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Positive income shocks and accidental deaths among Cherokee Indians: a natural experiment

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Background Several studies in low-income populations report the somewhat counterintuitive finding that positive income gains adversely affect adult health. The literature posits that receipt of a large portion of annual income increases, in the short term, risk-taking behaviour and/or the consumption of health-damaging goods. This work implies the hypothesis that persons with an unexpected gain in income will exhibit an elevated risk of accidental death—the fifth leading cause of death in the USA. We test this hypothesis directly by capitalizing on a natural experiment in which Cherokee Indians in rural North Carolina received discrete lump sum payments from a new casino.

Methods We applied Poisson regression to the monthly count of accidental deaths among Cherokee Indians over 204 months spanning 1990–2006. We controlled for temporal patterns in accidental deaths (e.g. seasonality and trend) as well as changes in population size.

Results As hypothesized, the risk of accidental death rises above expected levels during months of the large casino payments (relative risk = 2.62; 95% confidence interval = 1.54–4.47). Exploratory analyses of ethnographic interviews and behavioural surveys support that increased vehicular travel and consumption of health-damaging goods may account for the rise in accident proneness.

Conclusions Although long-term income gains may improve health in this population, our findings indicate that acute responses to large income gains, in the short term, increase risk-taking and accident proneness. We encourage further investigation of natural experiments to identify causal economic antecedents of population health.

Keywords Accidental death, American Indians, casino, income shock, risk-taking, unintentional injury

Introduction

Accidental death ranks as the fifth leading cause of mortality in the USA.[1] Unintentional motor vehicle crashes, poisoning and falls account for 80% of these deaths. Also referred to as mortality from unintentional injury, accidental death has gained increasing attention as its incidence has remained relatively stable despite the secular decline in age-adjusted

mortality.[1,2] The literature finds that both ecological and individual-level factors affect the incidence of accidental injury and death.[3–6]

Several studies in low-income populations, including a randomized, large-scale conditional cash transfer experiment,[7] report the somewhat counterintuitive finding that positive income shocks adversely affect adult health.[8,9] This literature typically assumes that receipt of a large portion of annual income increases, in the short term, risk-taking behaviour and/or the consumption of health-damaging goods.[10] State-level analyses, moreover, support that years of economic expansion coincide with a per capita increase in vehicle miles travelled, alcohol consumption and motor vehicle fatalities.[11–14] This work implies a 'full-wallet' hypothesis in which persons with an unexpected gain in income may alter behaviours which, in turn, increase the acute risk of accidental death. We know of no literature that directly tests this hypothesis.

In the late 1990s, the Eastern Band of Cherokee Indians in rural North Carolina underwent a natural experiment by way of the introduction of a casino on their lands. Under the terms of an agreement with the Cherokee, the casino allocated a percentage of profits in acute lump sums to all enrolled Cherokee Tribal members. Gaming proved profitable; since 1996, per capita payments to Cherokee have averaged $5655 per year. We note that the opening of the gaming casino was neither truly exogenous nor effectively randomly assigned by nature (such as an earthquake) and therefore does not adhere to the strict definition of a natural experiment. However, we use this term to be consistent with previous literature on this population.

Per capita disbursements raised income levels of an entire community that previously exhibited a high rate of poverty. Between the years of 1995 and 2000, the percentage of Cherokee families below the poverty line fell from almost 60% to <25%, whereas the percentage of non-Indian families in surrounding areas below poverty hovered at ~20% during the same time span.[15] In addition, Harrah's, the company that operates the casino, contributes a certain percentage of gaming profits to Tribal infrastructure every year. For example, in 2003, Harrah's directed 9% of gaming profits to Tribal health and medical services.[16] Previous studies indicate a long-term cumulative salutary impact of per capita checks on Cherokee health, educational outcomes and criminal behaviour.[15,17,18]

