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RESEARCH METHODS

Measuring the Incidence of Child Maltreatment Using Linked Data: A Two-State Comparison

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Introduction: Measuring and comparing the incidence of child maltreatment is challenging. Linkage of statewide birth cohorts with Child Protective Services reports to study incident child maltreatment over the life course are becoming more common. This study compares the reported incidence between 2 states derived from population-based administrative data linkages.

Methods: Linked births (2009–2011) with Child Protective Services records (2009–2015) and deaths in each state were used to compare the cumulative incidence of a Child Protective Services report before age 7 years. Given differences in population race structure and documented disparities of race groups in Child Protective Services data, variation was adjusted for using direct standardization. Unadjusted cumulative incidence, race cumulative incidence, and race-adjusted cumulative incidence were compared. Analyses were completed in 2018.

Results: Before age 7 years, 26.0% of Alaskan children and 19.0% of Californian children were reported to Child Protective Services (RR=1.37, $p<0.001$). Aside from Asian/Pacific Islanders, the cumulative incidence between states was similar for each race. The race-adjusted cumulative incidence indicated that children born in Alaska were 1.10 times as likely to experience a report before age 7 years compared with children in California.

Conclusions: Much of the difference in risk for child maltreatment observed between Alaska and California is most likely due to variation in the population structure by race as opposed to modifiable factors. Standardization is a simple method to adjust for population structure differences. This study contributes to the growing body of knowledge regarding the use of linked administrative data to study maltreatment and provides insights into considerations for making comparisons or conducting cross-jurisdictional analyses based on commonly aligned data sets.

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INTRODUCTION

Child maltreatment, which encompasses all forms of abuse and neglect occurring to children aged younger than 18 years, is a preventable public health problem. National estimates of referrals to Child Protective Services (CPS) for alleged child maltreatment are upwards of 4 million reports, involving 7.2 million children, with neglect and physical abuse being the most commonly reported forms of maltreatment.[1] Despite the occurrence of child maltreatment spanning all races and ethnicities, black and American Indian/Alaska Native children are more commonly reported to CPS.[1,2] In 2017, the national rate of reported maltreatment was 13.9 per 1,000 among black children and 14.3 per 1,000 among American Indian/Alaska Native children, compared with 8.1 for white and 8.0 for Hispanic children.[1]

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Measuring the incidence of child maltreatment in a community, state, or nation is challenging. Annual incidence measures of child maltreatment are obtained primarily through the National Child Abuse and Neglect Data System and National Incidence Study.[3] Population-based longitudinal data can be used to effectively estimate risk, evaluate causal etiology, and assess the outcomes associated with child maltreatment. However, longitudinal data measuring the cumulative incidence of child maltreatment are not available through any national data system. Prior studies derived national lifetime prevalence estimates by creating synthetic cohort life tables using National Child Abuse and Neglect Data System and Census data.[4,5] These studies documented that approximately 1 in 3 U.S. children experience an investigation by CPS before age 18 years with substantial variation by race with a high of 53% for black children, and a low of 19% for Asians/Pacific Islander children. These findings suggest that CPS involvement during childhood is much more common when viewed from a life course perspective, and substantial racial disparities persist through childhood.[4,5]

The value of population-based integrated administrative data for conducting child maltreatment research and surveillance is described extensively in the literature.[6–9] Longitudinally integrated administrative data linked to a population base, such as birth records, are especially valuable as they enable researchers to map what services clients receive over time, measure incidence, study risk and protective factors, and evaluate outcomes across subgroups.[10] As a result, some states have integrated entire birth cohorts with CPS records to directly measure the cumulative incidence of child maltreatment and identify underlying population-based risk factors.[11–14] The Centers for Disease Control and Prevention and the Administration of Children and Families both suggest administrative record linkages as a method for conducting comprehensive child maltreatment surveillance.[15,16]

Despite recognized challenges with making cross-jurisdictional comparisons of child maltreatment because of differences in population structure (i.e., age, race/ethnicity) and child welfare practices, comparative rankings are frequently done by news media outlets, legislative bodies, and evaluation efforts, and are often required to justify or prioritize funding. In addition, ecological studies comparing the impact of policy change, and prevention efforts, frequently rely on statewide maltreatment rates for comparative analysis. For example, Brown et al.[17] recently compared maltreatment rates between states with and without Medicaid expansion.

