for children who sustained a fatal injury before the age of five (n=1,917), with stratifications by birth cohort, as well as manner and mechanism of death. Cohort differences were examined for evidence of secular trends using (non-parametric test for trends).

3.2.2 Rates and Risk Ratios

The count of children in each birth cohort was used as the denominator to compute cohort-specific rates of injury death (by manner and mechanism) and CPS contacts (by allegation and disposition type). Unadjusted risk ratios and 95% confidence intervals were also computed to compare children with a high risk birth characteristic to those for whom no such risk was present. For purposes of comparison, rates and crude risk ratios were also presented for other forms of death.

3.2.3 Hazard Models

Bivariate and multivariate hazard models were employed as a means of modeling the independent association of a prior report to CPS and injury death. This class of models addresses both the censored nature of these data (since death and CPS observations for children born in later birth cohorts were censored) and accounts for the time-dependent nature of a child's first referral to child protective services (by allowing for CPS contact to be modeled as time-varying). As Jewell has pointed out, "how long an individual has been at risk usually affects the probability that the outcome will soon occur"[222] - which was true in this analysis both in term of the cumulative likelihood that a child had experienced the exposure variable of interest (a referral to CPS) and the outcome (injury mortality). By utilizing Extended Cox Models, "time at risk" was explicitly modeled as a confounding variable and was controlled for. The algebraic form of all models and additional modeling details are provided in Chapter 4.

4. Summary

This study is novel in its reliance on multiple sources of child surveillance data and is positioned to overcome many methodological issues common to child maltreatment research. Prior research has been limited by its: 1) Use of case-control or cross-sectional study designs which restrict causal inferences. *This research utilizes a longitudinal cohort design.* 2) Inappropriate comparisons with general population samples. *This research includes variables controlling for a number of sociodemographic risk factors.* 3) Examinations of injuries sustained by children across the age spectrum, without properly controlling for differential exposures to environmental hazards. *This research examines fatal injuries occurring within the first five years of life, when*

the majority of non-traffic injuries occur in the home. 4) Designs that have failed to address surveillance or detection bias in populations of maltreated children, or have not properly controlled for event censoring. *This research includes specific comparisons between referred and non-referred children who were part of a public welfare system at birth (Medi-Cal), helping to control for detection bias. Hazard models were used to examine time to death after a referral to CPS.*

CHAPTER 4
RESULTS

This chapter is devoted to reporting the empirical results that emerged from the linked data sources and analyses described in Chapter 3. These record linkages were pursued with the broad goal of augmenting administrative child protective service (CPS) records with population-based data in order to advance an understanding of children reported for maltreatment in the context of the full population of children born in California. As outlined earlier, data collected by child welfare agencies suffer from the notable limitations of being both narrow in scope (i.e., containing a limited set of variables) and narrow in coverage (i.e., capturing data for only those children who are reported). In isolation, these data are poorly situated to the identification of etiological risk factors preceding a first allegation of maltreatment, or to tracking outcomes that follow decisions made for each child at various points of system contact. Fortunately, technological and statistical advances in record linkage methodologies now allow for individuals to be linked across multiple sources of data with relative ease. This means that information captured for individuals in one database can be extended with information captured for those same individuals arising from another database, as was done in this study.

Through record linkages between child protective service records, eight years of vital birth records, and nine years of vital death records, the characteristics of over half a million children referred for maltreatment in California were examined on the day they were born and compared with their unreported counterparts. These children were then prospectively followed and rates of injury mortality were computed as a population-based indicator of child vulnerability and unmet service needs. Three research questions were posed in this study, the findings from which are reported in this chapter: *1) Is a referral to child protective services an independent risk factor for injury mortality? 2) Is allegation disposition associated with injury fatality risk? 3) Does injury fatality risk vary across maltreatment allegation types?*

Descriptive statistics are reported in Section 1, organized with a focus on increasingly high risk subsets of the full child population. The section begins with a description of the characteristics of the full study population: all children born in California between 1999 and 2006. Information gleaned from the birth record is presented for the full 4.3 million children in aggregate, as well as for each annual cohort of births. Narrowing in scope, the distribution of these same birth variables are then examined for children reported to CPS before the age of five. This subpopulation of reported children is further stratified based on maltreatment allegation type, disposition, and foster care placement history. Next, attention is directed to those children who died during the study window. Using the same birth indicators examined in the context of the full study population and the subset of children reported to CPS, children dying from injuries are described and referenced to all children who died before the age of five.

Section 2 reports rates (per 100,000 children) of overall death and injury death for each level of the main covariates included in the multivariate survival models. Unadjusted risk ratios and accompanying 95% confidence intervals are reported. Finally, Section 3 is devoted to reporting findings from the multivariate models used to answer the three questions noted above. For each research question, the fully specified model is described and quantified relationships between

each covariate and injury death are examined. Section 4 serves to briefly summarize findings, conclude the chapter, and preview the discussion of results that follow in Chapter 5.

1. Descriptive Statistics

Eligible for inclusion in this study were 4.3 million children born in California between 1999 and 2006. Of these children, 514,718 were reported for possible maltreatment and 1,917 were died from an unintentional or intentional injury before their fifth birthday. The characteristics of these children on the day of birth are reported in the sections that follow. Additional tabulations are provided for children reported to CPS based on data gleaned from the child welfare record. Likewise, information from the death record is used to further describe the subpopulation of children who died from an injury event versus those who died from other causes.

1.1 Characteristics of the Full Study Population

The distributions of the characteristics of children captured in this study – in aggregate, as well as by birth cohort –are reported in Table 8. Cuzick's non-parametric test for trends was used to assess distributional changes in variables across cohorts.[223] It should be noted that although the size of this population allowed for highly refined measures of such variables of interest as maternal age at birth and maternal education, characteristics are reported based on the same variable stratifications used in subsequent multivariate analyses where the event of interest (an injury death) was far less common and the use of such refined covariates was precluded due to small cell sizes.

1.1.1 Characteristics of the Full Population of Births

In 1999, just over 519,000 children were born alive in California. By 2006 the number of births had risen to over 564,000 children, an increase of 8% in as many years. Overall, 11.9% of children included in the study population were reported to CPS by the age of five. This average fraction, however, understates the actual percentage of children reported to CPS by their fifth birthday given that observations for later birth cohorts were censored (e.g., for the 2006 birth cohort, CPS reports were available only through January 1, 2008). For birth cohorts with data available for the full first five years of life, the cumulative percentage of children alleged to have been maltreated was roughly 14% of all children born. The percentage of male births across the full study period was slightly greater than female (51.2% vs. 48.9%). This birth sex ratio is consistent with that which is observed nationally and did not display any significant upward or downward trends over time.[224] Across the eight birth cohorts, 10.7% of children were identified as having a health risk present at birth as indicated by either low birth weight (<2500g) or the presence of one or more birth abnormalities. The fraction of children coded as having a health risk increased over time from 9.8% in 1999 to 11.6% in 2006 ($z=36.5$, $p<.001$). Overall, 43.5% of births were covered by Medi-Cal, California's Medicaid program. The percentage of Medi-Cal covered births increased every year from 1999 to 2006, peaking at 46.8% ($z=99.5$, $p<.001$).

Over time, the percentage of Black births dropped by 13%, from 6.7% in the 1999 cohort to 5.8% in the 2006 cohort ($z=-26.6$, $p<.001$). Overall, 6.1% of children captured in these data were Black. The White birth rate also declined by 20% over this period: in 1999, 33.6% of children born were White while in 2006 the number stood at just 28.9% ($z=-64.8$, $p<.001$). Across all years of data approximately 31% of children were classified as White. Meanwhile, the fraction of Hispanic children born each year rose steadily from 48.6% in 1999 to a full 53.4% of the

population in 2006, translating into a 21% increase ($z=62.9$, $p<.001$). Hispanic children represent roughly 50% of all children captured in this analysis. A slight but statistically significant increase in Asian and Pacific Islander (Asian/PI) births was also observed across birth cohorts ($z=15.3$, $p<.001$), which totaled 11.8% of births. Finally, although not reported, Native American children hovered at approximately half a percent of births across all years. The low rate at which this group was represented precluded its inclusion in the multivariate models that follow. Births for which race was either missing or coded as "other" amounted to approximately 1.5% of the total.

The fraction of mothers who were under the age of 25 at the time of birth dropped over time ($z=-30.9$, $p<.001$), standing at 32.9% overall. In 1999, 34.3% of children were born to a mother under 25. This was true for only 32.5% of children by 2006. The fraction of births to mothers with a high school degree or less also declined over the eight years of data examined from 59.6% in 1999 to 55.8% by 2006 ($z=-50.4$, $p<.001$). In aggregate, 57.3% of children were born to mothers whose education had ended before or at high school graduation. The percentage of children for whom no paternal information was captured in the birth record increased slightly across birth cohorts, ranging from 7.1% to 7.4% throughout the study window ($z=6.5$, $p<.001$). Modest declines were observed in the fraction of children falling second or higher in the birth order over the span of all cohorts ($z=-4.3$, $p<.001$). Overall, 38.8% of children were first born.

Table 8. Characteristics of the full study population, *by year of birth*

	All Years[1] n=4,317,321	1999 Births n=519,419	2000 Births n=532,844	2001 Births n=529,009	2002 Births n=531,005	2003 Births n=542,609	2004 Births n=546,611	2005 Births n=551,151	2006 Births n=564,673	Nonparametric Test for Trends[3,4]
	%	%	%	%	%	%	%	%	%	*test statistic (p-value)*
Maltreatment										
allegation	**11.9**	13.9	13.8	13.9	14.0	13.1 [5]	11.2 [6]	9.3 [7]	6.7 [8]	*n.s.*
no report	**88.1**	86.1	86.2	86.1	86.0	86.9	88.8	90.8	93.3	
Sex										
male	**51.2**	51.1	51.2	51.1	51.1	51.2	51.1	51.1	51.3	*n.s.*
female	**48.9**	48.9	48.8	49.0	48.9	48.8	48.9	48.9	48.7	
Health										
risk present	**10.7**	9.8	10.2	10.4	10.3	10.8	11.1	11.2	11.6	*36.5 (p<.001)*
none	**89.3**	90.2	89.8	89.6	89.7	89.2	88.9	88.8	88.2	
Birth Coverage										
medi-cal	**43.5**	40.3	40.5	41.6	42.9	43.9	45.3	46.3	46.8	*99.5 (p<.001)*
other	**56.5**	59.8	59.5	58.4	57.1	56.1	54.7	53.7	53.2	
Maternal Race/Ethnicity[2]										
black	**6.1**	6.7	6.4	6.3	6.0	5.8	5.7	5.7	5.8	*- 26.6 (p<.001)*
white	**31.3**	33.6	32.7	32.1	31.6	31.4	30.5	29.7	28.9	*- 64.8 (p<.001)*
hispanic	**50.9**	48.6	49.2	50.2	50.5	50.8	51.6	52.7	53.4	*62.9 (p<.001)*
asian/pi	**11.8**	11.1	11.7	11.5	11.9	12.1	12.1	12.0	11.9	*15.3 (p<.001)*
Maternal Age at Birth										
<=24 yrs	**32.9**	34.3	33.7	33.6	32.9	32.1	32.1	32.1	32.5	*- 30.9 (p<.001)*
25 yrs+	**67.1**	65.7	66.4	66.5	67.1	67.9	67.9	67.9	67.6	
Maternal Education										
hs or less	**57.3**	59.6	58.5	58.3	57.3	56.4	56.3	56.3	55.8	*- 50.4 (p<.001)*
some college+	**42.7**	40.4	41.5	41.7	42.6	43.6	43.7	43.7	44.2	
Father Information										
missing	**7.2**	7.3	7.1	7.1	7.1	7.3	7.3	7.4	7.4	*6.5 (p<.001)*
recorded	**92.8**	92.8	92.9	92.9	92.9	92.7	92.7	92.7	92.6	
Birth Order										
second or higher	**61.2**	61.2	61.3	61.5	61.3	60.9	61.1	61.2	61.0	*- 4.3 (p<.001)*
first born	**38.8**	38.8	38.7	38.5	38.7	39.1	38.9	38.8	39.0	

1. Missing values excluded from percent calculations.

2. Native American and other race children coded as race missing (1.6% of total) and excluded from analysis.

3. Z-statistic reported. Significance level set at 0.001.

4. Due to censoring of CPS reports for the 2003-2006 birth cohorts, test for trends for possible maltreatment was conducted using only 1999-2002 cohorts.

5-8. Allegations for the 2003-2006 birth cohort reflect only reports received during the first four, three, two, and first years of children's lives, respectively, due to censoring.

1.2 Characteristics of Children Reported to Child Protective Services

Of all children born in California between 1999 and 2006, 514,718 were reported for possible abuse or neglect prior to their fifth birthday. Among children born between 1999 and 2002, roughly 73,000 children from each birth cohort were reported to CPS before the age of five. Due to censored CPS observations for the 2003-2006 cohorts, counts dropped thereafter. Since age of first CPS contact was associated with birth characteristics, attempts to test for trends across the full study window were compromised by the censored data of later cohorts.[216] As such, although the characteristics of each annual cohort are reported in Table 9, tests for trends were restricted to the years 1999-2002. Variable distributions for the 2003, 2004, 2005, and 2006 cohorts should be treated as distinct as they do not reflect CPS contact across the full first five years of life. Table 10 is devoted to the presentation of additional characteristics of these reported children. Characteristics at birth are stratified by 1) the disposition of the allegation, 2) the allegation type, and 3) whether or not a child was ever placed in an out-of-home foster placement. For ease of reference, a column for the full population of children reported to CPS was also included. Table 11 reports the cumulative percentage of children who were reported to CPS before the age of five based on the four birth cohorts for which complete data are available (1999-2002). These percentages are also stratified by allegation and disposition type.

1.2.1 Birth Characteristics of Children Reported to CPS

Overall, the distribution of boys and girls referred for maltreatment aligned with the broader population of births – approximately 51% of children referred were male and 48% were female. The fraction of children reported to CPS who had a health risk present at birth was 14.1%. This is higher than observed for the overall population of births (10.7%). Also notable is the increasing presence of children with a health risk present among children reported from the 2004 through 2006 cohorts. As mentioned earlier, this reflects a younger distribution of children reported to CPS. Prior research has suggested that the presence of a health risk is more strongly associated with a report to CPS during infancy than it is between the ages of one and four.[216]

A higher percentage of children reported to CPS were covered by Medi-Cal at birth than was true in the overall population of births (66.7% vs. 43.5%). Just as the number of Medi-Cal births increased in the general population across the full study window (by 30%), and between 1999 and 2002 (by 12%), the fraction of children reported to CPS who had been part of the Medi-Cal program at birth also increased through 2002, although the percentage increase was less pronounced, with an increase of only 6% ($z=6.6, p<.001$).

The racial composition of children reported for possible abuse or neglect largely mirrored the population of births with just two exceptions. Although only 6.1% of children born in California during the study window were Black, over 13% of children reported to CPS were coded as Black. At the other extreme, 11.8% of all births were Asian/PI children, yet these children were represented at just 4.7% of reported children. Between 1999 and 2002, the percentage of reported children who were Black declined by 9% ($z=-6.5, p<.001$), lagging slightly behind the percentage decline in the overall population of births for this same period (10%). Meanwhile, the percentage of White children among children reported to CPS declined by 11% ($z=-10.8, p<.001$), modestly outpacing the White percentage decline observed among the overall population of births (9%). Also between 1999 and 2002, the presence of Hispanic children

among those reported to CPS increased by 16% (*z=14.7, p<.001*) compared with a 7% increase in the overall population of births. No trends were identified for Asian/PI children.

Between 1999 and 2002, the percentage of children reported to CPS who had been born to mothers under the age of 25 demonstrated no upward or downward shifts, while the share of children with mothers possessing a high school degree or less declined over time consistent with the trend observed for the full population of births *(z=-4.2, p<.001)*. Regardless of trends, children born to mothers from both of these groups were at high risk of being reported to CPS. 33% of all births were to a mother age 24 or younger, yet this group made-up 49% of children reported to CPS. Likewise, 79% of children reported to CPS were born to a mother with no more than a high school education, a characteristic true of only 57% of all children born.

Also associated with a child's referral to CPS for possible abuse or neglect was the absence of paternity information on the birth record, which increased over time (*z=3.9, p<.001*). 18% of reported children had no father listed compared with just 7% of children in the full birth cohort. The absence of paternity identification was particularly pronounced among later birth cohorts, however, it is unknown if this is a real secular trend or if children reported closer to birth are also more likely to be missing paternity information. Children falling second or higher in the birth order were also overrepresented among reported children (71%) versus the overall study population (61%). No significant trends over time were observed.

Table 9. Characteristics of children reported to child protective services, *by year of birth*

	All Years[1,2] ***CPS Contact*** **n=514,718**	1999 Births *CPS Contact* n=72,332	2000 Births *CPS Contact* n=73,570	2001 Births *CPS Contact* n=73,428	2002 Births *CPS Contact* n=74,111	2003 Births *CPS Contact* n=71,001	2004 Births *CPS Contact* n=61,313	2005 Births *CPS Contact* n=50,955	2006 Births *CPS Contact* n=38,008	Nonparametric Test for Trends[4,5]
	%	%	%	%	%	%	%	%	%	*test statistic (p-value)*
Sex										
male	**51.3**	51.1	51.4	51.0	51.1	51.4	51.7	51.3	51.5	*n.s.*
female	**48.7**	48.9	48.9	49.0	48.9	48.6	48.3	48.7	48.5	
Health										
risk present	**14.1**	13.1	13.3	13.3	12.9	13.8	14.9	16.0	17.6	*n.s.*
none	**85.9**	86.9	86.7	86.7	87.1	86.2	85.1	84.0	82.4	
Birth Coverage										
medi-cal	**66.7**	63.8	63.4	64.5	65.1	67.5	69.9	71.8	72.8	*6.6 (p<.001)*
other	**33.3**	36.3	36.6	35.4	34.9	32.5	30.1	28.2	27.2	
Maternal Race/Ethnicity[3]										
black	**13.4**	14.1	13.7	13.5	12.9	12.6	13.2	13.3	14.2	*-6.5 (p<.001)*
white	**30.6**	32.9	31.6	30.7	30.4	29.8	29.1	29.1	29.8	*-10.8 (p<.001)*
hispanic	**51.4**	48.1	49.9	51.1	51.8	52.9	53.1	53.0	51.7	*14.7 (p<.001)*
asian/pi	**4.7**	4.8	4.8	4.7	4.8	4.6	4.5	4.6	4.3	*n.s.*
Maternal Age at Birth										
<=24 yrs	**49.1**	49.6	49.4	49.9	49.2	48.8	48.7	48.5	48.4	*n.s.*
25 yrs+	**50.9**	50.4	50.6	50.1	50.8	51.2	51.3	51.5	51.7	
Maternal Education										
hs or less	**78.8**	79.3	79.0	78.9	78.4	78.3	78.8	79.3	78.5	*-4.2 (p<.001)*
some college+	**21.2**	21.0	21.0	21.1	21.6	21.7	21.2	20.7	21.5	
Father Information										
missing	**18.4**	16.9	17.1	17.3	17.6	18.3	19.4	21.0	23.1	*3.9 (p<.001)*
recorded	**81.6**	83.1	82.9	82.7	82.4	81.7	80.6	79.0	76.9	
Birth Order										
second or higher	**70.9**	70.2	70.9	70.6	70.7	70.9	71.3	71.7	71.3	*n.s.*
first born	**29.1**	29.8	29.2	29.4	29.3	29.1	28.7	28.3	28.7	

1. Missing values excluded from percent calculations.
2. Allegations for the 2003-2006 birth cohort are limited to reports received during the first four, three, two, and first years of life, respectively.
3. Native American and other race children coded as race missing (1.3% of total) and excluded from analysis.
4. Z-statistic reported. Significance level set at 0.001.
5. Due to right censored CPS reports for the 2003-2006 birth cohorts, test for trends for all variables were conducted using only the 1999-2002 cohorts.