The lump sum and relatively large amount of the per capita payment to the Cherokee provides a unique opportunity to test whether deaths due to unintentional injury rise above expected values in months of the positive income gain. We test this hypothesis using monthly mortality data on American Indians, a population that exhibits the highest incidence of accidental deaths of any race/ethnicity in the USA.[1,19] Our study aims to identify antecedents of accidental deaths and to expand the relatively scant literature that analyzes the potentially causal relation between income shocks and health.[20–22]

Methods

Variables and data

In 1995, the Eastern Band of Cherokee Indians opened a casino on the Qualla Boundary land trust. In 1997, they entered into an agreement with Harrah's to manage the casino. The Qualla Boundary lands span between Jackson and Swain counties, and the vast majority of Cherokee Indians live either in these counties or in non-contiguous lands known as Snowbird, primarily located in Graham County. We therefore focused our analysis on these three counties, which have a total population estimated at 57 000.

We acquired monthly incidence data for accidental deaths in these three counties from North Carolina Vital Statistics mortality file (NCVS) for 204 months spanning from 1990 to 2006 (longest series of mortality data at the time of our tests).[23] The reporting of deaths is believed to be nearly 100% complete.[24] Beginning in 1999, North Carolina moved from reporting cause of death using International Classification of Disease, 9th Revision (ICD-9) codes to the ICD-10 codes. As a result, we used the ICD-9 codes for the years 1990 through 1998 and the ICD-10 codes for 1999 through 2006.

We used as the outcome variable the monthly count of American Indian deaths that, consistent with the US Division of Vital Statistics, comprise mortality due to unintentional injury.[1] This selection strategy necessarily excluded deaths due to intentional injury (e.g. homicide). Table 1 lists the ICD codes used to classify accidental deaths.

We examined American Indian deaths in Jackson, Swain and Graham counties as a proxy for Cherokee deaths. No other federally recognized, state recognized or even unrecognized tribes claim lands in the western North Carolina area, and the Cherokee have historically been the only tribe in this region of western North Carolina. Previous studies have used the census indicator of American Indian or Alaska Native as a proxy for Cherokee in this region.[15]

We restricted our analysis to persons $\leqslant 55$ years to focus on the population whose accident proneness appears responsive to income gains.[7,21,25] We excluded older adults because many unintentional injury deaths at the age of over 55 years involve falls.[26] The main causes of falls in older adults involve inadequate muscle and bone strength, cognitive impairment and reduced vision.[27,28] We know of no literature that would point to a test of the relation between acute income gains and these factors. Moreover, we included children on the basis of the sensitivity of child unintentional injuries to caregiver risk-taking and reduced parental vigilance.[4,29,30]

Table 1 ICD-9 and ICD-10 codes that comprise accidental deaths, 1990–2006

Description	ICD-9 code	ICD-10 code
Transport accidents	E800–E807, E810–E819, E820–E829, E831, E833–E845	V01–V99
Falls	E880–E886, E888	W00–W19
Accidental discharge of firearms	E922	W32–W34
Accidental drowning and submersion	E830, E832, E910	W65–W74
Accidental suffocation and strangulation	E911–E913	W75–W84
Accidents caused by exposure to smoke, fire and flames	E890–E899, E924	X00–X09
Accidental poisoning and exposure to noxious substances	E850–E869	X40–X49
Other and unspecified accidents	E846–E848, E887, E914–E915, E918, E921, E923, E925–E927, E928, E929	W20–W31, W35–W64, W85–W99, X10–X39, X50–X59

We defined the independent variable as a binary indicator coded '1' in the 21 months in which Cherokee received the per capita disbursement and '0' for all other months. Checks began on 1 December 1995 and continue to this day.[16] Unlike other income transfer programmes in which recipients obtain monthly cheques, the Cherokee received their payout either as an annual or as a biannual lump sum. From 1995 to January 1998, all Cherokee aged $\geqslant$18 years received an annual lump sum on 1 December, after which they received payment twice a year, on 1 June and 1 December. Cherokee aged $<$18 years received the funds in a trust account that would accumulate until they turned 18 years [or 21 years if they had not obtained a high school degree or graduate equivalency degree (GED)] and could gain access.