Although multiple studies have used linked, administrative data to study child maltreatment,[11–14,18] there are no prior studies that compare the cumulative incidence between states that have integrated entire statewide vital birth and death data with CPS records. Both Alaska and California have well-established population-based data integration projects to study the incidence of child maltreatment over the life course and have validated their respective methodologies for data linkages. This study uses data from both states to compare linkage methodologies, aligns coding of race groupings, ensures similarity in the outcome measure, and uses common analysis code to calculate the cumulative incidence. To mitigate the influence of CPS policies and practices between states, this study measures the first child maltreatment report as opposed to those investigated by CPS or substantiated. Both Alaska and California have comparable legal definitions of what constitutes abuse and neglect,[19] and similar mandatory child maltreatment reporting laws (Alaska's Statue § 47.17.290 and California's Welfare and Institutions Code § 300). However, the list of mandated reporters in California is more extensive, and California's CPS programs are administered by the county.[20] As a result, reporting practices vary across the region in California. Therefore, the overall similarities for capturing first report are likely the most comparable endpoint between these 2 states.

The current study compares the unadjusted and race-standardized cumulative incidence to first contact with CPS before age 7 years between 2 states that use similar methodologies for integrating administrative records. This study adds to the growing knowledge of linking administrative data to study child maltreatment by specifically documenting the methods used to compare 2 states with drastically different population structures.

METHODS

Both Alaska and California previously linked their statewide 2009–2011 birth records with CPS and death records from 2009 to 2015 using probabilistic matching techniques to identify thresholds for manual review. By using these 2 data sources, the cumulative incidence to first CPS report before age 7 years was calculated and compared. Linkage processes and race classifications in both sources were assessed, and the state child abuse and neglect reporting laws were reviewed to inform the comparison. Owing to the large differences in population race structure between Alaska and California and the well-documented over- and under-representation of specific race groups in CPS data, this variation was adjusted for using direct standardization to compare the cumulative incidence between these 2 states.

Standardization is a simple and effective method to adjust for a single confounder related to population structure for the sole purpose of making comparisons and is widely used in the public health field.[21] Age standardization is well-documented and often used to compare mortality rates across populations with differential age structures. For example, states and communities with

substantially older populations have higher death rates compared with states with younger populations. Given that older people are more likely to die regardless of location, these methods calculate stratum-specific age rates that are then applied to a common population denominator to create a summary statistic that equalizes disproportionate distributions. Similarly, race standardization can control for racial differences in population structure and variation in race disparities.

Study Sample

The Alaska Division of Public Health integrated the statewide 2009–2011 birth records with death and state CPS records. These records were integrated using the R, version 3.1.0, RecordLinkage package based on first and last name, date of birth, and sex identifiers. Special characters and spaces were removed; case and character types were aligned before conducting matches. The match probability threshold was identified using a Pareto distribution estimation,[22] with match scores based on the Jaro–Winkler distance matrix.[23] Multiple births were first identified, isolated, and linked. Subsequent linkages first blocked on the year of birth, exact matches were accepted, and scores between 0.89 and 0.99 manually reviewed. Blocking was then removed, and remaining unlinked data were linked and reviewed again for scores between 0.94 and 0.99. Finally, subset training data sets were created and a single hidden layer neural network was used to crosscheck linkages. Data were created by the Alaska Division of Public Health under its public health authority. All data were from existing linked data that is housed at the Alaska Department of Health and Social Services. All linkages and analyses were conducted by employees of the Alaska Department of Health and Social Services and operated under state confidentiality and data-sharing agreements as outlined in Section 18 of the Alaska State code of routine public health evaluation.