1.2.2 Other Characteristics of Children Reported to CPS

Table 10 reflects the distribution of characteristics at birth for children reported to CPS based on allegation disposition, allegation type, and history of a placement in out-of-home foster care. As described in Chapter 3, allegation dispositions were coded according to a severity hierarchy in which those children with multiple allegations of maltreatment were coded based on the most severe disposition received. Similarly, allegation types were coded according to a severity hierarchy with the most severe allegation serving as the subject of analysis.

1.2.2.1 Allegation Disposition

Of the 514,718 children reported to CPS before the age of five, 44,457 (8.6%) were "evaluated out" and at no point received an in-person investigation. 160,404 (31.2%) of reported children had an allegation of maltreatment that was unfounded following an investigation, 113,228 (22.0%) an allegation investigated that resulted in an inconclusive disposition, and 196,629 (38%) had a substantiated allegation of abuse or neglect.

Across all allegation disposition types, a slight majority of children were male as was true in the overall birth cohort and subpopulation of children reported to CPS. 17.4% of substantiated children had a health risk present at birth compared with only 11 to 12% of children with an evaluated out, unfounded, or inconclusive allegation. The fraction of children covered by Medi-Cal at birth increased with the allegation disposition severity hierarchy: 59.5% of children who were evaluated out were covered by Medi-Cal, yet this was true of 63.9% of children with unfounded allegations, 65.1% of children with an inconclusive allegation, and 71.6% of children with a substantiated allegation. Black children comprised slightly smaller shares of those children with allegations that were evaluated out (11.6%) or coded as unfounded (12.2%) than was true among the group of children with inconclusive or substantiated allegations (14.3%). White and Asian/PI children were proportionately more likely to have had an allegation evaluated out (36.6% and 6%, respectively) than to have experienced other dispositions. Hispanic children were represented as the highest proportion of the total among children with unfounded allegations (56.4%).

Children born to mothers who were 24 or younger at the time of birth were overrepresented among all children reported to CPS versus the overall population (49% vs. 32%), but without any discernible or easily interpretable patterns observed across disposition type. In contrast, the proportion of children born to mothers with a high school degree or less increased along with the severity of the allegation disposition – from 72.3% of children with an allegation that was evaluated out versus 82.7% of children with a substantiated allegation of maltreatment. The absence of paternal information on the birth record was also associated with disposition type and associated with a more severe disposition. Just over 14% of children with an evaluated out or unfounded allegation had no father listed on their birth record. Meanwhile, 16.2% of children with an inconclusive allegation and 24.1% of children who had a substantiated allegation were missing paternity information. Finally, although children who were second or higher in the birth order were overrepresented among children reported to CPS compared with the full population of births (70.9% vs. 61.2%) there was no clear pattern between disposition severity and being a first or later born child.

1.2.2.2 Allegation Type

Neglect was the most severe allegation of maltreatment for a majority of children reported to CPS in this study (53.9%). Physical abuse was the alleged form of maltreatment for 58,015 or 11.3% of reported children. Just over 20,000 children were reported for possible sexual abuse amounting to 3.9% of the total. 11% of children were reported for possible emotional abuse. Finally, 104,050 children (20.2%) fell into a "risk/other" category that included sibling at risk and other abuse.

An allegation of physical abuse was more likely to involve a male than female child (55.6% vs. 44.4%) whereas sexual abuse allegations more commonly involved female versus male children (67.0% vs. 33.0%). The gender distribution for allegations of neglect, emotional abuse, and risk/other abuse were consistent with that observed for all children reported to CPS and in the full population of births. The presence of a health risk factor at birth was most strongly associated with an allegation type of neglect – over 16% of children reported for reasons of neglect were either low birth weight or had a birth abnormality, while this was true of only 10-12% of children reported for other reasons.

Although the overall rate of children covered by Medi-Cal at birth was higher among children reported to CPS than for the general population of births (66.7% vs. 43.5%), there was also notable variation across allegation types. 70.5% of children reported for neglect were covered by Medi-Cal at birth compared with only 54.3% of children reported for sexual abuse. Children reported for physical abuse, emotional abuse, and risk/other abuse fell in the middle, ranging from 60 to 65%. The racial distributions for each allegation type were fairly comparable to those observed for all children. Black children were slightly more likely to have been reported for reasons of neglect (14.6%) and less likely to have been reported for reasons of emotional abuse (10.5%) than suggested by their overall proportion among children reported to CPS. White children comprised a greater fraction of children reported for reasons of neglect (34.4%) and sexual abuse (35.7%) than for other allegation types. Meanwhile, Hispanic children were overrepresented among children reported for risk/other abuse (59%) and emotional abuse (58.1%) when considered in the context of their aggregate presence among reported children (51%).

Births to mothers under the age of 25 were more common within the group of children reported to CPS (49.1%) than among the full population of births (32.9%). Among children reported to CPS, births to younger mothers were most frequently observed for children reported for risk/other abuse (60.4%) and physical abuse (53.3%) while relatively less common among children reported for sexual abuse (47.1%) and emotional abuse (43.6%). Some differences across allegation types were also observed for the proportion of children born to mothers with no more than a high school degree. Although 78.8% of all reported children were born to mothers in this lower educational group, this was true of only 68.4% of children reported for sexual abuse compared with 81.5% of children reported for reasons of neglect.

Likewise, the absence of an identified father on the birth record, true of only 7% of children in the birth cohort, yet 18% of children reported to CPS, also differed across allegation type. Among children reported for neglect, almost 23% had no father listed, while only 10-14% of children reported for sexual abuse, emotional abuse, or risk/other abuse were missing paternity

information. 16% of children identified as possible victims of physical abuse had no father listed. Finally, children who were second or higher in birth order were overrepresented in the group of children reported to child protective services (70.9%) compared to all children in the overall birth cohorts examined (61.2%). This was true, however, much more so for children reported for allegations of neglect or risk/other abuse (70.7% and 81.1%, respectively). The proportion of later-born children reported for reasons of physical abuse was almost the same as that which was observed for the general population (62.9%) and only slightly higher for children reported for emotional abuse (65.5%). The proportion of later-born children was actually lower among children reported for sexual abuse (58.2%).

1.2.2.3 Out-of-home Foster Care Placement

Among the 514,718 children identified as reported to CPS before the age of five, 30,778 or 6% were placed in foster care for at least one day. The average length of stay for children placed in foster care was 518 days; the median length of stay was 446 days. When considered in the context of the full study population of 4.3 million children, approximately 7 of every 1,000 children had been removed from his or her family and placed into foster care for at least one day.

The distribution of male (51.9%) and female (48.1%) children among those placed in foster care aligned with that observed in the overall population and the subpopulation of children reported to child protective services. Children placed in foster care were more likely to have a health risk present at birth than the overall group of children reported for maltreatment (21.2% vs. 14.1%). Also overrepresented among children placed in out-of-home care were children covered by Medi-Cal: three-quarters of all children placed in foster care had been born a part of this public system at birth.

The racial distribution of children placed in foster care presents a slightly more extreme version of the distribution of children with substantiated allegations of maltreatment. Children placed in foster care consisted of greater fractions of Black (17.8%) and White (34.5%) children than in the overall population of children reported, while Hispanic and Asian/PI children were underrepresented at 44.1% and 3.6% of placements, respectively. Among children who had been placed in foster care, the distribution of maternal age tracked that of all children who had been reported to CPS with an almost perfect split of mothers who were under the age of 24 at birth (49.1%) and mothers who were 25 or older (50.9%).

86% of children placed in foster care were born to mothers whose education had ended at (or before) the completion of high school, compared with only 57% of children in the general population, 79% of children reported to child protective services, and 83% of children with a substantiated allegation of maltreatment. The fraction of children without an identified father on the birth record also increased with a child's penetration into the child welfare system. 7% of all children in the study were missing paternity information in the birth record. This jumped to 14% of children who were reported to CPS for possible maltreatment and had the allegation evaluated out or unfounded, 16% of children whose allegation was inconclusive, 24% of children with a substantiated allegation, and 33% of children placed in foster care. Among the most recent birth cohort (2006) there was an even higher rate of missing paternal information among children who had entered foster care: 40%. Children placed in foster care were more likely to be second or

higher in the birth order (76.4%) than suggested by their presence in the population of children reported for possible maltreatment (70.9%).

Table 10. Characteristics of children reported to CPS, *by disposition, allegation, and placement*

	CPS Contact	**Allegation Disposition**				**Allegation Type**					**Placement**
	all children	*evaluated out*	*unfounded*	*inconclusive*	*substantiated*	*risk/other*[3]	*emotional*	*neglect*	*physical*	*sexual*	*all children*
	n=514,718	n=44,457 (8.6%)	n=160,404 (31.2%)	n=113,228 (22.0%)	n=196,629 (38.2%)	n=104,050 (20.2%)	n=55,142 (10.7%)	n=277,403 (53.9%)	n=58,015 (11.3%)	n=20,104 (3.9%)	n=30,778 (6%)
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Sex											
male	**51.3**	50.2	51.2	51.5	51.5	50.9	51.3	51.8	55.6	33.0	51.9
female	**48.7**	49.8	48.8	48.5	48.5	49.2	48.7	48.2	44.4	67.0	48.1
Health											
risk present	**14.1**	12.9	11.6	12.2	17.4	11.7	10.6	16.3	12.1	10.9	21.2
none	**85.9**	87.1	88.4	87.8	82.6	88.3	89.4	83.7	87.9	89.1	78.8
Birth Coverage											
medi-cal	**66.7**	59.5	63.9	65.1	71.6	64.7	60.3	70.5	62.6	54.3	75.6
other	**33.3**	40.6	36.1	34.9	28.4	35.3	39.7	29.5	37.4	45.7	24.4
Maternal Race/Ethnicity[2]											
black	**13.4**	11.6	12.2	14.3	14.3	12.0	10.5	14.6	13.6	12.3	17.8
white	**30.6**	36.6	26.8	29.4	33.0	23.4	24.8	34.4	29.0	35.7	34.5
hispanic	**51.4**	45.8	56.4	51.5	48.4	59.5	58.1	47.1	51.7	48.2	44.1
asian/pi	**4.7**	6.0	4.7	4.9	4.3	5.1	6.7	4.0	5.7	3.8	3.6
Maternal Age at Birth											
<=24 yrs	**49.1**	51.4	45.8	52.4	49.5	60.4	48.9	51.6	53.3	47.1	49.3
25 yrs+	**50.9**	48.6	54.3	47.6	50.5	39.6	51.1	48.4	46.7	52.9	50.7
Maternal Education											
hs or less	**78.8**	72.3	76.5	78.1	82.7	77.4	74.8	81.5	75.9	68.4	86.1
some college+	**21.2**	27.7	23.5	21.9	17.4	22.6	25.2	18.5	24.1	31.6	13.9
Father Information											
missing	**18.4**	14.2	14.3	16.2	24.1	13.9	10.1	22.8	15.7	13.1	33.0
recorded	**81.6**	85.8	85.7	83.8	76.0	86.1	89.9	70.7	84.3	86.9	67.0
Birth Order											
second or higher	**70.9**	60.7	71.8	68.3	73.9	81.1	65.5	70.7	62.9	58.2	76.4
first born	**29.1**	39.3	28.2	31.7	26.1	19.0	34.5	29.3	37.2	41.8	23.6

1. Missing values excluded from all percent calculations, across all variables.

2. Native American and other race children coded as race missing (1.3% of total) and excluded from analysis.

3. Includes allegation categories for risk, sibling at risk, and other abuse.

1.2.3 Cumulative Percentage of Children Reported to CPS by Age Five
Based on the complete data available for the 1999-2002 birth cohorts, this analysis suggests that approximately 14% of children born in California were reported (one or more times) for possible maltreatment before the age of five. By their fifth birthday, the same fractions of male and female children had been reported at least once. 18% of children with a health risk present at birth had been identified as possible victims of maltreatment. Over 20% of children whose birth was covered by Medi-Cal had been reported to CPS versus just 8.5% of children who had some other form of insurance coverage.

Nearly 30% of Black children born in California had been reported to child protective services during the first five years of life. This was true of 13% of White children, 14% of Hispanic children, and only 6% of Asian/PI children. Just over one in five children born to a mother who was under the age of 25 at the time of birth had been referred as a possible victim of maltreatment. Only one in 10 children whose mother had been 25 or older had been reported. 19% of children born to mothers whose education had concluded at or before the completion of high school had CPS contact compared with 7% of children born to mothers with at least some college. 33% of children born without a father listed on their birth record were reported to child protective services. Roughly 10% of first born children were reported to CPS versus 16% of children higher in the birth order.

1.2.3.1 Cumulative Percentage by Disposition Type
Of the 14% of children born in California and reported to CPS before the age of five, 5.2% had at least one substantiated allegation of abuse or neglect. 3.4% of children were reported at least once, but the most severe disposition received was coded as inconclusive. For another 4.1%, the allegation was unfounded. The remaining 1.2% of children had their allegation evaluated out, receiving no formal investigation or disposition.

Children with a health risk present face a high risk of substantiation. 8% were identified as substantiated victims of maltreatment even though the cumulative percentages for other disposition types generally aligned with those observed for all children reported to CPS. Almost 9% of children covered by Medi-Cal were substantiated victims of maltreatment. Over one in every 10 Black children born in California (12%) was identified as maltreated before their fifth birthday, with the allegation deemed inconclusive for another 7.7%. 16% of children without an identified father were substantiated victims of maltreatment.

1.2.3.2 Cumulative Percentage by Allegation Type
Neglect was the leading referral reason among children reported for possible maltreatment before the age of five. 7.4% of children born in California had been reported for neglect, another 2.5% for risk of maltreatment, 1.8% for physical abuse, 1.5% for emotional abuse, and less than 1% for sexual abuse. 11% of children with a health risk present at birth were reported for neglect (compared with 7.4% of all children). Likewise, 12% of all children covered by Medi-Cal at birth, and 17% of Black children, were reported for neglect. 1.4% of all Black children, 1% of children born to mothers under the age of 25, and 1.2% of children with no identified father were reported for sexual abuse before the age of five.

Table 11. Cumulative percentage of children reported to CPS by age five, *by disposition and allegation type*

	Children Reported to CPS	**Allegation Disposition**				**Allegation Type**				
	all children	*evaluated out*	*unfounded*	*inconclusive*	*substantiated*	*risk/other*	*emotional*	*neglect*	*physical*	*sexual*
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Full Population [1]	**13.9**	1.2	4.1	3.4	5.2	2.5	1.5	7.4	1.8	0.7
Sex										
male	**13.9**	1.2	4.1	3.4	5.2	2.5	1.5	7.5	2.0	0.4
female	**13.9**	1.2	4.1	3.4	5.2	2.6	1.5	7.3	1.6	0.9
Health										
risk present	**18.1**	1.5	4.4	3.8	8.3	2.7	1.5	11.1	2.1	0.7
none	**13.4**	1.2	4.1	3.3	4.9	2.5	1.5	6.9	1.8	0.7
Birth Coverage										
medi-cal	**21.6**	1.6	6.0	5.2	8.8	3.8	2.1	12.2	2.7	0.9
other	**8.5**	0.9	2.7	2.1	2.7	1.7	1.1	3.9	1.2	0.6
Maternal Race/Ethnicity										
black	**29.7**	2.3	7.7	7.7	12.1	4.8	2.4	17.4	3.8	1.4
white	**13.5**	1.4	3.5	3.1	5.4	1.8	1.2	7.9	1.7	0.8
hispanic	**14.1**	1.1	4.6	3.5	5.0	3.1	1.8	6.8	1.8	0.6
asian/pi	**5.8**	0.6	1.7	1.4	2.0	1.2	0.9	2.5	0.9	0.2
Maternal Age at Birth										
<=24 yrs	**20.6**	1.9	5.7	5.3	7.7	3.0	2.3	11.4	2.9	1.0
25yrs+	**10.5**	0.9	3.2	2.4	4.0	2.3	1.1	5.3	1.3	0.5
Maternal Education										
hs or less	**18.7**	1.5	5.4	4.5	7.4	3.4	2.0	10.2	2.4	0.8
some college+	**7.0**	0.8	2.3	1.8	2.1	1.4	0.9	3.2	1.0	0.5
Father Information										
missing	**33.6**	2.2	7.7	7.4	16.4	4.3	2.1	22.2	3.8	1.2
recorded	**12.4**	1.1	3.8	3.1	4.4	2.4	1.5	6.2	1.6	0.6
Birth Order										
second or higher	**16.0**	1.2	4.8	3.8	6.3	3.4	1.6	8.5	1.9	0.7
first born	**10.6**	1.2	3.1	2.7	3.5	1.2	1.4	5.6	1.7	0.7

1. Reported rates reflect data restricted to the 1999-2002 birth cohorts because CPS reports were censored for children born after 2003.

1.3 Characteristics of Decedent Children

Among the 4.3 million children born alive in California between 1999 and 2006, 25,475 (or approximately 6 out of every 1,000 children born) died before age five. 11,226 (44%) of these deaths occurred within three days of birth and a total of 15,391 (60%) had occurred by the conclusion of the neonatal period (the first 28 days of life). In total, 11,123 children (44%) died from perinatal conditions and 6,101 (24%) died from congenital and chromosomal abnormalities or other deformities. 3,456 children (14%) died from disease while another 460 (4%) succumbed to cancer. 2,356 (9%) were coded as non-classified clinical abnormalities or ill-defined causes of death, of which 1,394 were classified as Sudden Infant Death Syndrome (SIDS). 1,917 children (8%) died from injuries.

This dissertation focused on those children who sustained fatal injuries during the study window and before the age of five, the birth characteristics of whom are reflected in Tables 12 and 13. Due to censored death observations for the 2003 through 2006 birth cohorts, nonparametric tests for trends were restricted to the years 1999-2002 in Table 12. Variable distributions for the 2003, 2004, 2005, and 2006 cohorts should be treated as distinct as they do not reflect all injury deaths occurring before age five. Table 13 presents additional characteristics of these reported children based on the manner and mechanism of injury death. These stratifications are reported alongside a column that captures the characteristics of all fatally injured children for comparison.

1.3.1 Birth Characteristics of Fatally Injured Children

No significant trends across birth cohorts were observed in the distribution of fatally injured children for any of the birth variables examined in this analysis (no doubt, in large part, to the small cell sizes that resulted when injury fatalities were stratified by year). Overall, just over 20% of children who died from an injury had been previously reported for maltreatment. Although the fraction of fatally injured children appears to decline over time, this is the result of censored death observations for later cohorts. Across all years, male children faced a greater risk of injury death (58.3%) than did female children (41.7%). Children who were born low birth weight or with one or more birth abnormalities were overrepresented among those who were fatally injured (16.8%) relative to their overall presence in the general population of children (10.7%). Children whose births were covered by Medi-Cal also faced a heightened risk of injury death: 56% of all children who died from an injury were covered by Medi-Cal compared with only 44% of children in the overall population of births.

At 13.2%, Black children were overrepresented among fatally injured children while Asian/PI children were underrepresented at 7.5%. White and Hispanic were present among decedent children in roughly the same proportion they were observed in the population of births. Birth to a mother who was 24 years old or younger, or to a mother who had no more than a high school degree, were both associated with a child's risk of injury death. Only 33% of all births were to young mothers, yet 50% of fatally injured children were born to a young mother. Likewise, although 57% of children were born to a mother with a high school degree or less this was true of 73% of children who died from an injury. Compared with all children born in California, over twice as many fatally injured children had no father listed on their birth (7.2% vs. 16.1%). A slightly higher fraction of deceased injured children fell second or higher in the birth order (69%) than was true of the overall study population (61%).