Design and analysis

Our test turns on whether the observed value of accidental deaths among the Cherokee rises above expected values during months in which the Cherokee receive the per capita payment. Literature that examines the temporal distribution of accidents typically assumes that the expected value of the outcome follows a Poisson probability distribution.[4,31] We began the analysis with this assumption. To ensure that the probability of accidental death in a particular month was proportional to the size of the population at risk, we used as an offset variable the estimated monthly Cherokee population size aged $\leqslant$55 years in Jackson, Swain and Graham counties.[32]

Next, we added the binary variable indicating months in which Cherokee received the per capita disbursement to the model. We specified a concurrent relation at Month 0 (i.e. accidental deaths rise in the month of per capita payment) because we hypothesize a proximate response to the income receipt. This acute response, moreover, appears consistent with previous research on economic antecedents of accidental death.[4]

The above steps yielded the following test model:

$$\text{Log}(\mu_{jt}|\text{percap}_{jt}) = \beta_0 + \beta_z \text{percap}_{jt} + \log(N_{jt})$$

where:

- $\text{Log}(\mu_{jt}|\text{percap}_{jt})$ is the log- mean count of Cherokee deaths due to unintentional injury in year j and calendar month t, conditional on covariates
- β_0 is the overall intercept;
- β_z is the coefficient for the per capita payment variable at lag 0;
- percap_{jt} is an indicator variable for the per capita payment in year j at month t, coded '1' for months of payment and '0' otherwise;
- N_{jt} is the estimated Cherokee population size aged $\leqslant$55 years in Jackson, Swain and Graham counties in year j at month t (i.e. offset variable)

We also included a dispersion parameter that allows the variance of the outcome to be greater or less than its mean. If the dispersion parameter differed from the null, then the computational program [i.e. PROC GENMOD, LINK= NB command in statistical analysis system (SAS)] assumed a negative binomial, rather than a Poisson, error structure. We specified robust standard errors for count data that allow for potentially non-independent observations.[33]

Accidental deaths may exhibit temporal patterns such as trend or seasonality.[34] This circumstance could confound our test if, for example, many accidental deaths predictably occurred in December and coincided with the timing of per capita disbursement. We, therefore, tested the sensitivity of our results to an alternate specification which included fixed-effect indicator variables both for year and for calendar month.

A positive association between the per capita month variable and the log-count of accidental deaths would

favour the 'full-wallet' hypothesis. If results supported the hypothesis, we performed an additional exploratory analysis to assess whether behavioural and ethnographic data from the Cherokee would illuminate behaviours consistent with our initial hypothesis.

Results

Table 2 describes the characteristics of accidental deaths to Cherokee Indians in Jackson, Swain and Graham counties from 1990 to 2006. Unintentional motor vehicle/transport injury accounted for the majority of the 75 deaths. Males comprised 76% of total accidental deaths, and persons with less than a high school education comprised 48% of the total.

Figure 1 plots the observed probability distribution of accidental deaths over the 204 months for the Cherokee as well as the discrete probabilities expected under the Poisson distribution. Inspection of these two plots indicates that accidental deaths follow a Poisson distribution. In 72% of all months analysed, no (i.e. 0) accidental deaths occurred (Figure 2). The mean number of deaths was 0.37 per month. The risk of accidental deaths in the months with per capita payments was 0.85, whereas the risk in non-payment months was 0.34 (crude relative risk = 2.5).

Table 3 shows the results from the Poisson regression in which we included the per capita payment variable and population offset term. The dispersion parameter [coefficient = −0.48; 95% confidence interval (CI) −0.23 to 1.19] indicates that the Poisson model offers a sufficient fit for the analysis. Results show increased accidental deaths in months of the per capita payment (relative risk = 2.62, 95% CI 1.54–4.47). We tested whether findings appeared sensitive to inclusion of fixed-effects indicator variables for calendar month and for year. We specified 16-year indicators and 11-month indicators in addition to the variables included in the original model and re-estimated the equation. Inclusion of these additional parameters yielded less precise CIs; inference for the per capita payment variable, however, remained essentially the same (relative risk = 2.95, 95% CI = 1.06–8.19).