California's population-level administrative vital birth and death records were obtained from the California Department of Public Health. State child protection records were obtained from the California Department of Social Services. Linkages were conducted using ChoiceMaker, a probabilistic linkage software program. Identifiers used to link the 2 data sources included first name, last name, date of birth, residential address, and guardian/parent names and birthdates. Probability scores were based on prespecified comparisons of identifiers (e.g., exact name match, Soundex comparisons, birthdate comparisons), and the match probability was calculated based on the amount of agreement and disagreement between the identifiers in each set and indicated how likely it was that the records referred to the same individual. Data access was within existing state data use agreements and both state and university IRB protocols.

Measures

Race/ethnicity classification groupings were aligned between Alaska and California using the primary maternal race/ethnicity indicated on the birth certificate. California had 30 race/ethnicity groupings compared with 17 in Alaska. Ad hoc assessments resulted in the current classification structures. Hierarchal classification was used to specify Hispanic; any mention of Hispanic ethnicity resulted in Hispanic classification followed by primary race indicated if Hispanic ethnicity was null (Appendix 1 describes race/ethnicity groupings and classifications; available online).

For this study, the date of first report of harm was used, regardless of screening (i.e., evaluated out or investigated by CPS) or findings (i.e., substantiated for maltreatment). The use of first report mitigates differences in CPS policies and processes between states but is still subject to differences in reporting laws. Maltreatment reports included those for physical abuse, sexual abuse, neglect, and mental injury in both states. Reports were limited to only those occurring at the time of or after birth through the end of 2015.

Alaska's Statue § 47.17.290 and California's Welfare and Institutions Code § 300 have similar definitions of what constitutes abuse and neglect.[21] Both states include sex trafficking as a form of abuse, allow for reports because of circumstances that may create substantial harm to the child, include emotional abuse and mental injury, and exclude reports of medical neglect if the parents did not seek care because of religious beliefs. Alaska and California both have mandatory child maltreatment reporting laws. The 2 states both include teachers and administrative staff, peace officers, counselors, medical providers, and coaches. However, the list of mandated reporters is more extensive in California than Alaska. California additionally names any administrator at organizations that have contact with children, public assistance workers, firefighters, and any individual who presents at a school, among others. The primary difference between the 2 states is that California's CPS programs are administered by the county, whereas Alaska's CPS program is administered by the state.[22]

Statistical Analysis

After data sources were aligned by race groupings, structure, and end date, each state calculated the age at first report, death, or end of follow-up using the same procedures. The survivorship function S(t) was calculated using a Kaplan–Meier approach,[24] and 95% CIs on the log survival scale.[25] The cumulative incidence (incidence proportion) was then calculated as ($F[t] = 1 - S[t]$). The authors plotted and compared the crude cumulative incidence and race strata–specific estimates between Alaska and California using z-score statistics. They then adjusted the Alaska estimates to the California population distribution to create race-adjusted RRs for comparison. Direct standardization was used to adjust for the disparate racial distributions between Alaska and California. Although the choice of the standard population is somewhat arbitrary so long as both are standardized to the same population,[26] standardization to the California child population distribution was done owing to the large population sizes in each race stratum. All analyses occurred between July and August 2018 with R, version 3.1.0 using the survival package.

RESULTS

From 2009 through 2011, a total of 33,923 births occurred in Alaska and 1,538,994 births occurred in California. Based on the unadjusted statewide cumulative incidence, 26.0% (95% CI=25.5%, 26.5%) or 1 in every 3.8 Alaskan births and 19.0% (95% CI=18.9%, 19.1%) or 1 in every 5.3 Californian births experienced a report of harm to CPS before age 7 years (Figure 1). Relative to California, children born in Alaska were 37% more likely to be reported to CPS for an allegation of harm before age 7 years (RR=1.37, $p<0.001$).