Table 12. Characteristics of fatally injured children, *by year of birth*

	All Years[1] *Injury Deaths* **n=1,917**	1999 Births *Injury Deaths* n=294	2000 Births *Injury Deaths* n=269	2001 Births *Injury Deaths* n=260	2002 Births *Injury Deaths* n=270	2003 Births *Injury Deaths* n=240	2004 Births *Injury Deaths* n=244	2005 Births *Injury Deaths* n=186	2006 Births *Injury Deaths* n=154	Nonparametric Test for Trends[3,4]
	%	%	%	%	%	%	%	%	%	*test statistic (p-value)*
Maltreatment										
prior allegation	**20.7**	20.4	19.7	25.0	22.2	23.3	18.0	17.2	16.9	*n.s.*
no report	**79.3**	79.6	80.3	75.0	77.8	76.7	82.0	82.8	83.1	
Sex										
male	**58.3**	57.8	57.3	64.2	59.3	58.8	54.5	51.6	62.3	*n.s.*
female	**41.7**	42.2	42.8	35.8	40.7	41.3	45.5	48.4	37.7	
Health										
risk present	**16.8**	17.7	15.6	18.5	13.7	17.6	13.1	20.4	19.5	*n.s.*
none	**83.3**	82.3	84.4	81.5	86.4	82.4	86.9	79.6	80.5	
Birth Coverage										
medi-cal	**56.3**	52.8	52.9	59.8	55.5	58.5	53.7	64.5	54.7	*n.s.*
other	**43.7**	47.2	47.2	40.2	44.5	41.5	46.3	35.5	45.3	
Maternal Race/Ethnicity[2]										
black	**13.2**	15.1	12.5	13.4	13.2	10.0	11.5	14.8	15.3	*n.s.*
white	**32.4**	27.5	36.4	31.2	32.5	36.4	36.8	26.2	32.0	*n.s.*
hispanic	**46.9**	49.8	44.3	49.8	45.7	47.2	41.9	50.8	45.3	*n.s.*
asian/pi	**7.5**	7.6	6.8	5.5	8.7	6.5	9.8	8.2	7.3	*n.s.*
Maternal Age at Birth										
<=24 yrs	**49.6**	49.3	43.5	51.2	52.2	46.7	51.6	55.4	47.4	*n.s.*
25yrs+	**50.4**	50.7	56.5	48.9	47.8	53.3	48.4	44.6	52.6	
Maternal Education										
hs or less	**72.7**	70.4	72.0	77.2	71.9	73.7	70.7	76.5	69.2	*n.s.*
some college+	**27.3**	29.6	28.0	22.8	28.1	26.3	29.3	23.5	30.8	
Father Information										
missing	**16.1**	15.0	14.1	16.5	15.2	22.9	15.6	16.1	13.0	*n.s.*
recorded	**83.9**	85.0	85.9	83.5	84.8	77.1	84.4	83.9	87.0	
Birth Order										
second or higher	**69.0**	68.2	72.9	67.8	68.3	69.5	68.2	61.1	76.8	
first born	**31.0**	31.8	27.1	32.2	31.7	30.5	31.8	38.9	23.2	*n.s.*

1. Missing values excluded from percent calculations across all cohorts.

2. Native American and other race children coded as race missing (2.4% of total) and excluded from analysis due to small numbers.

3. Significance level set at 0.05.

4. Due to right censored death data for the 2003-2006 birth cohorts, test for trends for all variables were conducted using only the 1999-2002 cohorts.

1.3.2 Other Characteristics of Fatally Injured Children

Table 13 reports the birth characteristics of fatal injury victims across stratifications of injury manner and mechanism. Manner (or intent) data are presented for all mechanisms of injury and therefore include deaths that were the result of everything from drowning to unspecified assault. These tabulations are followed by a presentation of the leading mechanisms of death. The mechanism categories included reflect 93% of all injury deaths, each of which may have been coded as of unintentional, intentional, or undetermined intent. Not captured in the mechanism tabulation (although included under manner of injury) are 25 deaths attributed to environmental exposure (1.3%), 24 gun deaths (1.2%), 23 deaths from being struck (1.2%), 7 deaths from cutting or piercing (0.4%), and 57 additional deaths from both classifiable and unclassifiable mechanisms not otherwise coded (2.9%).

1.3.2.1 Intent or Cause of Injury Death

Of the 1,917 children in this study who died from an injury, 75% had their death declared unintentional (or accidental), 20% were deemed victims of an intentionally inflicted injury (from some form of assault), and for the remaining 5%, the cause or intent was undetermined. A prior allegation of maltreatment was more common among intentionally injured children (33.1%) compared with unintentional injury victims (17.5%), with injury victims whose death was deemed of undetermined intent falling in the middle (22.5%). The gender distribution across intent types was consistent with that observed for all injuries – males faced a greater risk of both unintentional and intentional deaths. Gender parity was observed for deaths of undetermined intent, but the smaller count of deaths falling in this category mean that these percentages are less stable than for the other two intent types. The presence of a health risk at birth was more frequently observed among children whose deaths were classified as intentional (23.4%) or of undetermined intent (23.5%) than for deaths that were unintentional (14.5%). Likewise, Medi-Cal coverage at birth was more common among children dying from intentionally inflicted (64.2%) or undetermined (70.2%) injuries than was true of unintentionally injuries (53.4%).

Compared with the overall racial distribution of fatal injuries, Black children were underrepresented among the unintentionally injured (10.3%), while overrepresented among injury victims whose deaths were deemed intentional (21.7%) or undetermined in nature (21.7%). Of all fatally injured children with deaths coded as unintentional, 35.1% were White while among intentionally injured children, White children were 22% of the total. Hispanic and Asian/PI children were identified as unintentional injury victims (47.4% and 7.3%, respectively) and intentional injury victims (48.4% and 7.9%, respectively) in roughly the same proportions. Hispanic children were underrepresented among children with deaths coded as of undetermined intent (34.0%); Asian/PI children were overrepresented (10.3%).

45.9% of unintentionally injured fatality victims and 41.8% of undetermined intent were born to mothers age 24 or younger, compared with 65.4% of intentionally injured victims. Of all fatally injured children, 16.1% had no father identified on the birth record. The comparable percentages among unintentional injury victims and injury victims of undetermined intent were 11.8% and 17.4%, respectively. Of intentional injury victims, 32.3% had no identified father. Finally, although over 70% of unintentional and undetermined intent injury victims fell second or higher in the birth order, only 57.8% of intentional injury victims were non first born children.

1.3.2.2 Mechanism of Injury Death

The three leading mechanisms of injury death were transport related (26.7%), drowning (23.6%), and suffocation (18.8%). It should be noted that the transport related category includes pedestrians and cyclists injured in transport crashes, as well as deaths coded as the sequalae of transport crashes; the suffocation category excluded deaths coded as Sudden Infant Death Syndrome (SIDS) which is not considered an injury death. 174 child deaths (9.1%) fell into a combined category capturing deaths from fire, poison, or falls. Another 140 child deaths (7.3%) were coded as assaults by "other" or "unspecified" means. 139 children (7.3%) had their mechanism of death coded as either "neglect and abandonment" or "other maltreatment syndromes."

Among children whose deaths were coded as arising from an assault or maltreatment, over 37% of children had been previously reported for maltreatment. The fraction of children with prior non-fatal reports among children who death was coded as transport related, drowning, or suffocation was much lower, ranging from only 13.9% (drowning) to 17.6% (transportation). Fatal injuries involving fire, poisoning, or a fall included a larger relatively share of children previously reported for maltreatment (28.2%). Overall, the gender distribution across all mechanisms of death was fairly constant. Male children were consistently overrepresented among fatally injured children, but this overrepresentation was most pronounced among children who had drowned: 65% of children who died from drowning were male while for other mechanisms of death, only 55 to 59% of decedent children were male. The presence of health risk at birth was most frequently observed among children who were the victims of an unspecified assault (25.0%) and least commonly reported among children who had drowned (10.6%). Poor health was also characteristic of children who suffocated (21.3%) and died of maltreatment (20.3%). As was true of poor health, this risk factor was least likely to be observed among children who had drowned (45.4%) and more frequently reported among victims of unspecified assault (61.5%) or maltreatment (67.7%). Medi-Cal coverage was also relatively more common among children dying from fire, poison, or falls (63.4%).

Distinct racial patterns emerged based on injury mechanism. Although Hispanic children accounted for 46.9% of fatal injury victims, 62.6% of children whose mechanism of death was coded as transport related were Hispanic. Meanwhile, Hispanic children were relatively less common among children dying from fire, poison, or falls (35.3%), suffocation (39.5%), and drowning (40.9%). Although slightly underrepresented among maltreatment victims (44.1%), Hispanic children were slightly overrepresented among victims of unspecified assault (54.5%). White children (32.4% of all fatally injured children) comprised the greatest share of drowning victims (44.1%) and lower shares of decedent children from unspecified assault (17.2%), transportation (22.6%), and maltreatment (25.0%). Among Black children, injury victims were far more likely to have their death coded as due to maltreatment (25.0%) or unspecified assault (20.2%) than their presence in the overall group of injured children would predict (13.2% of the total). At the other extreme, Black children were less frequently observed among transportation (8.6%) and drowning victims (8.9%). Lower fractions of Asian/PI children were coded as fatal victims of a maltreatment related injury (5.9%); a greater share were observed among children dying from fire, poison, or falls (9.3%).

Table 13. Characteristics of fatally injured children, *by manner and mechanism of injury death*

	Injury Deaths[1]	Manner of Injury Death *(all mechanisms)*			Leading Mechanisms of Injury Death *(all manners)*					
	all deaths	*unintentional*	*intentional*	*undetermined*	*transportation*	*drowning*	*suffocation*[3]	*fire, poison, falls*[4]	*unspec. assault*[5]	*maltreatment*[6]
	n=1,917	n=1,438	n=381	n=98	n=512	n=452	n=361	n=174	n=140	n=139
		(75.0%)	(19.9%)	(5.1%)	(26.7%)	(23.6%)	(18.8%)	(9.1%)	(7.6%)	(7.3%)
	%	%	%	%	%	%	%	%	%	%
Maltreatment										
prior allegation	**20.7**	17.3	33.1	22.5	17.6	13.9	16.3	28.2	37.9	37.4
no report	**79.3**	82.8	66.9	77.6	82.4	86.1	83.7	71.8	62.1	62.6
Sex										
male	**58.3**	59.1	57.0	51.0	56.1	64.6	57.3	58.6	55.7	56.1
female	**41.7**	40.9	43.0	50.0	43.9	35.4	42.7	41.4	44.3	43.9
Health										
risk present	**16.8**	14.5	23.4	23.5	14.1	10.6	21.3	18.4	25.0	20.3
none	**83.3**	85.5	76.6	76.5	85.9	89.4	78.7	81.6	75.0	79.7
Birth Coverage										
medi-cal	**56.3**	53.4	64.2	70.2	58.9	45.4	59.6	63.4	61.5	67.7
other	**43.7**	46.6	35.8	29.8	41.1	54.6	40.4	36.6	38.5	32.3
Maternal Race/Ethnicity[2]										
black	**13.2**	10.3	21.7	21.7	8.6	8.9	14.9	18.5	20.2	25.0
white	**32.4**	35.1	22.0	34.0	22.6	44.1	37.0	37.0	17.2	25.0
hispanic	**46.9**	47.4	48.4	34.0	62.6	40.9	39.5	35.3	54.5	44.1
asian/pi	**7.5**	7.3	7.9	10.3	6.2	6.1	8.6	9.3	8.2	5.9
Maternal Age at Birth										
<=24 yrs	**49.6**	45.9	65.4	41.8	51.2	38.3	48.5	48.3	72.1	65.5
25yrs+	**50.4**	54.1	34.7	58.2	48.8	61.7	51.5	51.7	27.9	34.5
Maternal Education										
hs or less	**72.7**	71.1	79.8	70.2	79.6	66.4	68.8	72.2	87.1	77.7
some college+	**27.3**	28.9	20.2	29.8	20.4	33.6	31.2	27.8	12.9	22.3
Father Information										
missing	**16.1**	11.8	32.3	17.4	10.2	11.1	17.5	20.7	30.7	33.1
recorded	**83.9**	88.3	67.7	82.7	89.8	88.9	82.6	79.3	69.3	66.9
Birth Order										
second or higher	**69.0**	71.4	57.8	73.7	65.4	79.3	72.9	71.7	57.7	53.7
first born	**31.0**	28.6	42.2	26.3	34.6	20.7	27.1	28.3	42.3	46.3

1. Missing values excluded from percent calculations across all cohorts.

2. Native American and other race children coded as race missing (2.4% of total) and excluded from analysis due to small numbers.

3. Excludes deaths coded as Sudden Infant Death Syndrome (ICD-10 code R95).

4. Includes 56 deaths from fire, 51 deaths from poisoning, and 43 deaths from falls.

5. Includes only deaths coded as "Assault by other specified means" (ICD-10 code Y08) and "Assault by unspecified means" (ICD-10 code Y09).

6. Includes deaths coded as "Neglect and abandonment" (ICD-10 code Y06) and "Other maltreatment syndromes" (ICD-10 code Y07).

2. Unadjusted Incidence Rates and Risk Ratios of Death

Cumulative incidence rates, crude risk ratios, and accompanying 95% confidence intervals were computed based on several different death-type specifications. Since children in this study were under observation for varying lengths of time (e.g., five years of data were available for children in the 1999-2002 cohorts, while data for children born in 2003 or later were censored), rates were computed based only on the 1999-2002 birth cohorts. An alternative method would have been to use all birth cohorts, adjusting denominators to reflect child-years of exposure. Given that this latter method produced results that were less intuitively interpreted, for the purposes of descriptive discussions, it was dismissed in favor of the simpler reporting achieved by restricting the cohorts to those for which data were not right-censored. Survival models presented later reflect exposure adjustments to account for censored data and the time-varying nature of a first report to CPS.

Tables 14-15 capture the cumulative incidence of overall death and injury death by age five for children born in California. All deaths are presented as rates per 100,000 children born, while crude risk ratios and 95% confidence intervals reflect the unadjusted associations between birth characteristics and subsequent death. Overall child death rates are reported in Table 14, stratified by deaths occurring pre- and post-neonatally (i.e., before and after 28 days of life). Child injury death rates are reported in Table 15, stratified by manner of death. Rates by mechanism of death are not presented as the restriction to children born prior to 2003 for the computation of these rates translated into small cell sizes and high levels of rate instability.

2.1 Child Death Rates

The deaths of 25,475 children are included in this study. 13,152 of these deaths involved children born between 1999-2002 and are reflected in the rates reported in Table 14. The estimated rate of death by age five for children in California was 622.7 per 100,000 children born. As described earlier, a majority of these deaths occurred during the first 27 days of life (the "neonatal period") and were the result of congenital abnormalities and other perinatal conditions. The overall death rate before 28 days of life was 359.3 per 100,000 children born. The cumulative death rate among children surviving until 28 days summed to a rate of 263.3 per 100,000 children.

Children with a prior allegation of maltreatment died at a rate that was over 50% lower than children who had not been reported (RR: 0.47, 95% CI [0.44, 0.50]). It is not until the analysis is restricted to non-infant deaths that a prior allegation emerges as a risk factor for death (RR: 1.68, 95% CI [1.50, 1.87]). Important to remember when considering these statistics, however, is the bias introduced in terms of exposure time. Given that a majority all child deaths occur in the first three days of a child's life, the window in which a report to CPS might have been made is relatively short for most children who die. This finding underscores the importance of utilizing survival models with the ability to accommodate a time-varying measure of a first report to CPS in the multivariate models presented in the next section of this chapter.

Overall, male children were more vulnerable to death during the first five years of life (RR: 1.19, 95% CI [1.15, 1.23]). Children with a health risk present at birth (low birth weight or a birth abnormality) died at 84 times the rate of their healthier peers during the first month of life (95% CI [77.71, 90.72]), a rate that declines thereafter. Medi-Cal coverage was consistently associated a heightened risk of death (RR: 1.32, 95% CI [1.28, 1.37]), but was most pronounced during the

post-neonatal period (RR: 1.67, 95% CI [1.57, 1.79]). Over twice as many Black children born alive died before the age of five as White children (RR: 2.41, 95% CI [2.28, 2.55]), while Hispanic were slightly more likely to die (RR: 1.09, 95% CI [1.05, 1.14]) and Asian/PI children slightly less like to die (RR: 0.91, 95% CI [0.86, 0.98]. These disparities were generally constant from the neonatal through the post-neonatal and non-infant periods.

Young maternal age was associated with a heightened risk of death during the post-neonatal period (RR: 1.52, 95% CI [1.42, 1.62]), but not the neonatal period. Low maternal education was also associated with a heightened risk of death throughout the first five years of life, with the relative risk of death greatest during the post-neonatal period (RR: 1.67, 95% CI [1.54, 1.73]). Also a risk factor for death was the absence of any father on the birth record. Among children for whom no paternity information was recorded, 1,263 children out of every 100,000 died before the age of five. For children with an identified father the rate of death was 573 per 100,000. The disparity between children with and without an identified father was greatest during the first 27 days of life (RR: 2.37, 95% CI [2.22, 2.52]). Birth order was unrelated to a child's overall risk of death due to the competing nature of the observed association. During the neonatal period, falling second or higher in the birth order was protective against death (RR: 0.87, 95% CI [0.82, 0.91]). In contrast, from 28 days of life onward, status as a non-first born was a risk factor for death (RR: 1.26, 95% CI [1.19, 1.34]).

Table 14. Cumulative death rates during the first five years of life, *by age at death*

	All Deaths *by age five*			**Neonatal Deaths** *first 27 days of life*			**Post-Neonatal Infant Deaths** *28 days to 1 year*			**Non-Infant Deaths** *1 to 4 years*		
	per 100,000	*Crude RR*	*(95% CI)*	*per 100,000*	*Crude RR*	*(95% CI)*	*per 100,000*	*Crude RR*	*(95% CI)*	*per 100,000*	*Crude RR*	*(95% CI)*
Full Population [1]	622.7	--	--	359.3	--	--	172.4	--	--	90.9	--	--
Maltreatment												
allegation	314.2	0.47	(0.44, 0.50)	31.7	0.08	(0.06, 0.09)	143.1	0.8	(0.73, 0.90)	139.4	1.68	(1.50, 1.87)
no report	672.4	--	--	412.2	--	--	177.1	--	--	83.1	--	--
Sex												
male	674.2	1.19	(1.15, 1.23)	331.5	1.16	(1.11, 1.21)	188.0	1.21	(1.13, 1.29)	102.0	1.28	(1.17, 1.41)
female	566.8	--	--	384.2	--	--	155.9	--	--	79.4	--	--
Health												
risk present	4241.2	19.98	(19.25, 20.74)	3191.7	83.86	(77.71, 90.72)	815.7	8.20	(7.68, 8.76)	233.8	3.13	(2.82, 3.47)
none	212.2	--	--	38.1	--	--	99.4	--	--	74.8	1.50	(1.37, 1.64)
Birth Coverage												
medi-cal	710.5	1.32	(1.28, 1.37)	374.1	1.14	(1.09, 1.19)	223.4	1.67	(1.57, 1.79)	113.1	1.50	(1.37, 1.64)
other	537.1	--	--	328.2	--	--	133.5	--	--	75.4	--	--
Maternal Race/Ethnicity												
black	1315.0	2.41	(2.28, 2.55)	743.9	2.37	(2.19, 2.55)	410.1	2.73	(2.46, 3.04)	161.6	1.99	(1.69, 2.34)
white	545.6	--	--	314.5	--	--	150.0	--	--	81.1	--	--
hispanic	596.2	1.09	(1.05, 1.14)	345.4	1.10	(1.04, 1.16)	159.9	1.07	n.s.	91.0	1.12	(1.01, 1.25)
asian/pi	499.0	0.91	(0.86, 0.98)	275.0	0.87	(0.80, 0.95)	148.1	0.99	n.s.	75.9	0.94	n.s.
Maternal Age at Birth												
<=24 yrs	697.4	1.19	(1.15, 1.24)	365.2	1.02	n.s.	223.1	1.52	(1.42, 1.62)	109.1	1.33	(1.22, 1.46)
25yrs+	584.9	--	--	356.4	--	--	146.7	--	--	81.8	--	--
Maternal Education												
hs or less	668.1	1.37	(1.32, 1.42)	356.6	1.20	(1.15, 1.26)	204.6	1.67	(1.55, 1.80)	106.9	1.57	(1.42, 1.73)
some college+	486.9	--	--	296.3	--	--	122.5	--	--	68.1	--	--
Father Information												
missing	1263.7	2.20	(2.10, 2.31)	775.3	2.37	(2.22, 2.52)	345.9	2.18	(1.98, 2.39)	142.5	1.64	(1.41, 1.89)
recorded	573.3	--	--	327.3	--	--	159.0	--	--	87.0	--	--
Birth Order												
second or higher	610.6	1.02	n.s.	325.9	0.87	(0.82, 0.91)	184.7	1.24	(1.16, 1.33)	100.0	1.31	(1.19, 1.44)
first born	600.8	--	--	375.5	--	--	149.0	--	--	76.3	--	--

1. Reported rates reflect data from the 1999-2002 birth cohorts since death observations were censored for children born in 2003 and beyond.

