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Child pedestrian deaths: sensitivity to traffic volume – evidence from the USA

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Abstract

Study objective **– In case centred epidemiological studies, traffic volume has been shown to be a potent risk factor for child pedestrian injuries. Nevertheless, over the past two decades child pedestrian death rates have fallen in many countries despite large increases in traffic volumes, suggesting that other factors are responsible for the long term decline in death rates. This study aimed to investigate the relationship between short term changes in traffic volume and child pedestrian death rates.**

Design **– The relationship between child pedestrian death rates and traffic volume in the USA for the period 1970–88 was investigated. Trends in death rates and in traffic volume were removed by the time series method of differencing.**

Results **– After removing the long term trends, there was a close relationship between the year to year variation in traffic volume and the year to year variation in the child pedestrian death rate. Most notably, in the two periods when traffic volume actually fell, the falls in the child pedestrian death rate were considerably larger than those seen at any other time. Overall, decelerations in the rate of increase in traffic volume were accompanied by accelerations in the rate of decline in the child pedestrian death rate.**

Conclusion **– While other factors may determine long term trends in child pedestrian death rates, they are very sensitive to short term changes in traffic volume. Public policy changes which limit the growth in traffic volume have the potential to accelerate the decline in child pedestrian death rates.**

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Pedestrian injuries are a leading cause of death and disability in childhood.[1,2] Each year in the United States over one thousand children are killed and approximately 18 000 children admitted to hospital as a result of injuries sustained in pedestrian motor vehicle collisions.[1] In case-control studies, high traffic volume has been shown to be a potent risk factor for child pedestrian injury.[3,4] It might therefore be expected that child pedestrian death rates would increase as traffic volume increases. Over the past two decades, however, child pedestrian death rates have fallen despite large increases in traffic volumes.[7] In this study we examine USA data for the period 1970–88 to investigate this apparent paradox. Data from the USA were chosen for study because the large population reduces binomial sampling variation in the child pedestrian death rates.

Methods

Pedestrian injury mortality rates (ICD 9 E code 814.7) for children aged 0–4, 5–9, and 10–14 years for the period 1970–88 were obtained from the Centres for Disease Control, Atlanta. The annual number of vehicle kilometres travelled (VKT) were obtained for the same period from the OECD International Road Traffic Accident Database in Germany.

The relationship between traffic volume, as measured by the annual number of VKT, and the child pedestrian death rate was examined by first removing the trend in each using the standard time series method of differencing, described by Box and Jenkins.[5] Specifically, the traffic volume and pedestrian death rate for each year were subtracted from the values for the following year. When these values are plotted they provide a graphical representation of the rate of increase in traffic volume and the rate of decline in pedestrian death rates. A constant decline would be represented by a horizontal line below the zero line, with a constant increase being represented by a horizontal line above the zero line. The strength of the associations between the two measures was quantified using Pearson correlation coefficients.

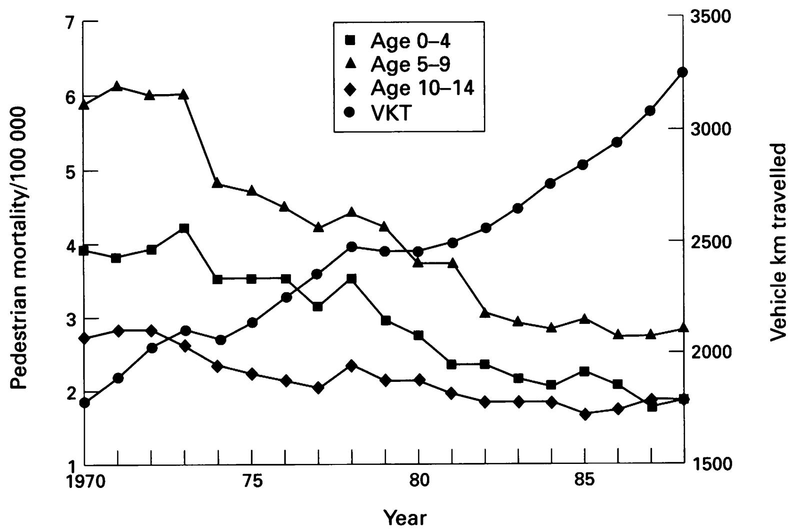

Figure 1 Child pedestrian death rates and traffic volume in the USA 1970–88.

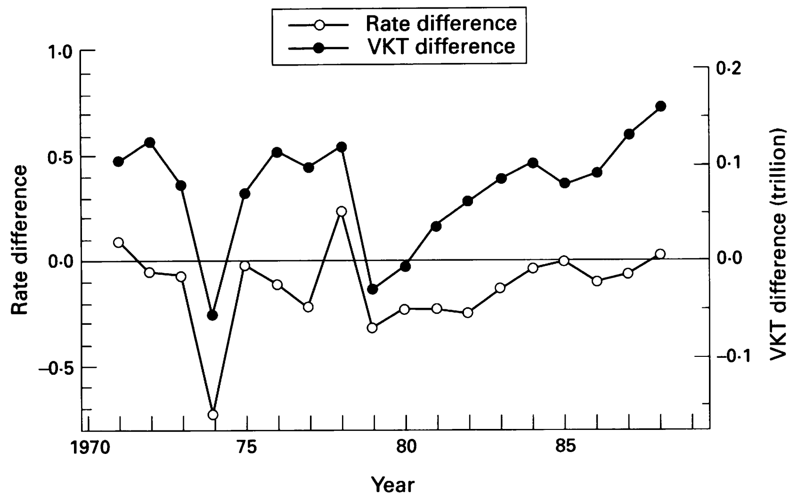

Figure 2 Relationship between year to year variations in traffic volume (vehicle kilometres travelled (VKT)) and year to year variations in child pedestrian death rates.