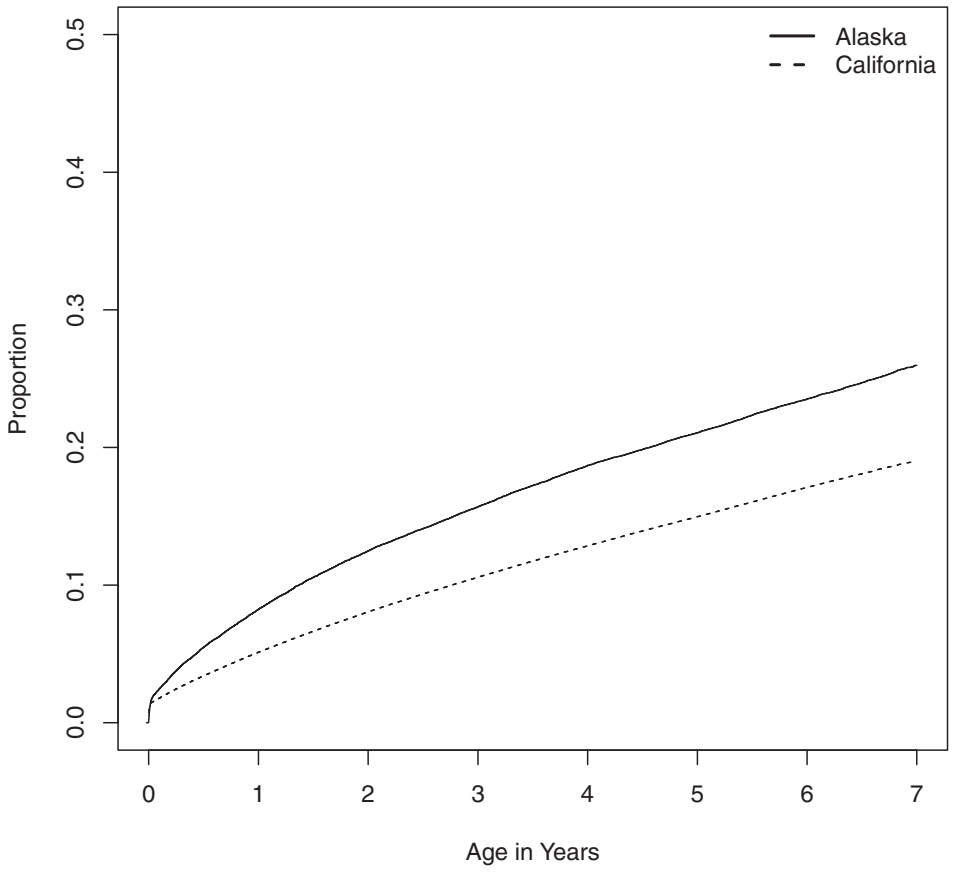

Figure 1. Statewide survival curves for Alaska and California. Crude (unadjusted) curves are shown, with Alaska indicating a CPS involvement rate of 26.0% and California 19.0% by age 7 years. CPS, Child Protective Services.

The distribution of births by maternal race classification varied by state (Table 1). Significantly different proportions in race and ethnicities were observed for all 6 racial groupings: (1) American Indian/Alaska Native (0.4% in California and 25.1% in Alaska, $p<0.001$), (2) Asian/Pacific Islander (12.5% in California and 8.6% in Alaska, $p<0.001$), (3) black (5.4% in California and 3.8% in Alaska, $p<0.001$), (4) Hispanic (50.6% in California and 6.1% in Alaska, $p<0.001$), (5) white (27.3% in California and 55.4% in Alaska, $p<0.001$), and (6) other (3.9% in California and 1.0% in Alaska, $p<0.001$).