Support for our hypothesis led us to explore whether responses to behavioural surveys among the Cherokee could illuminate mechanisms connecting per capita payments to a rise in accidental deaths. For this analysis, we used two sources of data. The second author (Brown) conducted ethnographic research of randomly sampled persons in and around Jackson, Swain and Graham counties from 2002 to 2005.[35] Data collection included 70 life-history interviews and 36 focus groups with youth aged 15–25 years ($n = 162$). All of the transcripts and interview notes with Cherokee participants (approximately half) were coded using Atlas.ti for any mention of per capita cheques and spending patterns or plans.[36] Respondents most frequently mentioned spending (or planning to spend) their per capita checks on motor vehicles. Cherokee youth also discussed spending money on alcohol or drugs, vacations (mostly involving destinations within driving distance) and paying off debts.

The second source of data comes from the Life Trajectory Interview for Youth (LTI-Y), whose survey properties are described elsewhere.[37] The LTI-Y includes a supplemental questionnaire regarding

Table 2 Characteristics of accidental deaths among Cherokee Indians in Jackson, Swain and Graham counties, 1990–2006 ($n = 75$)

Characteristic	*n* (%)
Type of death	
Transport/Motor vehicle	42 (56.0)
Poisoning	13 (17.3)
Falls	4 (5.3)
Other	16 (21.3)
Age (in years)	
⩽15	4 (5.3)
16–24	21 (28.0)
25–55	50 (66.7)
Gender	
Male	57 (76.0)
Female	18 (24.0)
Education	
<High school graduate	36 (48.0)
High school graduate	28 (37.3)
Some college	9 (12.0)
College graduate	2 (2.7)

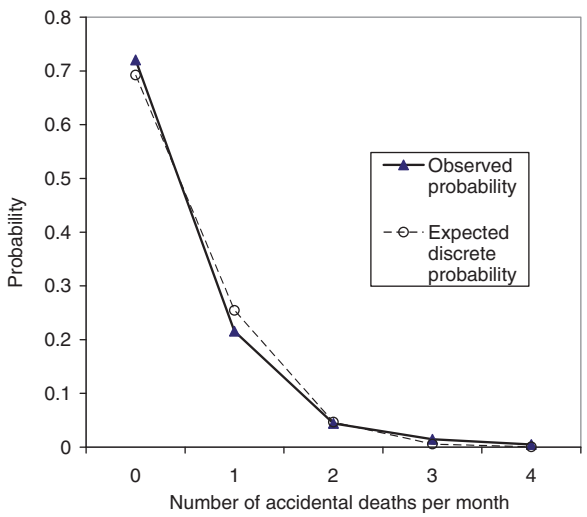

Figure 1 Observed probability and expected Poisson probability distribution of accidental deaths among Cherokee Indians ($n = 204$ months, 1990–2006)

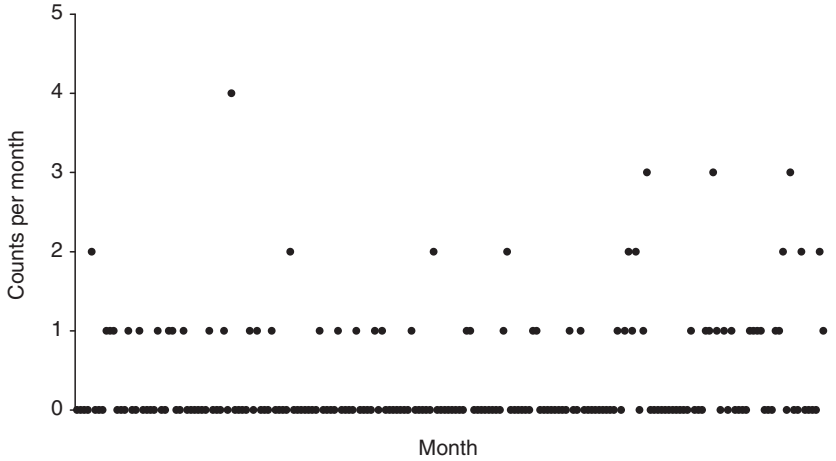

Figure 2 Count of accidental deaths among Cherokee Indians over 204 months from 1990 to 2006