2.2 Child Injury Death Rates

The deaths of 1,917 children are captured in this study; 1,093 of these deaths are reflected in the rates reported in Table 15. The cumulative injury death rate by age five was 51.8 per 100,000 children. By and large, the associations between birth characteristics and subsequent injury death risk were stronger than those reported in Table 14 for all deaths. The only notable deviation was the presence of a health risk at birth: poor health was much more strongly associated with the overall risk of death than with risk of injury death.

The rate of injury death among children with a prior, non-fatal report to CPS was 81.1 per 100,000 compared with a rate of 47.0 per 100,000 among unreported children. Male children died at a rate of 60.3 per 100,000 and were 40% more likely to die from an injury than were female children (RR: 1.41, 95% CI [1.25, 1.59]). While low birth weight and the presence of a birth abnormality were associated with an increased risk of injury death (RR: 1.73, 95% CI [1.46, 2.03], the risk was far reduced from that observed for all deaths. Children covered by Medi-Cal at birth had elevated rates of fatal injury (67.7 per 100,000) compared with other children (38.7 per 100,000). 110 of every 100,000 Black children died of injuries, over twice the rate of White children (RR: 2.19, 95% CI [1.79, 2.67]). The rates at which Hispanic children died of injuries (49.2 per 100,000) were statistically comparable to those of White children (50.3 per 100,000). Asian/PI children were less likely than White children to sustain a fatal injury (RR: 0.64, 95% CI [0.49, 0.82]).

Children born to mothers who were under the age of twenty five faced a risk of injury death that was 1.9 times greater than children born to mothers who were twenty five or older at birth (RR: 1.90, 95% CI [1.69, 2.15]). Likewise, children born to mothers whose education had concluded at or before the completion of high school were also 1.9 times as likely to be fatally injured before the age of five (RR: 1.90, 95% CI [1.66, 2.19]). 110 of every 100,000 children who had no identified father on their birth record died of an injury before the age of five. This was true of only 47.3 of every 100,000 children for whom paternity was reported (RR: 2.33, 95% CI [1.96, 2.75]). Non first-born children also faced a heightened risk of fatal injury. 57.5 of every 100,000 children falling second or higher in the birth order died of an injury compared with only 40.4 of every 100,000 first born children.

2.2.3 Injury Deaths by Manner (Intent)

Also reported in Table 15 are cumulative rates, crude risk ratios, and 95% confidence intervals for injury deaths stratified by the manner (or intent) of the injury death. The rates of unintentional and intentional injury deaths during the first five years of life were 39.8 per 100,000 and 10 per 100,000 children born, respectively. Although the rates of unintentional injury death were consistently higher than the rates of intentional injury death, many risk factors at birth were more strongly associated with intentionally inflicted injuries.

While rates of unintentional injury deaths among children previously reported were modestly elevated compared with those of children who had not been reported (RR: 1.43, 95% CI [1.20, 1.71]), the difference was much starker when only inflicted injuries were considered (RR: 3.39, 95% CI [2.36, 4.26]). Male children were significantly more likely than their female counterparts to die from an unintentional injury (RR: 1.51, 95% CI [1.32, 1.75]), but no gender differences were observed in the estimated rates for intentional injury deaths. Children with a health risk

present at birth faced over the 2.5 times the risk of being an intentional injury victim as did children with no risk present (RR: 2.79, 95% CI [2.00, 3.85]). These same children faced an unintentional injury risk that was 1.5 times as great as their healthier peers (RR: 1.46, 95% CI [1.38, 1.81]). Similarly, among children covered by Medi-Cal at birth, the relative risk of an intentional injury death (RR: 2.70, 95% CI [1.99, 3.67]) was greater than the relative risk of an unintentional injury death (RR: 1.58, 95% CI [1.38, 1.81]).

Among Black children, the rate of unintentional injury deaths (65.0 per 100,000) was less than twice the rate of intentional injury deaths (37.0 per 100,000). In contrast, for all other racial/ethnic groups, the rate at which children in that group sustained unintentional fatal injuries were 4 to 6 times greater than that group's rate of intentional injuries. In terms of between race injury comparisons, among Black children the relative risk of an unintentional injury was 1.6 times greater than for White children (95% CI [1.21, 1.99)] and the rate of intentional injury was 5.5 times the White rate (RR: 1.56, 95% CI [3.57, 8.34]. The rates of Hispanic unintentional and intentional fatal injuries were not statistically different from those of White children. Asian/PI children faced a reduced risk of unintentional injury death (RR: 0.59, 95% CI [0.43, 0.78]), but a statistically comparable rate of intentional injury deaths when compared to White children.

The rate of unintentional injury death for children born to mothers 24 or younger in age was 54.1 per 100,000 children born versus 32.5 per 100,000 among children born to mothers 25 or older (RR: 1.66, 95% CI [1.45, 1.91]). The death disparity between children based on this maternal age stratification was more pronounced for intentional injuries: the rate of intentional injury deaths among children born to the younger mother group was 3.5 times as great as the rate born to the 25 and older mother group (RR: 3.47, 95% CI [2.60, 4.65]). Children born to mothers with a high school degree or less faced an unintentional injury fatality risk that was 1.8 times the rate of children born to mothers with some college education or more (RR: 1.81, 95% CI [1.56, 2.12]) and an intentional injury fatality risk was 2.5 times greater (RR: 2.48, 95% CI [1.76, 3.57]).

Children for whom no father was listed on the birth record faced the greatest unadjusted rate of intentional injury death (43.7 per 100,000). This rate of fatal intentional injuries was almost 6 times higher than was true for children with an identified father (RR: 5.88, 95% CI [4.32, 7.91]). The disparity between children with and without fathers listed on the birth record was present but less pronounced among victims of fatal unintentional injuries (RR: 1.60, 95% CI [1.27, 1.99]). Falling second or higher in the birth order proved a risk factor for an unintentional injury death (RR: 1.64, 95% CI [1.41, 1.91]), but not for an intentional injury death.

Table 15. Cumulative injury death rates during the first five years of life, *by manner of death*

	Injury Deaths			Unintentional Injury Deaths			Intentional Injury Deaths		
	per 100,000	*Crude RR*	*(95% CI)*	*per 100,000*	*Crude RR*	*(95% CI)*	*per 100,000*	*Crude RR*	*(95% CI)*
Full Population [1]	51.8	--	--	39.8	--	--	10.0	--	--
Maltreatment									
allegation	81.1	1.72	(1.49, 1.99)	53.8	1.43	(1.20, 1.71)	25.5	3.19	(2.36, 4.26)
no report	47.0	--	--	37.5	--	--	7.7	--	--
Sex									
male	60.3	1.41	(1.25, 1.59)	47.7	1.51	(1.32, 1.75)	10.8	1.18	n.s.
female	42.8	--	--	31.5	--	--	9.2	--	--
Health									
risk present	83.2	1.73	(1.46, 2.03)	55.3	1.46	(1.19, 1.77)	23.7	2.79	(2.00, 3.85)
none	48.2	--	--	38.0	--	--	8.5	--	--
Birth Coverage									
medi-cal	67.7	1.75	(1.55, 1.98)	50.4	1.58	(1.38, 1.81)	14.8	2.70	(1.99, 3.67)
other	38.7	--	--	31.9	--	--	5.5	--	--
Maternal Race/Ethnicity									
black	110.3	2.19	(1.79, 2.67)	65.0	1.56	(1.21, 1.99)	37.0	5.46	(3.57, 8.34)
white	50.3	--	--	41.7	--	--	6.8	--	--
hispanic	49.2	0.98	n.s.	38.4	0.92	n.s.	9.5	1.40	n.s.
asian/pi	31.9	0.64	(0.49, 0.82)	24.5	0.59	(0.43, 0.78)	5.8	0.86	n.s.
Maternal Age at Birth									
<=24 yrs	63.3	1.90	(1.69, 2.15)	54.1	1.66	(1.45, 1.91)	19.0	3.47	(2.60, 4.65)
25yrs+	33.3	--	--	32.5	--	--	5.5	--	--
Maternal Education									
hs or less	63.6	1.90	(1.66, 2.19)	26.9	1.81	(1.56, 2.12)	12.4	2.48	(1.76, 3.57)
some college+	33.3	--	--	48.8	--	--	5.0	--	--
Father Information									
missing	110.0	2.33	(1.96, 2.75)	61.0	1.60	(1.27, 1.99)	43.7	5.88	(4.32, 7.91)
recorded	47.3	--	--	38.1	--	--	7.4	--	--
Birth Order									
second or higher	57.5	1.42	(1.24, 1.62)	46.8	1.64	(1.41, 1.91)	8.7	0.84	n.s.
first born	40.4	--	--	28.6	--	--	10.4	--	--

1. Reported rates reflect data from the 1999-2002 birth cohorts because death observations were censored for children born after 2003.

2.2.4 Cumulative Incidence of Injury Deaths Compared to Other Death Types

Although a majority of all child deaths occur during the neonatal period, as children age the threat posed by injuries is magnified. This is highlighted in Table 16 which tabulates cumulative child injury death rates through the age of five (also reported in Table 15), along with child death rates from Sudden Infant Death Syndrome (SIDS), disease, and cancer, by birth characteristics.

Table 16. Cumulative death rates during the first five years of life, *by type of death*

	Injury Deaths	SIDS Deaths	Cancer Deaths	Disease Deaths
	per 100,000	*per 100,000*	*per 100,000*	*per 100,000*
Full Population [1]	51.8	36.7	14.1	88.7
Sex				
male	60.3	42.3	14.8	96.6
female	42.8	30.8	13.3	80.4
Health				
risk present	83.2	79.0	34.4	440.6
none	48.2	31.9	11.8	48.8
Birth Coverage				
medi-cal	67.7	48.6	12.8	105.6
other	38.7	27.7	15.0	75.5
Maternal Race/Ethnicity				
black	110.3	109.5	18.9	183.5
white	50.3	43.7	14.0	72.6
hispanic	49.2	23.5	13.4	86.4
asian/pi	31.9	31.1	14.9	86.3
Maternal Age at Birth				
<=24 yrs	63.3	56.4	14.7	102.9
25yrs+	33.3	26.7	13.8	81.5
Maternal Education				
hs or less	63.6	43.1	14.3	100.2
some college+	33.3	27.2	13.6	69.4
Father Information				
missing	110.0	80.9	13.9	137.2
recorded	47.3	33.3	14.1	84.9
Birth Order				
second or higher	57.5	40.3	14.1	95.0
first born	40.4	30.3	13.9	76.8

1. Reported rates reflect data from the 1999-2002 birth cohorts since death observations were censored for children born after 2003 and beyond.

2.4 Fatally Injured Children with Prior (non-fatal) CPS Contact

Of the 1,917 children who died from an injury, 396 (20.7%) were identified as having been previously reported to child protective services for non-fatal maltreatment. Among the 381 deceased children whose injury death was declared intentional, 126 (33.1%) were found to have been previously reported to child protective services. 248 of the 1,438 children who died from what was deemed an unintentional injury had a prior allegation of maltreatment (17.3%). These numbers fall within the fairly wide range of cross-sectional estimates of intentional injury victims with prior child protective service contact, but the proportions reported here should be considered fairly conservative estimates of the fraction of children in which some protective action might have been taken.[22,225-228] This analysis reports only whether a given child had been

previously included in an allegation of maltreatment made to CPS. As such, it fails to capture family-level contacts that may have involved older siblings prior to the birth of the deceased child.

2.5 Fatally Injured Children Reported to CPS after Injury Event or Death

In addition to the 396 children who were reported to CPS prior to their death, there were 591 children dying from an injury who were first reported to CPS on or after either the date of injury event or date of death. This means that a full 51.4% of all fatal injury victims under the age of five either had a prior, non-fatal CPS record, or died from injuries in which the circumstances of the injury event were deemed suspicious enough to warrant a report to child protective services after the child's death. Considered only in the context of intentional injury deaths, 300 out of 381 (78.7%) victims were reported to CPS. And even among those victims of what was ultimately declared an unintentional injury, 43.0% were reported at some point either pre- or post-mortem.

3. Multivariate Models

Section 3 is devoted to the presentation of results arising from multivariate models specified to answer the three research questions first outlined in Chapter 1. To answer these three questions, a series of multivariate Extended Cox Models, also known as Cox Regression Models, were specified. The decision to employ this class of models was driven by the censored nature of these data (i.e., later birth cohorts were right censored as CPS records and death records were not available through the full first five years of life) and the time-dependent nature of a child's first referral to child protective services during the study window (i.e., a child may have been reported at birth, or not until the age of four). Background for the modeling decisions that were made is described in Section 3.1 along with additional details about the form of the final model. This is followed by three sections devoted to the presentation of the results emerging from models for each of the three research questions.

3.1 Analysis

The association between a prior, non-fatal maltreatment allegation and injury mortality were estimated using survival regression techniques. Both unadjusted (focused only on the nature and association of CPS contact) and adjusted models (with baseline covariates) were specified. In all models, CPS contact was entered into the analysis as a time-varying covariate coded 0 before the first report was received and 1 after the allegation of maltreatment was made. Also, for all three questions, separate models were estimated for overall risk of injury death, risk of unintentional injury death, and risk of intentional injury death.

3.1.1 The Model

In a traditional Cox Proportional Hazard Model, a baseline hazard (h_0) is specified as a function of time (t) and the assumption is made that the covariates multiplicatively shift this baseline function, maintaining proportionality.[229] The vector of covariates ($\boldsymbol{x}$), estimated as $\boldsymbol{\beta_x}$ is not modeled as a function of time and all covariates are therefore treated as "time-invariant". In the below model, $h(\mathrm{t}|\boldsymbol{x})$ is the hazard rate of injury death for children with covariate vector $\boldsymbol{x}$.

$$h(\mathrm{t}|\boldsymbol{x}) = h_0\,(t)\exp[\boldsymbol{x}\boldsymbol{\beta}_x]$$

In this analysis, the above proportional hazard models is appropriate for sociodemographic control variables as these covariates were all captured at birth and remain stable over time (e.g., *sex, race, maternal age at birth*). Yet, the main independent variable of interest – a first report to child protective services – is inherently time-dependent or time-varying. CPS contact varies with time in the sense that a child's status may change (*from 0, no CPS contact, to 1, prior CPS contact*) between the time that child became at risk of injury death (*on the day of birth*) and the time at which the child experiences the event of interest (*injury death*) or is censored (*non-injury death or end of the study window*). In order for CPS contact to be modeled as a function of time (*t*), an Extended Cox Model was utilized. In the model shown below, $h(\mathrm{t}|\boldsymbol{x}(t))$ is the hazard rate of injury death for children with covariate vector $\boldsymbol{x}$ at time (*t*).

$$h(\mathrm{t}|\boldsymbol{x}(t)) = h_0\,(t)\exp[\boldsymbol{x}(t)\boldsymbol{\beta}_x]$$

Using the Extended Cox Model, CPS contact was specified as a time-varying variable as follows:

$$x(t) = \begin{cases} 0\text{: if no CPS contact} \\ 1\text{: if CPS contact by time } t \end{cases}$$

Under this specification, an individual child was included in the overall risk set of children who had not been reported to child protective services (*cps=0*) until the exact moment (*t*) at which an allegation of maltreatment was recorded and their coding of CPS changed (*cps=1*). To code CPS as time-varying, the stsplit command was implemented in Stata. Time was measured in days.

Because the likelihood that a child sustains a fatal injury during the first five years of life is correlated with a variety of child, maternal, and household characteristics that affect mortality, the association between CPS and injury mortality was estimated after adjusting for the effects of these identified risk and confounding factors. As described in Chapter 3, these factors were all captured in the birth record and included child's sex (*male vs. female*), child's health (*health risk present vs. none*), family poverty (*medi-cal coverage vs. other*), race/ethnicity (*black vs. white, hispanic vs. white, asian/pi vs. white*), maternal age at birth (*<=24 years vs. 25 years+*), maternal education at birth (*<=high school vs. some college+*), a father identified on the birth record (*missing vs. recorded*), and birth order (*second or higher vs. first born*).

3.1.2. Additional Modeling Notes

Death is in many ways a classic example of a competing risk event: every child in this study was at risk of more than one mutually exclusive death events. A child who dies of disease, might have died from an injury had death from disease not struck first. But the occurrence of the first event (death from disease) removes the child from risk of the other event (death from injury). As such, competing-risks survival regression models were also specified using Stata's stccreg command.[230] The parameter estimates produced from these models, however, were almost identical to those derived from the Cox model (suggesting that deaths from other causes after a referral to CPS do not significantly bias risk estimates) and the decision was made to use the model that would be more familiar to most readers.

Race by poverty, maternal age by poverty, and maternal education by poverty interactions were tested based on prior analyses of these data in which Medi-Cal coverage at birth was found to interact with several other variables when a referral to CPS was modeled as the dependent variable.[216] However, none proved significant in the context of the analyses reported here. Time zero was recorded as the date of birth as listed on the birth record. Observations for each child were coded as censored upon non-injury death (or other forms of injury death in the models restricted to a specific manner of injury death), a child's fifth birthday, or the end of the study window. Robust standard error adjustments were made for all models to account for the possibility of non-independent observations. Results are presented as hazard ratios (HR) with 95% confidence intervals (95% CI).

3.2 Research Question 1

The first research question sought to examine whether a prior allegation of non-fatal maltreatment was associated with a heightened risk of injury death, after adjusting for baseline characteristics at birth. As described above, a referral to CPS was modeled as a time-varying variable (a function of time (*t*)) while 10 additional sociodemographic indicators were included as time-invariant baseline variables. The fully specified model used to answer Question 1 follows:

$$h(t|cps(t), \boldsymbol{x}) = h_0(t) \exp[\beta_1 cps(t) + \beta_2 male + \beta_3 health\ risk + \beta_4 medi\_cal + \beta_5 young\ mom + \beta_6 low\ education + \beta_7 no\ paternity + \beta_8 later\ born + \beta_9 black + \beta_{10} hispanic + \beta_{11} asian/pi]$$

Using this specification, six models are reported below (models 1.1-1.6). Model 1.1 captures *all injury fatalities* (all manners, all mechanisms) as the dependent variable and includes a time-varying measure of CPS contact as the only independent variable (*cps(t)*); model 1.2 includes the 10 baseline covariates listed above. Models 1.3 and 1.4 also model the unadjusted and adjusted associations between CPS contact and injury death, but with *unintentional* injuries as the dependent variable. Likewise, models 1.5 and 1.6 reflect the unadjusted and adjusted associations between CPS contact and an *intentional* injury fatality.

3.2.1 All Manners of Injury Death (models 1.1 and 1.2)

Children with a prior allegation of maltreatment died from fatal injuries at over 4 times the rate of their non-reported peers (HR: 4.14, 95% CI [3.68, 4.65]). After adjusting for baseline child and family characteristics, children with a prior allegation of abuse or neglect were found to die of injuries at a rate 2.6 times greater than that observed for non-reported children (HR: 2.60, 95% CI [2.28, 3.98]). All covariates included as baseline variables were also associated with an increased risk of injury death and were directionally consistent with earlier reported crude risk ratios.

The stratification of the dependent variable by the injury's coding as "unintentional" versus "intentional" led to hazard ratios that were (for the most part) directionally consistent with those reported for all injuries. It should be noted that cell size constraints resulted in several covariates emerging as statistically insignificant in the model for intentional injuries – despite fairly large hazard ratio estimates. Although these estimates are subject to a greater degree of variability and

instability, the absence of significance should be viewed as a signal of reduced power rather than an absence of association.