The cumulative incidence to first report of maltreatment by racial groupings varied within each state (Figure 2). However, the stratum-specific estimates by race were similar between states, aside from the incidence for Asian/Pacific Islanders. For both Alaska and California, American Indian/Alaska Native children experienced the highest cumulative incidence, followed

Table 1. Race/Ethnicity Specific Population Distributions and Cumulative Incidence for CPS Involvement by Age 7 Years

	Alaska		California	
Race/ethnicity	**Total population, % (N=33,923)**	**Cumulative incidence (95% CI)**	**Total population, % (N=1,538,994)**	**Cumulative incidence (95% CI)**
American Indian/Alaska Native	25.1	0.487 (0.475, 0.499)	0.4	0.432 (0.415, 0.448)
Asian/Pacific Islander	8.6	0.201 (0.194, 0.236)	12.5	0.067 (0.065, 0.069)
Black	3.8	0.305 (0.277, 0.331)	5.4	0.379 (0.374, 0.384)
Hispanic	6.1	0.222 (0.203, 0.241)	50.6	0.213 (0.211, 0.215)
White	55.4	0.167 (0.161, 0.173)	27.3	0.159 (0.157, 0.160)
Other	1.0	0.216 (0.167, 0.261)	3.9	0.218 (0.213, 0.223)

CPS, Child Protective Services.