Table 3 Relative risk of accidental deaths (robust 95% CI) for Cherokee Indians in Jackson, Swain and Graham counties, 1990–2006

Characteristic	Relative risk (95% CI)
Months of per capita payout (referent: all other months)	2.62 (1.54–4.47)
Population offset term	Yes
Dispersion parameter	No
Quasi-likelihood Independence criterion	230.85

Table 4 Frequency of reported spending of per capita payment among Cherokee youth ($n = 140$)

Reported spending per capita payment on	All	Female	Male
Vehicle (car, truck or motorcycle)	85 (68.0)	44 (66.7)	41 (69.5)
Vacation/travel	35 (28.0)	16 (24.2)	19 (32.2)
Alcohol or drugs	22 (17.6)	6 (9.09)	16 (27.1)

Note: Percentage totals do not sum to 100% since not all response categories are shown in the table and respondents may report spending in multiple categories. Values are represented as *n* (%).

spending patterns and plans for per capita cheques. In all, 140 Cherokee aged 19–24 years completed the LTI-Y, of whom 125 had received per capita cheques (15 were below the age of 21 years and had not yet received a high school degree or GED). A considerable proportion of these 125 Cherokee (68%) reported spending their per capita cheques on motor vehicles, whereas 28% and 17.6% reported spending this money on travel or drugs and alcohol, respectively (Table 4).

Discussion

Analysis of Cherokee Indians in rural North Carolina indicates that the risk of accidental death rises above expected values in the months of a large per capita casino payment to all Tribal members. We find >2-fold increased risk of accidental death in months of the per capita payment. Results imply that positive income shocks to low-income Cherokee elevate the risk of accidental death.

Explanations for the findings include that this population may respond acutely to a large per capita payment by consuming goods or changing behaviours in ways that increase accident proneness. Exploration of both ethnographic interviews and behavioural survey data support this claim. Cherokee young adults report spending per capita cheques on motor vehicles (often fast or luxury vehicles), as well as vacations that involve long driving distances, and alcohol or drugs. A considerable number of Cherokee receive their 'big cheque' of ~$30 000—a cumulative sum of per capita payments that have collected interest each year in childhood until they reach the age of 18 years—during the months of June and December. Similarly to the behaviour in which youth obtain their driver's licence immediately on their birthday, many Cherokee youth purchase a vehicle immediately upon receipt of their 'big cheque'. Some of these youth use alcohol and drugs regularly, and the addition of a vehicle may create an increased risk of accidental death. An added risk may arise from the fact that many of these individuals become first-time vehicle owners with little previous driving experience. Furthermore, recreational vehicles such as motorcycles and all-terrain vehicles are common in the area. The intermittent biannual cheques (roughly $3000) could cover the cost of a used motorcycle. Such vehicles involve a learning curve that creates a detectable accident hump in the

first few months of ownership.[38,39] In addition, an increase in vehicular travel and consumption of alcohol or other substances—either in isolation or in combination—reportedly predisposes individuals to increased unintentional injury and death.[40–42] We remind the reader that data limitations on the death file did not permit confirmation of any of these mechanisms as definitive causes of accidental deaths in our population.