Results

Between 1970 and 1988, there was a decline in child pedestrian death rates in the USA, in all age groups. Pedestrian death rates fell by 54% for 0–4 year olds, 53% for 5–9 year olds, and 33% for 10–14 year olds (fig 1). The greatest absolute reduction in fatality rates was in the 5–9 year age group, which saw a reduction of 3·1 deaths/100 000. The largest year to year reduction in fatality rates occurred between 1973 and 1974, with an absolute reduction of 0·67/100 000 for children aged 0–4 years, 1·23/100 000 for children aged 5–9 years, and 0·28/100 000 for children aged 10–14 years.

Between 1970 and 1988 traffic volume, as measured by the annual number of VKT, increased from 1·78 trillion VKT in 1970 to 3·24 trillion in 1988. Traffic volume increased each year apart from 1973–74 and 1978–80 (fig 1).

Year to year variations in the rates were investigated by the method of differencing (see methods section) in which the rate in each calendar year was subtracted from the next. Thus each data point represents the increase or decrease from the previous year. Figure 2 shows that year to year changes in child pedestrian death rates parallel those for traffic volume. In general, reductions in the rate of increase in traffic volume were associated with an acceleration of the rate of decline in the pedestrian death rate. This was most marked in 1974 and 1979, years when there were actual reductions in traffic volume. The correlation coefficients between the year to year differences in traffic volume and the year to year differences in mortality were 0·81 ($p=0·0001$) for the overall (0–14 years) rate and 0·64 ($p=0·004$), 0·69 ($p=0·001$), and 0·57 ($p=0·014$) for the rates for the age groups 0–4, 5–9, 10–14 respectively.

Discussion

These results show a close relationship between year to year changes in traffic volume, as measured by year to year changes in the number of VKT, and the decline in the child pedestrian death rate. This decline occurred against a backdrop of a substantial increase in traffic volume over the entire study period. There were two periods when traffic volume actually fell. The first in 1974, following the energy crisis, was followed by a sharp increase in traffic volume. The second in 1979, was followed by a gradual acceleration in the rate of increase in traffic volume. What is compelling about these data is that the rate of decline in the pedestrian death rate parallels the rate of change in traffic volume.

These findings beg the question, "Why are the long term trends of traffic volume and death rates in opposite directions whereas their short term variations are in concert?". Possibly the most plausible explanation for the long term decline in the death rate, is that it is a manifestation of reductions in children's traffic exposure, as parents impose greater restrictions on their independent mobility.[6] A British study found that whereas in 1971, 80% of 7 year old children walked to school unaccompanied, in 1990 the figure was 9%.[6] The observation that mortality rates have fallen the least for children aged 10–14 years would be consistent with this explanation, since it would be more difficult for parents to impose restrictions on the mobility of older children. The effect of this trend is to obscure the relationship with traffic volume.[7] The relationship between child pedestrian death rates and traffic volume becomes apparent only when the trends are removed, as in this analysis.

The relationship shown between child pedestrian death rates and traffic volume suggests that policy changes which limit the rate of increase in the traffic volume have the potential to accelerate the decline in child pedestrian death rates. The long term effects of actual reductions in traffic volume, however, would depend on whether there were corresponding increases in children's exposure to traffic as pedestrians. It is possible that in the situation of decreasing traffic volumes, parents might perceive roads to be safer and thus might be more willing to let children make pedestrian journeys and to make them unaccompanied. Such increases in children's traffic exposure might offset the beneficial effect on pedestrian death rates of the decline in traffic volume, and might even be accompanied by an increase in injury rates. Nevertheless, limiting traffic volume, as opposed to limiting children's traffic exposure, has other potential advantages. Most importantly, it may diminish the striking socioeconomic gradients in pedestrian injury mortality rates that currently exist.[8] Children from poor families are more dependant on pedestrian travel than are children from affluent families.[9] Thus, if traffic volume were to decrease then this group would be expected to benefit the most. On the other hand, children from poor families are least able to reduce their traffic exposure, since car access is lower and they are likely to have fewer alternatives to playing in the street. Other advantages of reducing traffic volume would be the beneficial environmental effects and the greater independent mobility that children might then enjoy.

Past injury prevention efforts have adopted the somewhat limited approach of seeking to improve pedestrian safety given existing patterns of travel. These results imply that reducing the need for travel or changing transportation modes from the private passenger car to public transportation, may be a more effective prevention strategy. Although the child pedestrian mortality rate is at its lowest level for the past 20 years, between 1983 and 1988 an annual average of 1132 children were killed as pedestrians in the USA. An alternative approach to the prevention of child pedestrian injuries may now be appropriate.

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