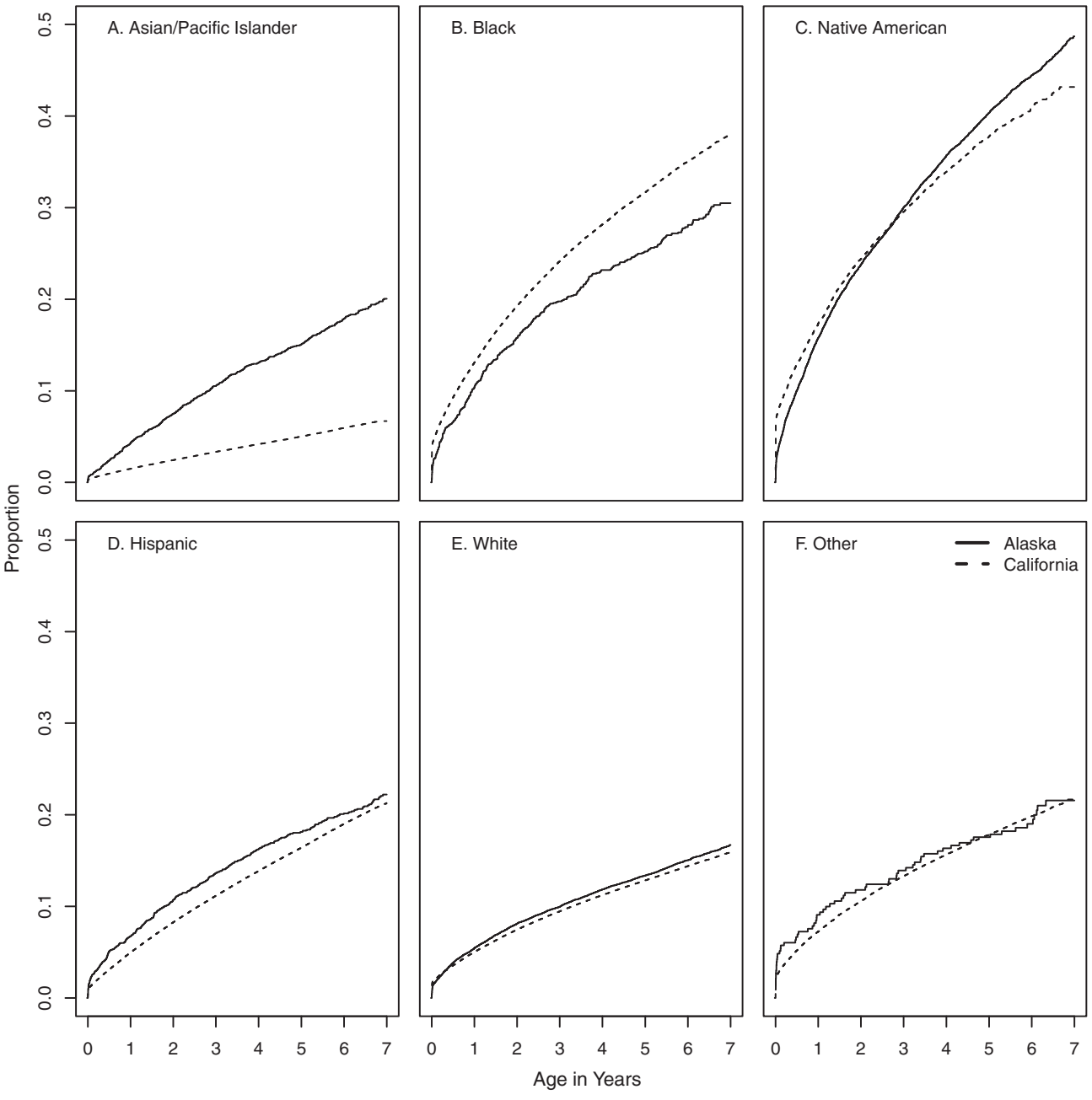

Figure 2. Race/ethnicity stratum-specific cumulative incidence for Alaska and California.

by black children. Asian/Pacific Islander children were found to have substantially lower cumulative incidence in California compared with Alaska (6.7% vs 20.1%).

After standardizing Alaska's race-specific cumulative incidence estimates to the California race population distribution, the race-adjusted cumulative incidence was 21.0% (95% CI =19.3%, 22.6%) in Alaska (Table 2), compared with 19.0% (95% CI=18.9%, 19.1%) in California ($p<0.05$). Relative to California, for every 100 births, Alaska experienced 2 additional cases compared with 7 additional cases when not accounting for differences in population structure using the unadjusted estimates. The standardized incidence ratio comparing CPS reports before age 7 years in Alaska to California was 1.10, indicating a 10% higher risk of reports in Alaska.

DISCUSSION

Both Alaska and California use linked statewide administrative data to measure the cumulative incidence of CPS involvement and study factors contributing to CPS

Table 2. Alaska Stratum-Specific Cumulative Incidence Estimates Directly Standardized to the California Birth Population

Race	Alaska cumulative incidence	California cumulative incidence	Standard birth population (California)	Expected number of cases in Alaska
American Indian/Alaska Native	0.487	0.432	5,580	2,717.7
Asian/Pacific Islander	0.201	0.067	192,178	38,544.4
Black	0.305	0.379	83,112	25,335.9
Hispanic	0.222	0.213	778,124	172,811.8
White	0.167	0.159	420,681	70,310.9
Other	0.216	0.218	59,319	12,794.8
Total			1,538,994	322,515.4
Adjusted cumulative incidence				0.210

involvement. After aligning these linked data between states, the unadjusted cumulative incidence observed in each state were compared. Three main findings were apparent: (1) adjusting for racial differences between jurisdictions reduces differences in cumulative incidence of maltreatment; (2) risk of CPS involvement remains largely consistent among racial/ethnic groups across jurisdictions; and (3) there is a persistent difference in cumulative risk for the Asian/Pacific Islander populations between states, likely attributed to the grouping of distinct racial/ethnic subgroups.

First, children born in Alaska are 1.37 times as likely to experience a report of harm before age 7 years compared with children born in California. Owing to well-known and documented disparities in CPS involvement by race/ethnicity and the substantial differences in race/ethnicity distributions between Alaska and California,[27–29] the confounding effect of population structure was adjusted for using direct standardization. When accounting for differences in population structure, the race-adjusted cumulative incidence indicates that children born in Alaska are only 1.10 times as likely to experience a report of harm before age 7 years relative to children born in California. Additional research should be undertaken to understand the underlying factors contributing to the elevated risk in Alaska after adjusting for racial differences.

Second, this study does not attempt to measure or explain racial disparities in reporting to CPS. However, this study does add knowledge about racial/ethnic disparities observed across jurisdictions. The use of cross-jurisdictional data from linked administrative data systems may increase sample sizes and improve comparisons for statistical assessments. For example, because the indigenous population in California only accounts for 0.4% of all live births in the state, the large observed disparity may inadvertently receive less attention. Combining information across states could enable increased sample sizes, allowing more sophisticated analyses to understand underlying factors contributing to persistent disparities.