Strengths and limitations

Strengths of our test include that the NCVS has almost complete enumeration of deaths. We also minimize potential bias due to confounding by time by specifying year and calendar month fixed effects in our equations. This adjustment rules out the possibility of spurious associations due to seasonality or annual changes in accidental deaths that coincide with the months of per capita payment. Moreover, results cannot arise from fluctuations in residential Cherokee population size because we included this variable as an offset term in our regression. In addition, knowledge of the timing of the per capita payment allows us to examine the acute mortality response, which appears consistent with induction periods in the literature.[4,21]

A notable strength of this study involves the ability to combine quantitative approaches to test our hypothesis with qualitative techniques to explore causal relations. Even with small samples, qualitative and mixed methods data using random sampling (as was the case with Cherokee ethnographic and survey data) can yield reliable estimates of behavioural processes that can be scaled up to inform population-level analyses.[43] As well as living and working in one of the focal North Carolina counties (Jackson County) for 3 years, the second author (R.B.) collected extensive ethnographic and survey data from Cherokee youth, which aided the interpretation of quantitative results.

The welcomed infrequency of accidental deaths among the Cherokee in rural North Carolina ($n = 75$ spanning 204 months from 1990 to 2006) may have contributed to the relatively wide CI (1.54–4.47) for our per capita payment coefficient. In addition, insufficient statistical power precluded secondary analyses on particular age groups or specific causes of accidental death. The reader, therefore, should interpret our results as the population health response to per capita payments. Data limitations did not allow for examination of non-fatal unintentional injuries, a circumstance 300 times more common than unintentional injury resulting in death.[26] Survey responses from Cherokee youth in LTI-Y lead us to speculate that non-fatal injuries may also rise above expected values in months of the per capita payment. Given that accidental deaths represent such a small fraction of overall unintentional injuries, we encourage further research on non-fatal injury.

Previous studies of the impact of the casino on Cherokee health suggest a cumulative salutary benefit over the life course, although no research attempts to disaggregate salutary effects due to per capita disbursements from the considerable investment in Cherokee Tribal infrastructure over the years.[15–17] Regardless of the mechanism, it remains possible that the Cherokee experience a long-term aggregate improvement in health although also displaying acute 'bumps' in risky behaviour—and their attendant accidents—during months of the per capita disbursement.[44] Furthermore, the salutary effects described by Costello and colleagues presumably arose via a 'trickle down' effect in that young children whose parents received the payment fared better. Such a family-mediated effect may operate differently for children compared with the health effects of per capita cheques on adults.

We caution against the intuitive inference from these findings that all income transfers increase risk of accidental death or reduce health in general. We tested the effects of acute positive income gains, which differ from transfers received at regular intervals such as through labour market participation. Receipt of income at regular intervals may in fact raise overall income levels and promote investments in health.

The economics and public health literatures suggest two main alternatives to currently structured lump-sum cash disbursements. Firstly, researchers recommend staggering payments over time to smooth out consumption behaviours.[10] This process would, for example, divide annual lump-sum payments into four even quarter-year payments. Secondly, a particularly promising approach involves the conditional cash transfer in which income receipt occurs only after mandatory attendance at a financial management course, counselling session and/or wellness seminars.[45,46]

Conclusion

A recent review highlighted the scarcity of research on natural experiments which could help identify causal economic antecedents of health.[22] Our study of low-income American Indians on a gaming reservation exemplifies such a natural experiment. We find that positive income shocks from gaming casino revenues coincide with >2-fold increase in the risk of accidental deaths. We encourage further investigation to determine both the external validity of our findings and the intervening mechanisms that may connect positive income shocks to fatal and non-fatal injuries.

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KEY MESSAGES

- We examine whether unexpected gains in income coincide with an elevated risk of accidental death using a natural experiment in which Cherokee Indians in rural North Carolina received lump sum payments from a new casino.
- The risk of accidental death rises above expected levels during months of the casino payments.
- Qualitative survey and interview data find that increased vehicular travel and consumption of health-damaging goods may account for the over 2-fold rise in accidental deaths.
- Although income gains over time may gradually improve health in this population, short-term behavioural responses to large income gains may increase the acute risk of accidents.

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