3.2.2 Unintentional Injury Deaths (models 1.3 and 1.4)
When the dependent variable was restricted to only those injury deaths in which the manner or intent was coded as unintentional, prior CPS contact was associated with a three-fold greater risk of injury death (HR: 3.02, 95% CI [2.62, 3.47]). After controlling for demographic factors, children reported to CPS died from unintentional injuries at twice the rate of those who were not reported (HR: 2.02, 95% CI [1.72, 2.36]).

Since unintentional injuries accounted for a majority of all injury deaths, very modest changes were observed in the associations across covariates when unintentional injury fatality risk was modeled. The already weak association between Medi-Cal coverage at birth and overall injury risk was no longer significant in the unintentional injury model, despite a negligible change in the magnitude of the estimated hazard ratio (HR: 1.14; 95% CI [0.99, 1.30]). The absence of an identified father on the birth record was associated with a 37% higher rate of overall injury death in model 1.2 (HR: 1.37, 95% CI [1.19, 1.58), an association that weakened when only unintentional injuries were modeled. Likewise, Black children faced a higher rate of overall injury death than White children (HR: 1.36; 95% CI [1.16, 1.59]), but did not face a significantly higher rate of fatal injuries coded as unintentional (HR: 1.08, 95% CI [0.88, 1.31]).

3.2.3 Intentional Injury Deaths (models 1.5 and 1.6)
An examination of only those fatal injuries that were deemed intentional in nature produced the strongest estimated association between prior CPS contact and injury death. Children with a prior report to child protective services died from intentional injuries at 10 times the rate observed for the overall child population (HR: 10.42; 95% CI [8.26, 13.14]). After controlling for sociodemographic differences between those children who were reported to CPS and the general population, a prior allegation of maltreatment was still associated with a rate of assault-related and other intentional injuries that was nearly six times that of unreported children (HR: 5.86; 95% CI [4.39, 7.81]).

Several notable shifts in the magnitude of covariate associations were observed between the fully specified unintentional injury model and the fully specified intentional injury model. These results, however, should be interpreted cautiously as the smaller count of intentional injury victims led to a reduced power to detect associations. The absence of an association between an identified father on the birth record and an unintentional injury fatality emerged as a statistically significant risk factor for an intentional injury death (HR: 2.08; 95% CI [1.58, 2.75]). Meanwhile, falling second or higher in the birth order– a variable significantly associated with unintentional injury deaths (HR: 1.82, 95% CI [1.61, 2.06])– was more weakly associated with intentional injury fatalities (HR: 1.11, 95% CI [0.88, 1.40]).

Although children born to mothers who were age 24 or younger at birth died from unintentional injuries at 1.7 times the rate of children born to mothers who were 25 or older (HR: 1.67, 95% CI [1.48, 1.89]), the maternal age disparity jumped to 3.3 when only intentional injuries were considered (HR: 3.28, 95% CI [2.52, 4.27]). Black children did not face a statistically significant greater rate of unintentional injury death than White children, but died of intentional injuries at

2.7 times the rate of their White counterparts (95% CI [1.93, 3.84]). Hispanic and Asian/PI children who were observed to die of unintentional injuries at lower rates than White children had statistically comparable rates of intentional injury deaths.

3.2.2 Summary

These data produced strong empirical support for the hypothesized association between a prior allegation of maltreatment and a heightened risk of subsequent injury death. In the fully adjusted model, an earlier report to child protective services emerged as the strongest predictor of all manners of injury death during the first five years of life. In the (adjusted) unintentional injury model, a prior allegation of maltreatment was identified as the single greatest risk factor for an accidental injury death during the first five years of life. Finally, even after adjusting for characteristics placing a child at heightened risk of an intentional injury fatality, children with child protective services history died at a rate that was over five times greater than non-reported children.

Table 17. Models for Question 1: Hazard ratios and 95% confidence intervals

	All Injury Deaths				Unintentional Injury Deaths				Intentional Injury Deaths			
	model 1.1		*model 1.2*		*model 1.3*		*model 1.4*		*model 1.5*		*model 1.6*	
Parameter: Variable	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*
time-varying												
$\beta_1(t)$: Prior CPS Report	4.14***	(3.68, 4.65)	2.60***	(2.28, 2.98)	3.02***	(2.62, 3.47)	2.02***	(1.72, 2.36)	10.42***	(8.26, 13.14)	5.86***	(4.39, 7.81)
baseline												
β_2 : Male			1.35***	(1.23, 1.49)			1.39***	(1.25, 1.55)			1.30*	(1.05, 1.62)
β_3 : Health Risk			1.39***	(1.22, 1.59)			1.33***	(1.13, 1.55)			1.53**	(1.15, 2.03)
β_4 : Medi-Cal Coverage			1.16**	(1.03, 1.30)			1.14	(0.99, 1.30)			1.04	(0.80, 1.36)
β_5 : Young Mom			1.86***	(1.67, 2.06)			1.67***	(1.48, 1.89)			3.28***	(2.52, 4.27)
β_6 : Low Maternal Education			1.46***	(1.28, 1.66)			1.51***	(1.31, 1.74)			1.38*	(1.01, 1.89)
β_7 : No Identified Father			1.37***	(1.19, 1.58)			1.17	(0.98, 1.40)			2.08***	(1.58, 2.75)
β_8 : Second or Higher in Birth Order			1.65***	(1.48, 1.83)			1.82***	(1.61, 2.06)			1.11	(0.88, 1.40)
β_9 : Black (*vs. White*)			1.36***	(1.16, 1.59)			1.08	(0.88, 1.31)			2.72***	(1.93, 3.84)
β_{10} : Hispanic (*vs. White*)			0.66***	(0.59, 0.75)			0.62***	(0.53, 0.70)			1.09	(0.80, 1.49)
β_{11} : Asian/PI (*vs. White*)			0.74**	(0.61, 0.90)			0.65***	(0.52, 0.81)			1.23	(0.83, 2.12)

*** p<.001
**p<.01
*p<.05

3.3 Research Question 2

The second research question addressed possible variations in the observed association between a maltreatment referral and injury death across allegation dispositions, given characteristics of the child and family at birth. Children with multiple allegations of maltreatment (either within a given referral received by CPS, or sequentially over time) were coded based on the most severe disposition received before the age of five (based on the earlier described severity hierarchy). Allegation dispositions were modeled as interactions with the time-varying indicator variable for a *first report* to child protective services: 1) *cps(t)*evaluated out*; 2) *cps(t)*unfounded*; 3) *cps(t)*inconclusive*; and 4) *cps(t)*substantiated*. This served to create four mutually exclusive dispositional groups, each of which could then be referenced to the general population of children who were not reported to CPS before the age of five. It should be noted that these variables were time-varying based on a *first report* to CPS and no attempts were made to make additional adjustments for sequential dispositions of maltreatment stemming from multiple allegations.

In addition to the disposition, an interaction between the indicator for *first* CPS contact and whether or not the child was ever placed in an out-of-home foster care was also included: *cps(t)*out-of-home placement*. Using the linear combination of this latter interaction and the interaction between CPS contact and allegation disposition produced unique hazard ratio estimates for children based on whether or not they were placed in foster care. Since over 95% of children who spent time in foster care were placed only after a substantiated allegation of maltreatment, placement-stratified hazard ratios are only reported for this disposition type (all others combinations of disposition by placement were insignificant). The fully specified model used to answer Question 2 follows:

$$\begin{aligned} h(t|cps(t),\boldsymbol{x}) = h_0(t)\exp[&\beta_1 cps(t) * evaluated\ out + \beta_2 cps(t) * unfounded \\ &+\beta_3 cps(t) * inconclusive + \beta_4 cps(t) * substantiated * placement \\ &+\beta_5 cps(t) * substantiated * no\ placement + \beta_6 male + \beta_7 health\ risk \\ &+\beta_8 medi\_cal + \beta_9 young\ mom + \beta_{10} low\ education + \beta_{11} no\ paternity \\ &+\beta_{12} later\ born + \beta_{13} black + \beta_{14} hispanic + \beta_{15} asian/pi] \end{aligned}$$

As was the case for Question 1, six separate models were specified. Models 2.1 and 2.2 reflect the unadjusted and adjusted associations between the disposition of the most severe, non-fatal allegation of maltreatment received and *all manners of injury death*. Models 2.3 and 2.4 report unadjusted and adjusted associations between allegation disposition and *unintentional injury fatality risk*. Finally, models 2.5 and 2.6 are used to examine associations between the disposition assigned to a prior allegation and intentional injury fatality risk.

3.3.1 All Manners of Injury Death (models 2.1 and 2.2)

In the unadjusted model, children with an evaluated out allegation of maltreatment were observed to die at a rate that was over 3.5 times greater than children who had never been reported to CPS (HR: 3.52, 95% CI [2.33, 5.33]). This injury death rate for children evaluated out by the child welfare system was statistically equivalent to the injury death rates observed for reported children who had received an in-person investigation that was unfounded or inconclusive ($\chi^2(2)=0.16$, $p=.92$). After adjusting for baseline birth covariates, the rate of injury

death among children who had been evaluated out without receiving a CPS investigation was 2.5 times that of unreported children (HR 2.49, 95% CI [1.62, 3.81]). As was true in the unadjusted model, this adjusted rate of injury death among evaluated out children was statistically equivalent to the injury death rates observed for children whose allegations had received investigations that were unfounded or inconclusive ($\chi^2(2)=0.66$, $p=.71$).

Children with a substantiated allegation of maltreatment (and no placement in foster care) faced a rate of injury death that was over 5.5 times that of unreported children in the general population (HR: 5.67; 95% CI [4.88, 6.56]). After adjusting for baseline risk factors (model 2.2), children with a prior substantiated allegation of maltreatment (and no foster care placement history) were found to die from injuries at a rate that was over 3 times that of unreported children (HR: 3.40; 95% CI [2.87, 4.03]).

Among children with a substantiated allegation of maltreatment who spent at least one day in out-of-home foster care, the adjusted rate of injury death was slightly elevated, but statistically comparable, to unreported demographic counterparts in the overall birth cohort (HR: 1.38, 95% CI [0.87, 2.19]). When compared with other reported children whose allegations were either not investigated, or investigated but not substantiated, substantiated children who *were not placed in foster care* faced a greater risk of injury death, after adjusting for other risk factors ($\chi^2(3)=16.57$, $p<.001$). In contrast, substantiated children who experienced what *proved a protective experience in foster care* sustained fatal injuries at a rate that statistically comparable to children with an unsubstantiated allegation ($\chi^2(3)=4.34$, $p<.22$) and lower than substantiated children not placed in foster care ($\chi^2(1)=14.1$, $p<.001$) after adjusting for other factors.

All baseline covariates included as controls for risk factors present at birth were significant and matched the estimated associations reported in the model for overall CPS contact and all manners of injury death (model 1.2).

3.3.2 Unintentional Injury Deaths (models 2.3 and 2.4)

When only unintentional injuries were modeled, children whose prior allegation of maltreatment was evaluated out were observed to die from "accidental" injuries at over three times the rate of the general child population (HR: 3.36; 95% CI [2.13, 5.30]) and almost 2.5 times the rate of socio-demographically similar children who had not been reported (HR: 2.45; 95% CI [1.53, 3.93]). Children whose prior allegation was investigated, but unfounded, sustained fatal injuries at 3 times the rate of all unreported children (HR: 3.00; 95% CI [2.31, 3.89]) and twice the rate of unreported children with similar characteristics at birth (HR: 2.20; 95% CI [1.68 2.87]). Among children with a prior inconclusive allegation of maltreatment, rates of unintentional injury death were roughly 3 times higher than unreported children before adjusting for covariates at birth (HR: 2.87; 95% CI [2.16, 3.81]). After covariate adjustments were made, a prior inconclusive allegation continued to be associated with a heightened rate of unintentional injury death (HR: 1.91; 95% CI [1.42, 2.58]).

For those children who had been identified as victims of abuse or neglect (i.e., a substantiated disposition), but did not receive any out-of-home foster care services, the unadjusted rate of injury death was over 3.3 times that of unreported children (HR: 3.33; 95% CI [2.73, 4.08]) and the adjusted rate of unintentional injury death was twice as high as unreported children (HR:

2.12; 95% CI [1.69, 2.65]). These children also had an adjusted rate of unintentional injury death that was statistically comparable to children with other, unsubstantiated or evaluated out dispositions ($\chi^2(3)=3.70, p=.29$). Yet, among children whose allegation of maltreatment was substantiated and, as a result, a placement in foster care followed, the risk of accidental death was estimated to be equivalent to that observed among unreported children, after adjusting for other risk factors (HR: 1.00; 95% CI [0.55, 1.84]). This group also had a rate of accidental death that was lower than the group of children with a substantiated allegation who were not placed in foster care ($\chi^2(1)=5.44, p=.02$).

Baseline covariates in the unintentional injury models displayed shifts in magnitude (away from the all injury model) that were comparable to those observed in the unintentional injury model reported without dispositional stratifications.

3.3.3 Intentional Injury Deaths (models 2.5 and 2.6)
Models 2.5 and 2.6 were used to examine associations between the disposition of a prior allegation of maltreatment and risk of a subsequent intentional injury death. In the unadjusted model, children who were evaluated out died of intentional injuries at over 3.5 times the rate of unreported children in the general population (HR: 3.71, 95% CI [1.18, 11.63]); children with an unfounded allegation died at over 4 times the rate of unreported children (HR: 4.23, 95% CI [2.37, 7.56]); and children with an inconclusive allegation were also fatally and intentionally injured at over 4 times the rate of unreported children (HR: 4.38, 95% CI [2.37, 8.08]). There were no statistically significant differences in risk of intentional injuries across these three unsubstantiated disposition types ($\chi^2(2)=0.07, p=.96$).

A parallel picture emerged after adjustments were made for risk factors present at birth. Children who had a prior allegation evaluated out without an investigation died from intentional injuries at over two times the rate of sociodemographically similar children who had never been reported (although this hazard ratio was almost identical to that computed for children with inconclusive and unfounded allegations, and the hazard ratio estimated for unintentional injuries, small cell sizes led to a large confidence interval (95% CI [0.78, 7.71]) and this difference did not achieve statistical significance). Children whose prior allegation received an unfounded disposition died from fatal, intentionally inflicted injuries at over two and a half times the rate of unreported children with similar characteristics at birth (HR: 2.65; 95% CI [1.43, 4.91]). And among children with an inconclusive disposition, the rate of intentional injury death was roughly 2.7 times that of unreported, demographic peers (HR: 2.69; 95% CI [1.43, 5.09]). As was true in the unadjusted model, although the rates of intentional injury deaths were elevated across all unsubstantiated disposition types when compared to unreported but demographically similar children, there were no differences in the inflicted injury death rates of children with an allegation that had been previously evaluated out, unfounded, or deemed inconclusive ($\chi^2(2)=0.02, p=.99$).

Children with a prior substantiated allegation of maltreatment (*and no foster care placement*) were observed to die from intentional injuries at over 18 times the rate of the general population of children born in California (HR: 18.45; 95% CI [14.35, 23.71]). Among substantiated children who spent *at least one day in foster care*, the rate of intentional injuries was significantly lower, falling to roughly one third the rate observed among children who had never been placed

($\chi^2(1)=7.71, p=.007$). Although foster care history was protective (even in the crude form it was measured in this analysis), children with a substantiation and placement history still died of intentional injuries at almost 7 times the rate of children who were never reported (HR: 6.87; 95% CI [3.40, 13.86]).

In the model with adjustments made for baseline differences in child and family characteristics at the time of birth, previously identified victims of child maltreatment with no foster care history were found to die from intentional injuries at 10 times the rate of unreported children (HR: 10.38; 95% CI [7.55, 14.27]) and at rates that were higher than children with unsubstantiated dispositions ($\chi^2(3)=35.5, p<.001$). Children who had spent time in foster care died at 3.5 times the rate of unreported children, after adjusting for other risk factors (HR: 3.45; 95% CI [1.57, 7.57]), but this rate was significantly lower than substantiated children without a placement history ($\chi^2(1)=7.80, p=.005$) and statistically equivalent to unsubstantiated children ($\chi^2(3)=0.39, p=.94$).

Overall, estimated hazard ratios for baseline covariates were directionally consistent with those reported for unintentional injury deaths modeled in the context of allegation dispositions. Notable were the stronger associations observed between an injury fatality coded as intentionally inflicted and young maternal age (HR: 3.32; 95% CI [2.56, 4.31]); an absence of paternity information (HR: 2.00; 95% CI [1.50, 2.64]); and Black race (HR: 2.79; 95% CI [1.98, 3.95]). These same shifts were observed in the models in which CPS contact was not stratified by disposition type. Also detected in these models (as well as earlier models examining any CPS contact) was a notably weaker association between intentional injury death risk and birth order (HR: 1.07; 95% CI [0.85, 1.35]) compared with that reported for unintentional injuries (HR: 1.82; 95% CI [1.61, 2.07]). Finally, although Hispanic and Asian/PI children were found to have lower rates of unintentional injury deaths than White children (models 1.4 and 2.4), in the intentional injury models, Hispanic and Asian/PI children were found to have estimated hazard ratios that, although not statistically significant, suggest an elevated risk when compared to White children (Hispanic HR: 1.12, 95% CI [0.83, 1.53]; Asian/PI HR: 1.35, 95% CI [0.85, 2.16]).

3.3.4 Summary

These data provide evidence that the association between a prior allegation of maltreatment and injury death risk varies with disposition type, specifically a substantiated disposition. Across unadjusted and adjusted models separately specified for all fatal injuries, unintentional fatal injuries, and intentional fatal injuries, no statistically significant differences were identified between the three forms of unsubstantiated dispositions (i.e., evaluated out, unfounded, inconclusive). Differences, however, among children with a substantiated disposition were observed based on whether or not the child was placed in foster care. Among children with a substantiated allegation and a history of placement in foster care, the overall rate of injury death was lower than that observed for substantiated children who were not placed in foster care, and statistically equivalent to children with unsubstantiated dispositions. This same pattern of lower rates of death held across both unintentional injuries and inflicted injuries. For those children who were substantiated, but not placed in foster care, the rate of inflicted injury fatalities was over 10 times that of children with similar risk factors present at birth.