Similar to the findings of Kim and colleagues,[5] both Alaska and California documented substantial disparities in race. However, unlike the synthetic cohort, the current study found American Indian/Alaska Native to have the highest risk of a CPS report in both states. Aside from Asian/Pacific Islanders, the risk of first report was similar for each racial group, indicating racial disparities in reporting remain across state jurisdictions and in need of focused attention.

Third, post-hoc analyses investigated the differences in risk within the Asian/Pacific Island group. Although small numbers precluded definitive assessment, it appears the heterogeneity of the Asian/Pacific Islander group is contributing to this difference. In particular, the Filipino population in Alaska may be experiencing a different risk than the Filipino population in California, which may be contributing to the differences observed after adjustment. Previous examination of Asian/Pacific Islander heterogeneity in California has shown variation in risk between specific subpopulations.[30] The current study suggests that the differences in subpopulation proportions should be further explored.

Limitations

The results of this study should be interpreted in the context of 4 main limitations. First, the authors sought to compare the cumulative incidence between 2 states with dissimilar racial structures, which magnifies the effect of standardization. Although there may be differences in the racial structures (i.e., California has a large Hispanic population and Alaska has a large Native population compared with other states), the current study provides a method for collapsing and harmonizing fields for accurate comparison. Second, though state reporting laws and practices are similar, unknown differences in reporting practices may contribute to detected

differences. Third, the authors were unable to account for potential differences in population emigration between and within states using the linked data available in both states. The addition of administrative records with information about current residence would improve the analyses given that CPS data are only collected for those who reside in a given state, and it is unknown which individuals in the birth cohort moved to another state. Finally, the races/ethnicities specified on the birth certificate were collapsed into larger racial groupings in California, likely because of the relatively small population in Alaska. This approach prevented the examination of some specific racial/ethnic subgroupings. However, the authors were able to group California's data based on the categories collected by Alaska.

CONCLUSIONS

This study underscores the effect large variations in underlying population structure (specifically race/ethnicity) can have on a direct comparison of CPS involvement between jurisdictions. Standardization is a simple and effective method to adjust for a single confounder related to population structure when making comparisons.[21,26] Although Alaska appears to have elevated cumulative incidence relative to California, much of the difference is potentially owing to the difference in the structure of the population by race. Further research should consider pooled and cross-jurisdictional assessment to identify those factors contributing to persistent racial disparities within states.

The population-based approach used for generating these measures is critical for developing public health interventions and accurate estimates of the longitudinal risk of CPS contact. With the increased use of population-based integrated administrative data to understand the factors contributing to maltreatment, cross-jurisdictional assessments and meta-analyses will likely follow. This study contributes to the growing body of knowledge using linked administrative data to study maltreatment and provides insights into considerations for rigorously making comparisons or conducting cross-jurisdictional analyses based on commonly aligned data sets.

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Although the reported findings and conclusions drawn from these data are solely those of the authors and should not be considered to reflect those of any agency of the Alaska or California governments, this analysis would not be possible without the partnership of the Alaska Department of Health and Social Services, California Department of Social Services, and the county child welfare departments. This collaboration reflects their ongoing commitment to data-driven programs and policy development.

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All authors developed the study concept and design, critically reviewed and revised the manuscript, and have approved the manuscript, as submitted. JWP conceptualized the study design and statistical analysis strategy, oversaw the analysis, constructed the initial code used to estimate cumulative incidence, and prepared the manuscript. JMF directed the study's initial conceptualization, led the writing of the initial manuscript, and supported the analysis strategy and interpretation of results. JP contributed to the development of the study design, conducted statistical analyses, supported the interpretation of results, and contributed to manuscript preparation. ALE contributed to coding, supported the interpretation of results, conducted the between state policy analysis, and contributed to manuscript preparation. LEGW conducted the literature review, contributed to interpretation of results, and wrote drafts of multiple sections of the initial manuscript.

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SUPPLEMENTAL MATERIAL

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