Table 18. Models for Question 2: Hazard ratios and 95% confidence intervals, *by most severe disposition*

	All Injury Deaths				Unintentional Injury Deaths				Intentional Injury Deaths			
	model 2.1		*model 2.2*		*model 2.3*		*model 2.4*		*model 2.5*		*model 2.6*	
Parameter: Variable	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*
time-varying												
$\beta_1(t)$: Evaluated Out	3.52***	(2.33, 5.33)	2.49***	(1.62, 3.81)	3.36***	(2.13, 5.30)	2.45***	(1.53, 3.93)	3.71***	(1.18, 11.63)	2.47	(0.78, 7.75)
$\beta_2(t)$: Unfounded	3.22***	(2.54, 4.06)	2.27***	(1.77, 2.88)	3.00***	(2.31, 3.89)	2.20***	(1.68, 2.87)	4.23***	(2.37, 7.56)	2.65**	(1.43, 4.91)
$\beta_3(t)$: Inconclusive	3.23***	(2.51, 4.15)	2.05***	(1.58, 2.68)	2.87***	(2.16, 3.81)	1.91***	(1.42, 2.58)	4.38***	(2.37, 8.08)	2.69**	(1.43, 5.09)
$\beta_4(t)$: Substantiated (*No Placement*)	5.67***	(4.88, 6.56)	3.40***	(2.87, 4.03)	3.33***	(2.73, 4.08)	2.12***	(1.69, 2.65)	18.45***	(14.35, 23.71)	10.38***	(7.55, 14.27)
$\beta_5(t)$: Substantiated (*Placement*)	2.53***	(1.63, 3.87)	1.38	(0.87, 2.19)	1.72	(0.98, 3.04)	1.00	(0.55, 1.84)	6.87***	(3.40, 13.86)	3.45**	(1.57, 7.57)
baseline												
β_6: Male			1.35***	(1.23, 1.49)			1.39***	(1.25, 1.55)			1.30*	(1.05, 1.62)
β_7: Health Risk			1.38***	(1.21, 1.58)			1.33***	(1.14, 1.56)			1.46*	(1.09, 1.93)
β_8: Medi-Cal Coverage			1.15*	(1.03, 1.30)			1.14	(1.00, 1.30)			1.03	(0.79, 1.34)
β_9: Young Mom			1.86***	(1.67, 2.06)			1.67***	(1.48, 1.88)			3.32***	(2.56, 4.31)
β_{10}: Low Maternal Education			1.45***	(1.28, 1.65)			1.51***	(1.31, 1.75)			1.35	(0.98, 1.86)
β_{11}: No Identified Father			1.37***	(1.18, 1.58)			1.19	(1.00, 1.42)			2.00***	(1.50, 2.64)
β_{12}: Second or Higher in Birth Order			1.64***	(1.48, 1.82)			1.82***	(1.61, 2.07)			1.08	(0.85, 1.35)
β_{13}: Black (*vs. White*)			1.37***	(1.16, 1.60)			1.08	(0.88, 1.31)			2.79***	(1.98, 3.95)
β_{14}: Hispanic (*vs. White*)			0.67***	(0.59, 0.75)			0.61***	0.53, 0.70)			1.12	(0.83, 1.53)
β_{15}: Asian/PI (*vs. White*)			0.74**	(0.61, 0.90)			0.65***	(0.52, 0.80)			1.35	(0.85, 2.16)

*** p<.001

**p<.01

*p<.05

3.4 Research Question 3

The third question addressed in this research surrounded the form or type of alleged maltreatment and its possible association with injury death. The most severe allegation received during the first five years of life was used in this analysis (based on the earlier described allegation severity hierarchy). This served to create four mutually exclusive groups of children reported to child protective services. Each allegation indicator variable was modeled as an interaction with the time-varying indicator of a *first report* to child protective services: 1) *cps(t)*other*; 2) *cps(t)*neglect*; 3) *cps(t)*physical abuse* and 4) *cps(t)*sexual abuse*. The inclusion of these four interaction variables allowed injury fatality risk to be estimated for each allegation type, and referenced to the population of children who not been reported to CPS for maltreatment. It should be noted that these variables were time-varying based on a *first report* to CPS. The fully specified model used to answer Question 3 follows:

$$h(t|cps(t), \boldsymbol{x}) = h_0(t)\exp[\beta_1 cps(t) * other + \beta_2 cps(t) * neglect + \beta_3 cps(t) * physical + \beta_4 cps(t) * sexual + \beta_5 male + \beta_6 health\ risk + \beta_7 medi\_cal + \beta_8 young\ mom + \beta_9 low\ education + \beta_{10} no\ paternity + \beta_{11} later\ born + \beta_{12} black + \beta_{13} hispanic + \beta_{14} asian/pi]$$

Consistent with the presentation of results for Questions 1 and 2 above, six models were specified. Models 3.1 and 3.2 capture the unadjusted and adjusted risk of all manners of injury death for children reported to CPS for reasons of physical abuse, neglect, sexual abuse, or other reasons, compared with children who were not reported for maltreatment before the age of five. Models 3.3 and 3.4 are based on the subset of injury deaths coded as unintentional. Finally, Models 3.5 and 3.6 examine unadjusted and adjusted associations between allegation type and intentional injury fatalities.

3.4.1 All Manners of Injury Death (models 3.1 and 3.2)

In both the unadjusted and adjusted models, all allegation types were associated with a heightened risk of injury. Falling at the low end of the allegation severity hierarchy were children falling in the "other allegation" category which included emotional abuse and at-risk categories, often involving the alleged maltreatment of a sibling. These children were fatally injured at a rate that was 72% greater than the general population (HR: 1.72, 95% CI [1.27, 2.33]) and still elevated, although statistically indistinguishable, to children with similar risk factors at birth (HR: 1.21, 95% CI [0.89, 1.66].

Children with a prior allegation of neglect – which encompassed general neglect, severe neglect, and caretaker incapacity – died of injuries at four times the rate of children in the general population (HR: 4.02, 95% CI [3.50, 4.63]). After adjustments were made for risk factors present at birth, a prior allegation of neglect continued to be associated with increased risk of injury death (HR: 2.43, 95% CI [2.07, 2.85]). An allegation of physical abuse proved to have the strongest crude and adjusted associations with all manners of injury death. Children with a prior report of physical abuse died from an injury before the age of five at over 11.5 times the rate of unreported children in the general population (HR: 11.76, 95% CI [9.59, 14.42]). After adjusting for baseline covariates, a prior allegation of physical abuse was still associated with a rate of injury death that was 7 times that observed among unreported children (HR: 7.39, 95% CI [5.93, 9.20]).

Finally, an earlier allegation of sexual abuse was associated with an injury death rate that was 3.5 times that of the general population (HR: 3.54, 95% CI [1.76, 7.10]) and 2.7 times that of sociodemographically similar children who were not reported for maltreatment (HR: 2.78, 95% CI [1.39, 5.57]). In the fully specified model, no significant differences in the rates of injury death were observed between children reported for neglect when compared with children reported for sexual abuse ($\chi^2(1)=0.14, p=.71$). Children reported for physical abuse sustained fatal injuries at higher rates than children reported for reasons of neglect ($\chi^2(1)=81.0, p<.001$) or sexual abuse ($\chi^2(1)=7.05, p=.007$).

3.4.2 Unintentional Injury Deaths (models 3.3 and 3.4)

Despite the strong association observed between a prior allegation of physical abuse and overall injury death, when the dependent variable was restricted to unintentional injuries, no such elevated risk for children reported for physical abuse was found. In the unadjusted model, children with a prior allegation of physical abuse were observed to die from "accidental" injuries at 2.7 times the rate of unreported children in the general population (HR: 2.68, 95% CI [1.75, 4.10]). After adjusting for child and family characteristics a prior allegation of physical abuse was associated with rate of unintentional injury death that was 1.8 times greater than unreported children (HR: 1.81, 95% CI [1.16, 2.84]).

Among children with a prior report to CPS, a prior allegation of neglect demonstrated the strongest association with subsequent unintentional injury risk in both the unadjusted (HR: 3.69, 95% CI [3.15, 4.32]) and adjusted (HR: 2.38, 95% CI [1.98, 2.85]) models. Although rates of unintentional injury deaths among children previously reported for neglect were elevated relative to unreported children both before and after adjusting for baseline characteristics, rates of unintentional injury death for children with this allegation type were statistically indistinguishable from children reported for sexual abuse ($\chi^2(1)=0.12, p=.73$) or physical abuse ($\chi^2(1)=1.29, p=.25$).

Children reported for other allegations demonstrated a modest increased risk of unintentional injury fatalities compared with the general population of unreported children as reflected in the unadjusted model (HR: 1.65, 95% CI [1.19, 2.30]), but as was true in model 2.2, the introduction of baseline covariates resulted in an estimated hazard ratio of unintentional death that was not statistically different than observed for children who had not been reported to child protective services (HR: 1.23, 95% CI [0.87, 1.73]).

3.4.3 Intentional Injury Deaths (models 3.5 and 3.6)

In both the unadjusted and adjusted models in which the dependent variable was restricted to those injuries deemed intentional, prior allegations of physical abuse, sexual abuse, and neglect were all associated with elevated rates of death. Hazard ratios estimated for a prior allegation stemming from other forms of maltreatment suggested a somewhat heightened risk of intentional death, but small cell sizes prevented a statistically significant determination that rates of death differed from unreported children in either the unadjusted (HR: 2.01, 95% CI [0.90, 4.52]) or the adjusted (HR: 1.16, 95% CI [0.48, 2.83]) models.

Children with prior allegation of physical abuse stood out as the most vulnerable to an intentional injury fatality. Absent any covariate adjustments, these children were observed to die

at over 70 times the rate of children with no prior allegation of maltreatment (HR: 73.65, 95% CI [54.77, 99.04]). After accounting for other risk factors, children previously identified as possible victims of physical abuse were still found to die from injuries at over 35 times the rate of unreported children (HR: 38.49, 95% CI [27.30, 54.27]). These rates of death were notably higher compared with not just children who had not been reported, but also children who were reported for sexual abuse ($\chi^2(1)=6.9, p=.009$), neglect ($\chi^2(1)=150.9, p<.001$), and other maltreatment ($\chi^2(1)=56.1, p<.001$).

In the unadjusted model, children with a prior allegation of sexual abuse were estimated to face a risk of intentional injury death that was 8.5 times that of the general population (HR: 8.54, 95% CI [2.09, 34.91]) and children with a prior allegation of neglect were observed to die from intentional injuries at roughly 5.5 times the rate of the general population (HR: 5.47, 95% CI [3.91, 7.66]). Bound by large confidence intervals, these rates of death were not statistically different from one another ($\chi^2(1)=0.37, p=.54$). In the adjusted model, children who had been reported to child protective services for possible sexual abuse were found to die from intentional injuries at over five times the rate of children who had never been reported for maltreatment (HR: 5.85, 95% CI [1.43, 24.03]) and children reported for neglect sustained fatal injuries coded as intentional in nature at three times the rate of unreported children (HR: 3.06, 95% CI [2.10, 4.46]). Again, the rates of death for children reported for sexual abuse did not differ from those children who had been reported for reasons of neglect ($\chi^2(1)=0.80, p=.37$).

3.4.4 Summary

This analysis provides strong empirical support for hypothesized variability across allegation types and manner of death. Children with a prior allegation of physical abuse were found to have *intentional* injury death rates that were dramatically higher than not only unreported children, but also children reported for reasons of sexual abuse, neglect, or other forms of maltreatment. In contrast, children with a prior allegation of neglect were observed to die from *unintentional* injuries at rates that were slightly elevated when compared to children with prior allegations of physical abuse, sexual abuse, or other maltreatment, although these differences were not statistically significant. Across manner of death stratifications, children with a prior allegation falling in the "other allegation" category died at rates that were not statistically different than unreported children after covariate adjustments were made. Although confidence intervals were large because of low rates of sexual abuse allegations, these data suggest that a prior allegation of sexual abuse is associated with heightened injury fatality risk.

Table 19. Models for Question 3: Hazard ratios and 95% confidence intervals, *by most severe allegation*

	All Injury Deaths				Unintentional Injury Deaths				Intentional Injury Deaths			
	model 3.1		*model 3.2*		*model 3.3*		*model 3.4*		*model 3.5*		*model 3.6*	
Parameter: Variable	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*
time-varying												
$\beta_1(t)$: Sexual Abuse Allegation	3.54***	(1.76, 7.10)	2.78**	(1.39, 5.57)	2.44*	(1.01, 5.87)	2.03	(0.85, 4.88)	8.54**	(2.09, 34.91)	5.85*	(1.43, 24.03)
$\beta_2(t)$: Physical Abuse Allegation	11.76***	(9.59, 14.42)	7.39***	(5.93, 9.20)	2.68***	(1.75, 4.10)	1.81**	(1.16, 2.84)	73.65***	(54.77, 99.04)	38.49***	(27.30, 54.27)
$\beta_3(t)$: Neglect Allegation	4.02***	(3.50, 4.63)	2.43***	(2.07, 2.85)	3.69***	(3.15, 4.32)	2.38***	(1.98, 2.85)	5.47***	(3.91, 7.66)	3.06***	(2.10, 4.46)
$\beta_4(t)$: Other Allegation	1.72***	(1.27, 2.33)	1.21	(0.89, 1.66)	1.65**	(1.19, 2.30)	1.23	(0.87, 1.73)	2.01	(0.90, 4.52)	1.16	(0.48, 2.83)
baseline												
β_5: Male			1.35***	(1.23, 1.48)			1.39***	(1.25, 1.55)			1.28*	(1.02, 1.59)
β_6: Health Risk			1.40***	(1.22, 1.59)			1.31**	(1.12, 1.53)			1.62**	(1.22, 2.15)
β_7: Medi-Cal Coverage			1.16*	(1.03, 1.30)			1.13	(0.99, 1.29)			1.06	(0.81, 1.38)
β_8: Young Mom			1.84***	(1.66, 2.04)			1.67***	(1.48, 1.89)			3.14***	(2.40, 4.11)
β_9: Low Maternal Education			1.46***	(1.28, 1.66)			1.50***	(1.30, 1.73)			1.40*	(1.02, 1.93)
β_{10}: No Identified Father			1.38***	(1.19, 1.59)			1.15	(0.96, 1.38)			2.21***	(1.68, 2.91)
β_{11}: Second or Higher in Birth Order			1.67***	(1.50, 1.85)			1.82***	(1.60, 2.06)			1.19	(0.94, 1.49)
β_{12}: Black (*vs. White*)			1.35***	(1.15, 1.58)			1.08	(0.89, 1.31)			2.64***	(1.86, 3.73)
β_{13}: Hispanic (*vs. White*)			0.67***	(0.59, 0.75)			0.62***	(0.54, 0.71)			1.08	(0.79, 1.48)
β_{14}: Asian/PI (*vs. White*)			0.74**	(0.61, 0.90)			0.65***	(0.52, 0.81)			1.32	(0.82, 2.10)

*** p<.001

**p<.01

*p<.05

4. Summary

This chapter reports empirical findings arising from the linked dataset that was constructed for this analysis. Based on these linkages, over 4.3 million children born in California between 1999 and 2006 were described based on their characteristics on the day they were born, with cohort trends in the presence of risk and protective factors examined. Among these 4.3 million children, were over 500,000 who were reported to child protective services before the age of five. The characteristics of these children were also examined on the day of birth and considered in the context of the broader child population and trends over time. Stratifications based on allegation type and allegation disposition were used to further describe this subset of children. Also detailed were the 25,000 children who died before the age of five, a majority of whom died during the neonatal period. An examination of the birth characteristics of these children highlights the extent to which these children faced significant health risk factors stemming from the perinatal period. Children sustaining fatal injuries were treated as a class of children for whom death was highly preventable and were described based on characteristics at birth, a prior history of child protective services contact, as well as the manner and mechanism of the injury death. Descriptive analyses are followed by a series of multivariate Extended Cox Regression models. These models were employed to assess whether or not a prior allegation of maltreatment was independently associated with subsequent risk of injury death, after controlling for risk factors present at birth and "time" as another potential confound. Results from these models are presented along with the three research questions that served to organize this dissertation.

CHAPTER 5
DISCUSSION

When a child dies after an allegation of maltreatment to child protective services (CPS) public outcries are quick to follow: the system tasked with responding to child abuse and neglect was informed a child was at risk, and yet failed to intervene in a manner ensuring the child was thereafter protected from harm. In an effort to learn from these tragic cases, Child Death Review Teams across the United States compile data to identify child deaths patterns and clusters, examine possibly flawed decisions made by CPS and other systems, summarize the characteristics of fatally injured children, and make policy and practice recommendations.[231] Yet, the scrutiny of individual decisions made for isolated cases provides limited insights absent a broader context. Looking only at a selected group of children who have already experienced the outcome of interest (death following CPS contact) fails to inform our understanding of how the experiences and characteristics of deceased children fit within the broader population of children who were similarly reported to CPS, *but did not die*. Nor does it allow for these deaths to be understood within the population of demographically similar children who *died despite having never been reported to CPS*. The absence of this epidemiological perspective profoundly limits our ability to make informed modifications to child and family practices or policies in an effort to prevent future deaths.

This dissertation provides the broader population-level context presently missing from child death discussions. Employing a prospective birth cohort study design, this study tracked over 4.3 million children from birth forward, isolating a child's prior report to CPS as the strongest predictor of injury death during infancy and early childhood. Prior to this study, efforts to identify CPS contact as an independent risk factor for injury death had produced contradictory findings, in part because none had possessed the power to fully control for other risk factors.[96,97] Likewise, prior research lacked the power to model unintentional and intentional injury fatalities separately, or to make adjustments for the time-varying nature of a first report to child protective services.[98] This dissertation was able to overcome these earlier limitations and reflects the most rigorous longitudinal analysis of mortality outcomes following an allegation of maltreatment to date.

This fifth and final chapter is organized into six sections. The first section briefly revisits the research conducted. This overview includes a summary of the record linkages underlying the constructed dataset, as well as a review of the research questions posed and the statistical techniques used for data analysis. The second section addresses the limitations of the present study, including its generalizability, study design, scope, and assumptions. Section three highlights the key findings arising from these linked records, including the fit of observed covariate associations within existing literature. Section four undertakes a discussion of the implications of these findings for child welfare practice and policy. Section five considers directions for future research. Finally, the sixth section serves to conclude this dissertation with remarks as to how a public health approach might be fruitfully applied to improve surveillance efforts and the prevention of child maltreatment.

1. Research Overview

1.1 Dataset Construction

This study was based on a unique dataset constructed through probabilistic matches established between vital birth records, administrative child protective service records, and vital death records. A brief summary of the data sources, record linkage methodology, and variables is provided below.

1.1.1. Data Sources

Confidential Birth files were obtained from the California Department of Public Health (CDPH) for the years spanning 1999-2006. These files contained information concerning all live births in California during each calendar year and included a death record locater if the child died during the first year of life. Confidential Death Master Files for the years 1999-2007 were also obtained from CDPH. Each annual death file captures all deaths occurring in California during a given year. Child protective services records for all children reported for possible maltreatment before the age of five and with a date of birth falling between 1999 and 2006 were extracted from California's statewide child welfare information database. This study received approval from the Committees for the Protection of Human Subjects at both the University of California at Berkeley and the State of California.

1.1.2 Death to Birth Linkages

Annual death files were restricted to decedents who were born between 1999 and 2006 and whose date of death fell before their fifth birthday. These annual files were then merged into a single file (n=25,987), with linkages established by successively running this merged file against each annual birth cohort file. Records were probabilistically matched based on personal identifiers common to both files (e.g., child's first and last name, date of birth, gender, maternal first and last name). Two reviewers then scanned all comparison pairs and independently classified pairs as matches or non-matches. After all classifications were made, match assignments were compared and all discrepant assignments were isolated for further examination. For those pairs where the match assignments did not align (less than 1%), additional information was retrieved from records in order to make a final assignment. These efforts resulted in 98.1% (25,496) of deaths successfully linked to a birth record. It should be noted this match rate includes infant deaths that were already linked to a birth record by CDPH (60% of deaths occurred within the first 28 days of life).

1.1.3 Child Welfare to Birth Linkages

Linkages between child welfare records and birth records required a slightly different linkage strategy. The high count of children meeting study inclusionary criteria (n=596,962), meant that the same level of clerical review conducted for the birth/death linkages was not feasible. Instead, the child welfare dataset was divided into eight single year files based on the child's year of birth. Each child welfare file was then probabilistically linked to the corresponding birth record file. Based on detailed reviews of both the 1999 and 2006 files, which included a close manual examination of a 1% random sample of comparison pairs falling within each 10-point weight strata, upper bound and lower bound cut-off scores were established and applied to all child welfare to birth linkages. All comparison pairs falling above or below established cut-off scores were automatically assigned match status. For the remaining comparison pairs with a score in the

established gray area, a clerical review was completed. Among pairs falling toward the upper end of this gray area, the review conducted was relatively cursory and merely involved a scan of the fields to ensure that the information generally aligned. As the scores dropped, the reviews became increasingly thorough. Match rates ranged from a low of 84.6% (1999 file) to a high of 91.9% (2006 file). The improved match rate largely reflects the improved quality of data over time and the shortened window during which children born out of state could have moved and been reported to child protective services in California. Files were matched in random order (not chronologically) as a means of reducing any bias stemming from reviewer effects.

1.1.4 Final Linked Dataset

The final dataset underlying this analysis covers the full population of children born in California between 1999 and 2006 (4,317,738 live births) and captures within-state child welfare contacts and deaths occurring through each child's fifth birthday or January 1, 2008. Children born out of state, but later reported to CPS or dying within California during the study timeframe, were excluded.

1.1.5 Variables

The main dependent variable of interest was an unintentional or intentional injury fatality occurring before a child's fifth birthday. Injury deaths were identified based on the external cause of death codes (e-codes) found in the International Classification of Diseases, 10th Revision (*ICD-10*) [214]. In the latest revision of the ICD, injuries are described using e-codes which incorporate both the mechanism (e.g., fall, poisoning, firearm, drowning) and the manner (e.g., unintentional, homicide/assault, suicide/self-harm, or undetermined) of death into a single ICD code. Specially designated *U letter codes used to identify victims of terrorism were not included. Also excluded were Y letter codes used to specify deaths stemming from complications of medical or surgical care.

A non-fatal report of maltreatment served as the key independent variable in this analysis. The date of first referral was used to establish whether or not a child should be coded as having had prior non-fatal CPS contact. All children reported for maltreatment were included, even if the child was evaluated out and therefore did not receive an in-person investigation. Upon completion of linkages with birth and death records, those children who were first reported to CPS only on or after the date of death were re-coded as having had no prior CPS contact. Children first reported to CPS only on or after the date of the injury event associated with death were also re-coded as having had no prior CPS contact.

Failing to control for the multitude of variables that have demonstrated an independent association with both the key independent variable (CPS contact) and the outcome of interest (injury death) could have led to spurious associations between CPS contact and injury mortality.[37,42,158,174,216,232] In an, an attempt to control for these confounds, multivariate models adjusted for characteristics at birth including: child's sex (*male vs. female*), child's health (*health risk present vs. none*), family poverty (*public insurance vs. other*), race/ethnicity (*black vs. white, hispanic vs. white, asian/pi vs. white*), maternal age at birth (*<=24 years vs. 25 years+*), maternal education at birth (*<=high school vs. some college+*), a father identified on the birth record (*missing vs. recorded*), and birth order (*second or higher vs. first born*).

1.2 Research Questions and Analysis

Three research questions were posed at the outset of this study: *1) Is a referral to child protective services an independent risk factor for injury mortality?* 2) *Is allegation disposition associated with injury fatality risk?* 3) *Does injury fatality risk vary across maltreatment allegation types?* The association between a prior maltreatment allegation and injury mortality was then estimated using survival regression techniques. For each research question, separate unadjusted and adjusted models were specified to estimate risk of: 1) overall injury death, 2) unintentional injury death, and 3) intentional injury death.

In all models, first CPS contact was entered into the analysis as a time-varying covariate; other covariates were modeled as baseline or time-invariant variables. CPS contact is inherently time-dependent in the sense that a child's status may change from "no report to CPS" (0) to "non-fatal report to CPS" (1) between the time that child became at risk of injury death (on the day of birth) and the time at which the child experiences the event of interest (injury death) or is censored (non-injury death or end of the study window). To model a first report to CPS as a function of time (t), Extended Cox Regression Models were specified. In these models, an individual child is included in the risk set of children who had not been reported to CPS, until time (t) at which an allegation of maltreatment is recorded. Observations for each child were censored upon non-injury death (or other manner of injury death, for models in which the dependent variable was stratified by manner), a child's fifth birthday, or the end of the study window. Time zero was recorded as the date of birth as listed on the birth record. Robust standard error adjustments were made for all models to account for the possibility of non-independent observations. Results were presented as hazard ratios (HR) with 95% confidence intervals (95% CI). Days served as the unit of time.

1.3 Summary

Through record linkages between vital birth records, child protective service records, and vital death records, this study prospectively followed eight California birth cohorts of children. In total, 4.3 million children born between 1999 and 2006 were administratively tracked from the day of their birth, through the age of five or the study end date of January 1, 2008. Baseline birth characteristics were gleaned from vital birth records, allegations of possible abuse or neglect were obtained from child protective service records, and deaths were tracked through vital death records. The primary purpose of this study was to determine whether a prior, non-fatal allegation of maltreatment to child protective services (CPS) was an independent risk factor for subsequent injury death.

2. Limitations

Administrative data concerning children reported for abuse or neglect in the United States suffer from the notable limitations of being both narrow in scope (i.e., containing a restricted set of variables) and narrow in coverage (i.e., capturing data for only those children who are reported). Attempts were made to overcome these two shortcomings through child-level record linkages across multiple sources of data. Birth records provided a population cohort of children that could be prospectively followed, while also offering information concerning children reported to CPS unavailable in administrative child welfare data. Child welfare records documented those children who were reported for maltreatment. Death records provided information concerning the most objective measure of the absence of child well-being – death. Although information

generated from these linkages provided valuable and previously unavailable data, many of the hurdles that accompany work with large clerical datasets were still present, and several limitations must be noted.[233]

2.1 Generalizability

This study is restricted to children from California. Given widespread state-level differences in child welfare practices and policies, generalizations are cautioned.[234] With that said, it is worth noting that California is home to roughly 13% of the nation's children, with a still higher proportion of the nation's foster care population.[127,235] This means that the research findings reported for this study bear important implications for a significant number of children, regardless of whether the study population is representative of the nation as a whole.

2.2 Scope

Despite the strengths associated with a prospective birth cohort design, this analysis was unable to account for children born in California who were maltreated or died in other states. Likewise, the use of this study design meant that children born in other states who were subsequently maltreated or died in California were excluded. Estimates of the fraction of children in each birth cohort who were reported to CPS before the age of five should be considered a lower-bound estimate. It should also be noted that while this study found that 20% of fatally injured children had been previously reported to CPS (33% when only intentional injuries were considered) this was a child-level analysis and did not consider whether the family was known to child protective services based on an allegation involving an older sibling. Although the fractions of children with prior CPS contact in this study fall within the fairly wide range of cross-sectional estimates of intentional injury victims with prior child protective service contact, the proportions reported here should be considered fairly conservative, lower-bound estimates of the fraction of children in which some protective action might have been taken. [22,225-228]

Noteworthy is that in addition to the 396 children with a non-fatal allegation of maltreatment prior to their death, there were 591 children who were first reported to child protective services on or after either the date of injury event or date of death. This means that a full 51.4% of all fatal injury victims under the age of five either had a prior, non-fatal CPS record, or died from injuries in which the circumstances of the injury event were deemed suspicious enough to warrant a report to child protective services after the child's death. Post-mortem reporting such as was uncovered in this study may explain some of the high rates of apparent CPS contact reported elsewhere.[227]

2.3 Unmatched Records

Roughly 14% of child protective service records could not be matched to a birth record. Approximately 1.5% of death records were similarly unmatched to a birth record. Some of these unmatched records likely involved children who were born out of state and therefore did not meet inclusionary criteria. Yet, some fraction were undoubtedly missed matches arising from empty variable fields and data entry errors in the underlying source files. Although these missed matches represent a potential source of bias, the matching strategy employed means that unmatched records should have only dampened reported findings rather than overstating associations. The strategy of linking death and birth files independently and in advance of any birth record matches to CPS data not only ensured that the decision to identify a CPS-birth

record pair as a match or non-match was not biased by knowledge of the death outcome, but it also means that this analysis is likely to include fatally injured children who had prior non-fatal contact with CPS, but were instead included in the general population of children because their child welfare record went unmatched to a birth record. No direct matches of CPS records to death records were undertaken in this study.

2.3 Crude and Omitted Variables

The limitations of variables typically available in administrative data systems were only partially overcome by linking records across data sources. Only a crude measure of poverty at birth was available (i.e., whether or not a birth was covered by Medi-Cal, the state's public health insurance program). Since California state law prohibits the release of marital status in confidential birth files, a constructed measure of paternity was the only indicator of the child's birth into a single or two-parent family. Birth records do not contain any measure of maternal mental health or substance use, both of which have been identified as risk factors for CPS contact and child injuries and may be key omitted variables. Other than an out-of-home foster care placement, the current analysis was unable to ascertain whether any services were provided following a report of maltreatment. Additionally, the nature of the administrative death data used in this analysis prevents any definitive determination of the circumstances of a given child's injury death, including where the injury occurred, perpetrator information, or who the caregiver was at the time. Yet, although not all variables were ideal, the strong associations observed between covariates and injury death in bivariate models suggest chosen covariates were effective proxies well-positioned to absorb demographic variations in risk. Further, the low population base rates of injury deaths that have complicated prior studies would have largely precluded the inclusion of highly stratified variables or additional covariates.

2.4 Assumptions

This study implicitly assumes that fatal injuries sustained by infants and young children are largely of parental etiology, and preventable. Although research indicates that the physical well-being of non-ambulatory infants and young children is defined by the adequacy of age-appropriate supervision and caregiving,[51,64,82,236] variability in children's exposure to neighborhood or environmental hazards falling outside of parental domains cannot be ignored. Among children residing in impoverished and dangerous neighborhoods, it may be that a greater risk of injury death should not be attributed to unobserved parent or family-level factors associated with the risk of maltreatment and assumed to be captured by a report to CPS. Although there was no way to directly control for these non-parental risk factors, all analyses were also run with motor vehicle, pedestrian, and other transport-related injury deaths excluded since these, by definition, would have occurred outside of the home. The exclusion of these deaths did not directionally impact findings. Additionally, as other researchers have pointed out, it may be that distinctions in parental versus environmental etiology are overemphasized in the context of child deaths given that the outcome is the same[237] and "a parent's overall capacity to protect a child from anger may be connected to the capacity to protect the child from environmental hazards."[238, 595] In other words, "A mortality-based standard for evaluating parental behavior may be the closest we can get to 'culture-free' definitions of neglect and abuse."[138]

3. Risk Factors for Injury Death

This section is devoted to a discussion of the key findings that emerged from this research. It begins with an overview of the ten covariates included as control variables in each of the adjusted models. This is followed by three sections that focus, in turn, on discussions of the findings that arose from each of the CPS-related research questions addressed in this study.

3.1 Covariates

Ten covariates were employed to control for child and family-level differences in risk at the time of birth. Although these variables were not the focus of this research, the independent contribution of each covariate to risk of injury death is briefly discussed below. The logic for this discussion is that although these covariates confirm risk factors observed in prior injury research, this is the first time these covariates have been included in multivariate models, within the context of a birth cohort study design, alongside an indicator of contact with child protective services. Additionally, this study provides covariate associations stratified by the manner of injury death. Given that this is one of the first studies that has simultaneously examined unintentional and intentional injury fatality risk within a given population of children, a discussion of notable variations in across injury manner seemed in order.

3.1.1 Child Gender

In this analysis, after controlling for other variables, male gender was associated with an overall rate of injury death that was 35% greater than was observed for female children. This gender disparity is consistent with a large body of prior research, as well as an injury conceptualization in which child-level attributes and behaviors influence the manner in which children engage with their environment and caretakers, which in turn affects injury risk.[36,38,51,60,169,178,236,239,240] The mechanism through which gender operates, however, is less clear. It may be that gendered expectations for child behaviors allow boys to engage in riskier behaviors without the same level of parental supervision and active correction, resulting in higher rates of unintentional injuries. These same gendered interactions between parents and male children may also mean these behaviors may be more likely to provoke a physical response when some behavioral threshold is crossed, heightening the risk of an inflicted injury. Alternatively, it may be that biological differences in risk-taking and activity level result in characteristic patterns of unintentional injuries for male children that differ from female children. Likewise, these same differences may make male children more difficult to parent, heightening their risk of inflicted injuries. Of course, culture and biology need not be viewed as mutually exclusive explanations: the independent effect of gender may well operate via both pathways.

3.1.2 Child Health

Children were coded as having a health risk at birth if they were either born weighing less than 2500 grams, or had one or more birth abnormalities. These risk factors have been separately identified in prior research as risk factors for both injury death and CPS contact.[8,172,216,218,241,242] Aligning with existing literature, a health risk at birth was associated with the heightened rate of injury death. As was true for gender, the association between poor health and later injury death is also likely to operate via one, or both, of two possible paths. The first path is one in which unobserved maternal and family characteristics place a child at risk of both poor health at birth, and subsequent injury death. Because this analysis was unable to control for maternal substance abuse, it may be that drug use prenatally resulted in low weight at birth, and continued substance

use during the child's first few years of life heightened the risk of injury death. (It is worth noting that health care providers in California are not required to report a positive toxicology report at birth.) A second path is one in which the physical fragility that accompanies children who are born low birth weight or with a congenital abnormality leaves them particularly vulnerable to dying from injuries that would not have proved fatal among their healthier counterparts. Again, clearly these two paths are not mutually exclusive and these data fall far short of identifying the path through which this association more frequently operates.

3.1.3 Poverty

Prior research has identified poverty, often extreme poverty, as a consistent trait among children reported to child protective services, as well as children fatally injured during the first few years of life.[17,20,21,25,39,191,216,243] In this study, poverty was captured based on a child's Medi-Cal eligibility at birth (California's public health insurance program). This covariate had a rather modest association with overall injury risk, and was not statistically significant in models stratified by manner of injury. This is a at least partly a reflection of the crude nature of the manner in which poverty was measured: there is no doubt that a dichotomous measure of public versus private health insurance coverage masks notable and important wealth gradations associated with child health.[244] The absence of an observed association, however, also highlights the salience of other demographic parent and family variables for their association with a child's risk of injury death.[245,246] These data suggest that poverty, albeit crudely measured, explains a relatively small fraction of a child's vulnerability to injury death when compared with what prove to be more salient parental traits such as education and age at birth.

3.1.4 Maternal Age

Consistent with prior literature, maternal age emerged as a significant risk factor for all manners of injury death.[178,241] In capturing maternal age, this analysis relied on dichotomous measure with mothers stratified at the age of 25. Although somewhat arbitrary, this cut-point was based on a prior examination of the distribution of maternal age in which birth to a mother under the age of 25 proved an independent risk factor for contact with CPS in California.[216] Notable, however, was the much stronger association between maternal age and an inflicted (or intentional) injury compared with the association for an accidental (or unintentional) injury. Although there is no prior research which is directly comparable to this study, earlier studies also point to young maternal age as a particularly salient risk factor for child homicide or a maltreatment-related injury death.[241]

3.1.5 Maternal Education

In this analysis, low maternal education (a high school degree or less) proved a risk factor for all manners of injury death. This finding is consistent with the existing body of empirical injury fatality research, as well as child welfare literature, in which similar stratifications were used.[158,178,216,241] Variations in the independent contribution of low maternal education across manners of injury death were modest.

3.1.6 Paternity

Birth to a single mother has been consistently identified as a risk factor associated with a child's report to CPS for possible maltreatment, as well as injury death.[158,178,241,247] Recent research, however, indicates that it is not the mother's single parent status that heightens a child's risk, but

the indirect result of her single status which leads to an increased likelihood there is an unrelated adult male in the home.[37,99,187] Unfortunately, none of the three data sources underlying the final linked dataset (e.g., birth records, child protective service records, death records) included a variable capturing adults in the home or the parents' relationship status. To estimate the likelihood that the child would have been consistently exposed to unrelated adult men, this analysis used the establishment of paternity on the birth record as a proxy of paternal involvement with the mother.[220,221] Although only 7.2% of all children included in this were missing a named father on their birth record, 18.4% of children reported to CPS were missing paternity information. Conceptualized differently, among children without an identified father at birth, one-third of these children were reported to CPS before their fifth birthday. Likewise, the absence of an identified father proved a risk factor for sustaining a fatal injury, with the cumulative injury death rate estimated to be 110 out of every 100,000 children for whom paternity was not established, compared to just 47 out of every 100,000 children with a father listed on the birth record.

In the multivariate models, a missing father on the birth record was associated with a rate of injury death that was 37% greater than among children with a father listed. This variable, however, failed to emerge as statistically significant when injury fatalities were restricted to only those that were classified as unintentional, proving to be a much more pronounced independent risk factor in the model for intentional injury deaths, with children without an identified father dying from inflicted injuries at twice the rate of children for whom paternity was established. This finding raises more questions than can be answered with the available data in this study. It may be that, so far as missing paternity truly does measure a child's exposure to unrelated male caregivers, these children are truly at a significantly heightened risk of fatal injury. Alternatively, it may be that this variable is significant less for its ability to capture exposure to unrelated male caregivers, and more because it captures the parenting stress and overall resource constraints (human, social, and material) experienced by mothers giving birth to children whose fathers fail to establish paternity. A limitation of these data is the ability to identify the perpetrator of the injury. Finally, it may also be that the apparent differentiation across manner of injury (unintentional versus intentional) is an artifact of the greater scrutiny with which child deaths are examined when arising from homes in which both biological parents are not present.[24]

3.1.7 Birth Order

Based largely on injury research which suggests higher rates of death among later born children, an indicator variable for a first-born child was included as a covariate in all multivariate models.[178,241] In this analysis, non-first born children were observed to die from unintentional injuries at rates that were significantly higher than their first born counterparts, controlling for other differences. In contrast, these children died from inflicted injuries at a rate that was statistically comparable to first born children. The significant birth order effect as it relates to unintentional injury risk is consistent with an argument that children falling later in the birth order may be at higher risk of injuries, due both to a greater propensity to engage in risky behaviors following the lead of older siblings, as well as less vigilant supervision on the part of parents whose attention is divided across children. Although the absence of an observed association for those deaths coded as intentional cannot be explained from these data, a prior study found that maternal age modified birth order effects in infant homicides, and maternal age may also be associated with where a child falls in the birth order.

3.1.8 Race

The inclusion of race as a covariate in this analysis was critical given that a primary objective was to ascertain whether a prior report of maltreatment was an independent risk factor for injury death: race is strongly associated with both a report to CPS and injury death. Consistent with prior research, racial differences in rates of injury death were observed in this study.[36,60,158,241,248] The direction of these findings, however, shifted across injury type. When all injuries were modeled, Black children were observed to die of injuries at rates significantly higher than White children, while Hispanic and Asian/Pacific Islander children died at rates that were significantly lower than White children. Examining overall rates of injury death in this first multivariate model, however, masked notable variations by the manner in which the death occurred. The heightened risk of death among Black children was heavily concentrated in deaths coded as intentionally inflicted. Black children were identified as victims of an *intentional* injury death at over 2.5 times the rate of White children, after adjusting for other factors. Yet, Black children were observed to die from *unintentional* injuries at rates that were statistically comparable to White children, after adjusting for other risk factors. In contrast, the differences between Hispanic and Asian/Pacific Islander children were largely due to lower rates of *unintentional* injuries. When the model was restricted to intentional injuries, previously statistically significant differences disappeared and hazard ratios for Hispanic and Asian/Pacific Islander children indicated a slightly heightened risk of *intentional* injury death compared with White children (albeit, statistically insignificant).

Race is widely viewed as a marker for a complex interaction of economic, social, political, and environmental factors that influence the health of individuals and communities, making the interpretation of these findings far from straightforward. If taken at face value and the determination of manner of death is assumed to reflect an unbiased coding of each racial group's rate of injury death, these data suggest that a confluence of unmeasured risk factors place Black children at a notably higher risk of sustaining an inflicted injury death during the first five years of life. This interpretation would also suggest that both Hispanic and Asian/Pacific Islander children benefit from unmeasured protective factors for which accruals are most significant in reduced rates of unintentional injury death. Alternatively, it may be that racial disparities in fatality rates by manner of death arise from a biased coding of these deaths. Throughout this dissertation, it has been repeatedly noted that a death's coding as unintentional versus intentional may be compromised by an under- or over-ascertainment of certain groups. The high rates at which Black children are reported to CPS in California (just under 30% of Black children born in the state were reported for maltreatment before their fifth birthday) may mean that coroners, responsible for making a cause of death determination, and who may well be privy to information concerning prior allegations of maltreatment, may also be more likely to scrutinize these deaths.

These data fall short of determining whether there exists a biased over-identification of Black children as victims of intentional injuries, or a biased under-ascertainment of White victims. Yet, by utilizing all injury deaths and ignoring the death's coding as unintentional or intentional, this research avoids the identification bias that may factor into elevated rates of intentional injury deaths for Black children. This analysis suggests that, overall, Black children face a heightened

risk of injury death during the first five years of life, above and beyond that which can be explained by other demographic variables.

3.2 A Non-fatal Maltreatment Allegation as a Risk Factor for Injury Death

This analysis provides strong empirical evidence that a prior non-fatal allegation of maltreatment is an independent risk factor for both unintentional and intentional injury death during the first five years of life. After adjusting for other risk factors present at birth, a prior allegation to CPS emerged as the *single greatest predictor* for not just an inflicted or intentional injury death, but also an accidental unintentional injury fatality. In short, a report to CPS signals a level of risk that is far greater than a child's demographic profile alone would suggest.

The heightened rates of death among children reported to child protective services align with Schnitzer's recent research in which she found that prior CPS contact was more common among cases (children dying from unintentional or inflicted injuries) than controls (children dying of natural causes) and with Jonson-Reid's finding that a majority of deaths among children previously reported for maltreatment could be classified as "preventable injuries," whereas health-related deaths were more common among the comparison group.[37,98,99] Barth also found high rates of injury death among deceased children with a history of foster care placement, as did Sabotta and Davis.[39,96] While the findings reported in this dissertation are seemingly at odds with White and Widom's study which failed to detect a heightened risk of death among maltreated children, this difference may arise from the fact that the present analysis examined deaths only during the first five years of a child's life.[97] It may be that a prior allegation of maltreatment is a pronounced risk factor for death very early in life when children are most physically vulnerable, but a less salient variable as children age.

The heightened risk of unintentional injury fatalities among children with a prior allegation of maltreatment has been infrequently examined in the empirical literature and represents a largely new finding consistent with either of two possible interpretations.[225] The first is that this heightened risk of death reflects a high level of parental culpability in unintentional injury fatalities involving young children. Given that this study found that the strongest risk factor for an "accidental" death was the child's earlier identification as child at risk of maltreatment, it stands to reason that these unintentional fatalities stemmed from an absence of age-appropriate supervision or caregiving falling somewhere along a neglect-spectrum of parental supervision. Alternatively, it may be that the association between a prior allegation of maltreatment and risk of unintentional injury death is nothing more than an artifact of misclassified deaths and the inability to correctly ascertain maltreatment-related fatalities.[24,85-87]

3.3 Disposition and Injury Death Risk

These data provide evidence that the disposition assigned to an allegation of maltreatment by CPS moderates the association between prior contact and injury death, presumably because the disposition is a reflection of an assessment of a child's risk, or because services were offered that altered the risk state. In all adjusted models, including both the overall injury death model and models stratified by manner of death, no statistically significant differences were identified between children who had been evaluated out (e.g., received no in-person investigation), and the two forms of unsubstantiated dispositions (e.g., unfounded, inconclusive). The only dispositional group identified as clearly facing a risk of injury death that differed from other reported children

were those children who had been previously identified as substantiated victims of maltreatment, and their risk varied based on whether or not a placement in foster care followed. Placement in foster care for children with a substantiated allegation of maltreatment was protective against injury death.

An important reminder is in order when comparing injury death rates by disposition. Although these data suggest that rates of injury death are comparable across allegations evaluated out and those that are screened in for investigation but unfounded, these data cannot be used to draw the conclusion that there were no differences in *initial risk* across these dispositions, at the time that a risk determination was made. What remains unknown is what the rate of injury death would have been for a given group *absent any CPS services or interventions that may have been provided*. In other words, although these data leave little doubt that children evaluated out by the child welfare system face a rate of injury death that is significantly greater than their non-reported peers, these data do not indicate that on a relative basis and at the time of the allegation, the risk of injury death was the same for children screened-in versus evaluated out. It may be that children who received an in-person investigation did truly face a greater threat of death. It may also be, however, that the investigation itself proved protective (e.g., it served as the impetus for single mother to extract herself from a violent partner whose presence in the home also threatened her child), or that informal services followed the allegation through which the child accrued safety benefits, resulting in a rate of death that was reduced to the level of a child who would have been evaluated out.

3.4 Variations in Injury Death Risk by Allegation Type

This dissertation research also identified significant variations in a child's risk of injury death based on the allegation type. After adjusting for other risk factors and demographic differences, children with a prior allegation of physical abuse were observed to die from inflicted or intentional injuries at rates that were dramatically higher than not only unreported children, but also children reported for reasons of sexual abuse, neglect, or other forms of maltreatment. Although these differences emerged in the overall injury death rate, the heightened rate of injury death associated with physical abuse was driven almost entirely by a dramatically higher rate of *intentional* injury death (children with a prior allegation of physical abuse died at a rate that was over 38 times greater than unreported children, after adjusting for other risk factors).

The risk of death associated with a prior allegation of physical abuse aligns with prior research findings, although it has received very little attention in discussions of child deaths.[22,98,226] Although, in aggregate, this and other studies have found that that more children die following an allegation of neglect, neglect is also the far more common form of maltreatment. Past research has tended to focus on the overall number of child deaths, failing to consider differences in risk and ignoring the potential for these differences to inform efforts to target high-risk children.

4. Implications for Practice and Policy

4.1 A Maltreatment Allegation: It's Not Just About Poverty

The question as to whether children reported to CPS are identified as possible victims of maltreatment not because of any heightened level of actual physical risk, but simply because they are poor, has been passionately debated for decades.[17,249,250] These data suggest that children

reported to CPS comprise a group with a truly distinctive risk profile that is defined by much more than just poverty or class. Children with a prior, non-fatal allegation of maltreatment face a risk of injury death that is many times that of unreported children, including those born into families that, at least on paper and at birth, look very similar. In many ways, it is reassuring that allegations of maltreatment made to CPS are not random events, disturbing the lives of families (particularly, poor families) in an entirely unpredictable fashion and with little accompanying risk. Yet, these findings also underscore the serious nature of the problems encountered by families reported to CPS and the critical decisions that must be made by child protective service workers.

4.2 An Expanded Recognition of Unintentional Injury Deaths

Over thirty years ago, a social worker noted that although child welfare has long recognized its mandate to protect children from abuse and neglect, these same agencies "have not extended their definition of child protection to include the prevention of so-called nonintentional injuries."[170] The author concluded that "social services agencies that focus exclusively on inflicted injuries overlook a critical aspect of child protection." Echoing this same sentiment, Peterson noted that for reasons partly political in nature – including funding turf wars and the lack of a common constituency – injuries had been artificially dichotomized, with unintentional injuries claimed by epidemiologists in public health and intentional injuries by those in sociology and social work.[239] These data suggest that, from a practice and policy perspective, a narrow focus on maltreatment-related deaths fail to consider that children reported for maltreatment also die from unintentional injuries at rates far higher than their unreported peers. During the study window, more children with a prior allegation of maltreatment died from an unintentional injury than an intentional injury (although the risk of an intentional injury death was greater). Although it may be that these unintentional injury fatalities reflect an underascertainment of inflicted injuries, these findings lend support to researchers who have pointed out that injury death has the same outcome, whether it is declared intentional or accidental, and have called for child protective services to be pursued under a broader, public health-oriented agenda, focused on the prevention of all manners of injury.[39,170,239]

4.3 Hotline Screening of Allegations

The trade-offs between Type-I and Type-II errors are well-understood and certainly apply to decisions that must be made by child protective service workers in the face of limited information, time, and resources.[29,30,251] The child protection system will never be able to prevent all child deaths. Yet, the magnitude of the adjusted risk of injury death faced by children whose allegations of maltreatment were evaluated out over the telephone without an in-person investigation is both disturbing and telling. Infants and toddlers reported, yet evaluated out, died from injuries at rates suggesting that they faced threats much more profound than poverty or sociodemographic risk factors alone would indicate. These data suggest that the report itself provides a critical piece of information for understanding child safety. Given that over 40% of children who are evaluated out are subsequently re-reported within two years, and the profound vulnerability of this youngest population of children, screening maltreatment allegations over the phone, especially when they involve infants and young children, would seem a questionable policy.[193]

4.4 Children Reported for Physical Abuse

This study suggests that an allegation of physical abuse involving a child under five years of age signals a far greater risk of death than does any other allegation type. It is interesting to note that although data which support this assertion have consistently appeared in official national fatality data arising from NCANDS, as well as other studies examining risk of death following CPS contact, the heightened rate of death associated with a physical abuse allegation has been little discussed.[22,98] These data suggest that there may be the potential to use an allegation of physical abuse involving a young child as a method for strategically tailoring the level of service and monitoring that follow. The reconsideration of child welfare practices and policies specific to physical abuse cases is also supported by a recent study in which the authors attempted to predict child fatalities among less-severe cases that were also investigated by CPS.[226] The authors noted that while their model for physical abuse cases "can help to identify cases at risk for child fatality, there is no noticeable improvement when neglect cases are handled with a similar type-specific model." Further underscoring the potential for practice and policies specific to children with an allegation of physical abuse is the fact that these children represent but a small fraction of all children reported to CPS, providing an easy group to target. These data indicate that the 12% of children reported for reasons of physical abuse face a much greater risk of injury death than the 88% of children reported for other reasons.[193]

4.5 Targeted Injury Death Prevention Campaigns

This study provides strong empirical evidence that, on a *relative* basis, infants and young children reported to child protective services are extremely vulnerable to injury death. Although on an *absolute* basis, few children reported to child protective services died before the age of five, over 20% of all fatally injured children had been previously reported for maltreatment. The purpose of identifying high-risk subsets of children vulnerable to negative outcomes is to be able to provide narrowly targeted services in order to decrease the incidence of the outcome's occurrence. These data point to the fact that families in which infants and young children have been reported for maltreatment provide a fairly direct access point for reaching a group at risk of injury mortality. The risk associated with a prior allegation outweighed any other sociodemographic variable captured for the child or family in this analysis. These data suggest that public health prevention campaigns, with the goal of decreasing the incidence of injury death among children, might be fruitfully targeted to families reported to CPS.

4.6 Placement in Foster Care

This study identified foster care as a service intervention protective against injury death. This finding serves to highlight both that many deaths are preventable, and that placement into foster care is one means by which overall injury death rates can be reduced. A child's placement in foster care, however, also reflects the value-laden policy and practice decisions entrenched in child welfare services. Placement into foster care falls at one extreme on a spectrum of possible services that can be offered. CPS workers face an incredibly difficult task when they attempt to make an assessment of a child's present and future risk of harm. When a foster care placement decision is made, implicit is that CPS determined that the risks associated with keeping a child in his or her home, outweighed the uncertainty that the child needed protection through a foster care placement. Unfortunately, errors in which a child is harmed following a decision to *not place in foster care* are more tangibly measured (e.g., injury or death) than the more difficult, longer-term effects that may accompany an unneeded removal. This analysis found that after being reported

to CPS, children who were placed in foster care had *overall* rates of injury death that were statistically indistinguishable from children who had never been reported, upon adjustments for other factors (these children had equivalent rates of unintentional injury deaths, and rates of intentional injury death that while still heightened, were significantly lower than children with a substantiated allegation and no placement). In contrast, children who were reported but received either no services, or some home-based services, sustained fatal injuries at rates that were higher than their unreported peers, after adjusting for other risk factors. One possible policy response to this finding would be to place *every* child who is under the age of five and reported to CPS into foster care. Yet, remember that of the more than 500,000 children reported, less than 1% died from an injury. On a relative basis these children were at high risk of death, but on an absolute basis, very few actually died. Still, a key finding to emerge from this research is that a child's risk of death can be reduced through foster care placement. It is important for lawmakers and the lay public (as well as child welfare agencies) to realize that foster care can have a powerfully protective effect for those children who need it. Efforts to reduce foster care caseloads based on a perception that it is damaging to all children are misguided. How a state or community weighs the value of foster care placement in terms of relative versus absolute rates of death translates into a normative policy question.

4.7 Utilizing Demographic Variables to Assess Risk

This study identified a number of easily measured demographic variables that demonstrated strong and independent associations with injury death risk, even after adjusting for a prior report to CPS. These findings highlight opportunities for hotline screening tools to be adjusted and for subsequent practice protocols to be further tailored to the risk of individual clients. Currently, information such as a mother's age does not explicitly factor into investigatory or service decisions made in California. Nor are there formal protocols for adjusting the level of monitoring upon discovery that a biological father is not present in the home, heightening the risks that unrelated males may have caregiving contact with the child. A standardized assessment tool that relies on a demographic profile can never replace more comprehensive assessments of an individual family's strengths and risks. But against an invariable backdrop of limited resources, the ability to prioritize investigations and adjust levels of case monitoring in order to meet the greater needs of a targeted swath of at-risk children and families has the potential for cost-savings to be realized, while also improving child well-being and reducing the incidence of child deaths. An unknown number of child fatalities are prevented through service interventions offered by CPS every year. The question then becomes, how can the system be even more deliberate in its efforts, relying on the best available data to ensure those children who are most at risk are protected from harm?

5. Future Research

5.1 Additional Analyses

It is anticipated that the linked dataset created for this dissertation will be utilized for many additional analyses, yielding rich findings and insights beyond the scope of this particular paper. As a next step, attempts will be made to incorporate what limited service information can be gleaned from child welfare records in order to provide a more complete picture of whether any formal services were offered by CPS. Future efforts will also include an analysis of the specific injury mechanisms (e.g., drowning, fall), rather than whether or not the injury was unintentional

or intentional. Finally, a more qualitative analysis of those children who died following an allegation of maltreatment, inclusive of data available in the assessment tools that were utilized to classify the level of risk, may also serve to generate important new information.

5.2 Extended Record Linkages

This research serves as a methodological example of how probabilistic record linkage can be used to extend administrative child welfare data. Linkages with vital birth and death record variables were used to generate new child and family-level information for each reported child. These data also allowed for the estimation of cohort specific prevalence rates of CPS contact and injury mortality with adjustments for a host of risk and protective factors. Future research will extend the findings reported here through linkages with population-level emergency department and hospital patient discharge data for an examination of injury morbidity as it relates to a child's contact with child protective services. Efforts to establish cross-system, child-level linkages with mental health and educational data will also be pursued as a means of better understanding children involved with the child welfare system in California. It is hoped that the tremendous potential for valuable information to be generated is realized as the findings from this study are disseminated, resulting in the formalization of longer-term data sharing agreements between social service agencies serving children and families throughout the California.

6. Conclusion

Historically, public health efforts in the United States were focused on the study and prevention of communicable disease transmission.[57] Only in the latter half of the 20th century were unintentional injuries recognized as threats to health that could be controlled and prevented through epidemiological study, improvements to the social environment, and health promotion campaigns. More recently, child maltreatment has also begun to be recognized as a social problem that lends itself to a public health framework of study and subsequent prevention activities.

In the United States, child protection service systems were developed in a manner largely consistent with a traditional medical model of case identification, assessment, and treatment.[252] While CPS agencies play a critical role in ensuring the well-being of children, it has become increasingly clear that the child welfare system is poorly suited to addressing the broader social and economic causes of child maltreatment, and is not easily adapted to prevention-focused efforts. Certainly, a number of compelling arguments have been forwarded as to why child maltreatment prevention and intervention activities should be included under the public health umbrella.[253]

First, even after maltreatment ends, the consequences of the abuse or neglect are often far-reaching.[12,13,16] Adverse effects associated with a child's physical, cognitive, social, and emotional development are commonly observed in victims of maltreatment.[13,102,254,255] While on the one hand disheartening, this growing-body of scientific evidence also means that preventing child maltreatment may be a highly effective strategy for promoting health and reducing disease later in life – objectives of most public health agendas.[256]

Second, public health agencies fall within a large health infrastructure with ready access to a broad population of young children and their families. In contrast, child protective service

agencies have been shown to have contact with only a fraction of children affected by maltreatment.[20,21,257] Maternal and child health programs offer opportunities to reach children who may be at risk of maltreatment, but are unknown to child protective services agencies with the ability to offer services under less stigmatized and adversarial circumstances. Relatedly, public health approaches rely on epidemiologic methods for studying the incidence and of social problems across places and populations, and over time. These methods lend themselves well to the resource constrained environments within which child protection agencies must function and can inform the allocation of limited services to those populations at greatest risk.[16]

Finally, overlapping risk factors for unintentional (or accidental) injuries and intentional (or maltreatment related) childhood injuries suggest that integrated child safety campaigns may be more successful and efficient means of improving child safety.[239] Although public health has been most effective in promoting health through passive campaigns targeting environmental changes (e.g., child safety tops on toxic substances), it also has an established track record in reducing harm to children through the employment of education, policy, and intervention programs focused on behavior modifications (e.g., use of bicycle helmets). Lessons learned from successful public health efforts may translate well to maltreatment prevention.

6.1 Research Contribution

A key feature of a "public health approach" is the ability to utilize surveillance data both as a tool for the identification and tracking of the health threat at the population-level and as a means of determining risk and protective factors among subgroups, information that can then be used to develop targeted prevention and intervention programs. Unfortunately, administrative child welfare data often used to study victims of child maltreatment are both incomplete and serve as a poor source of surveillance information. Beyond the fact that administrative CPS data capture only those children who are officially reported for maltreatment, these data suffer from other notable limitations. Because child protection databases were designed for administrative reporting purposes, the variables it contains are typically limited to those associated with billing and other management tasks. Absent are more descriptive measures of case characteristics, such as family-level variables, that may confound apparent associations (e.g., race often emerges as a risk factor only when socioeconomic data are not available).[216] Also missing is information on etiological risk factors that predate CPS contact, or subsequent outcomes that could be used to assess decision-making surrounding child risk.

This dissertation advances a public health approach to the study of child maltreatment by establishing record linkages between child protective service records and vital birth records, providing crucial surveillance information. Linkages with universally collected data at birth serve to aid in the identification of those groups at greatest risk and who stand to benefit the most from targeted services. For example, although a multitude of studies have documented that children residing in single-parent families face a heightened risk of maltreatment, information concerning a child's family configuration is not available in California's administrative child welfare records. Through birth record linkages this study determined that although only 7% of the more than 4.3 million children born in California were missing paternity information, 33% of these children were reported for maltreatment before the age of five. The information gleaned from these record linkages not only provides important (and otherwise unavailable) information about the characteristics of children reported to CPS, but because this data originates in the birth

record, it also serves to identify a very high risk group that could be readily targeted for services on the day of birth.

Another surveillance shortcoming common to administrative child welfare data surrounds the ability to place the threat of child maltreatment in the context of other, more easily measured, public health problems. The record linkages reported in this paper allow for child maltreatment to be considered in terms of the full population of children born in the state – serving to frame the problem in magnitude and scope. All told, 14% of children born in California between 1999 and 2002 were identified as possible victims of abuse or neglect before reaching their fifth birthday and over 5% of all children were deemed victims of maltreatment. Notable variations based on easily measured (albeit crude) demographic characteristics allow a more nuanced picture to emerge. In terms of the health threat posed by injuries and the ability to provide targeted services to high risk groups, 20% of fatally injured children in California had been reported to CPS.

Finally, even if the ability to track changes in the "true" incidence and prevalence of maltreatment over time remains limited in the context of administrative child welfare data, linkages across successive birth cohorts allow for the examination of population-level trends in the presence of risk factors associated with child abuse and neglect, and the incidence of injury deaths. In light of the multitude of parental risk factors associated with child maltreatment, it certainly stands to reason that various health promotion strategies might lead to drops in the prevalence of child maltreatment. For example, effective teen pregnancy prevention programs could shift the population of children born to mothers at high-risk of child protective services contact. In California, 20.6% of children born to a mother age 24 or younger were identified as possible victims of maltreatment compared with only 10.5% of children born to mothers over the age of 25. Although residual efforts to provide services to young mothers of newborns has been shown to prevent some child maltreatment and improve child well-being (Olds, 1999), unknown is whether even modest declines in the overall rate of children born to younger mothers might prove an even more impactful method for lowering the prevalence of child maltreatment. Linkages with population-based data offer an opportunity to monitor population-level trends with corresponding shifts in rates of CPS contact.

6.2 Summary

This study represents the most rigorous longitudinal analysis of mortality outcomes following a report to CPS to date, with several key implications for the child welfare system's work with vulnerable populations. First, these data indicate that a child's report to CPS is not random, nor is it simply a function of poverty. Rather, a report to CPS signals a level of risk that is greater than their characteristics at birth would alone predict. A second and related point is that children evaluated out after a CPS hotline call reflect a group whose risk of injury death is far greater than their unreported sociodemographic peers. The decision to screen these children out without an investigation, under the logic that these children are not at risk, is not supported by the empirical evidence generated from this research. Third, these data highlight that although there has been a recent emphasis on the unmet service needs of children reported for neglect, it is young children reported for physical abuse who face the greatest risk of death. Given that physical abuse allegations represent a minority of reports received by CPS, these data suggest that a different protocol for investigating and intervening in cases in which physical abuse is alleged may be

justified. Finally, the finding that a prior allegation of maltreatment is the single greatest predictor of not just intentional injury death, but also unintentional injury death, lends support to calls that have been made for child welfare services to be pursued under a broader, public health-oriented agenda, focused on the prevention of all manners of injury.

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