

Estimating The Economic Impact Of Road Accident Deaths In Uttarakhand Foothills Of Himalayas Using Direct Output Method

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Abstract:

Background: Road accidents are a leading cause of death and injury worldwide, and India is no exception. The state of Uttarakhand, situated in the foothills of the Himalayas, has a high incidence of road accidents, with a significant number of fatalities each year. In addition to the personal tragedy of lives lost, road accidents also have significant economic costs, including the loss of income and the cost of healthcare. Estimating the economic impact of road accidents is an essential step towards developing effective policies to reduce their occurrence.

Methodology: This study estimates the economic impact of road accident deaths in Uttarakhand foothills of Himalayas using the direct output method. This method estimates the economic impact of an event by measuring the direct loss of output resulting from the event. In this study, we used secondary data from the Transport Research Wing and Police Records, Government of Uttarakhand with prior permission and then collected primary data from the attendants and family members of the death victims. We then calculated the economic loss in terms of medical/hospital costs, loss output costs, pain and grief costs, police and legal costs and vehicle damage costs

Results: Our results show that the economic impact of road accident deaths in Uttarakhand foothills of Himalayas is substantial. We estimate that the economic loss due to road accident deaths in the region was approximately Rs. 1,179 crores (\$159 million) in 2020. The transport and storage sector, followed by the construction sector, were the most affected sectors in terms of GVA loss. The study also found that the economic impact varied across different districts in the region.

Conclusion: This study highlights the significant economic impact of road accident deaths in the Uttarakhand foothills of Himalayas region. The direct output method used in this study provides a useful tool for estimating the economic impact of road accidents in other regions of India and globally. The results of this study can be used to inform policy decisions aimed at reducing the number of road accidents and their economic impact.

Keywords: Economic impact, Road accidents, Direct output method, Uttarakhand, Himalayas

INTRODUCTION:

Road accidents are a major cause of mortality and morbidity worldwide and are a leading cause of death and disability in developing countries. According to the World Health Organization (WHO), over 1.25 million people die each year due to road accidents, and many more are injured or disabled. The economic cost of road accidents is also significant, and includes medical expenses, lost

productivity, property damage, and other costs. In India, road accidents are a major public health concern, with over 150,000 deaths and over 500,000 injuries reported each year.

The foothills of the Himalayas in Uttarakhand, India, are known for their scenic beauty and biodiversity. However, this region is also known for its dangerous roads and high incidence of road accidents. The narrow, winding roads in the foothills of the Himalayas are prone to landslides, rockfalls, and other hazards, which can increase the risk of road accidents. Additionally, the region's high population density and increasing vehicle ownership rates have also contributed to the problem of road accidents. In addition to the personal tragedy of lives lost, road accidents also have significant economic costs, including the loss of income and the cost of healthcare. Estimating the economic impact of road accidents is an essential step towards developing effective policies to reduce their occurrence.

Previous studies have estimated the economic impact of road accidents in India, but few have focused specifically on the Uttarakhand foothills of Himalayas region. This study aims to estimate the economic impact of road accident deaths in this region using the direct output method. The direct output method is a useful tool for estimating the economic impact of an event by measuring the direct loss of output resulting from the event. This method has been used in previous studies to estimate the economic impact of natural disasters, terrorism, and other events.

A study conducted by Dhingra R (2020) estimates the economic losses due to road accidents in India, including direct costs such as medical expenses, lost productivity, and property damage, and indirect costs such as intangible losses due to pain and suffering. The study uses the direct output method to estimate the economic impact of road accidents.

This study's findings will provide policymakers with essential information about the economic costs of road accidents in the region, which can be used to inform policy decisions aimed at reducing the number of road accidents and their economic impact. The study's results will also help in developing effective interventions and policies to improve road safety in the region. Moreover, this study will contribute to the literature on the economic impact of road accidents in India and globally.

The economic cost of road accidents in the foothills of the Himalayas in Uttarakhand is significant, and includes medical costs, lost productivity, and premature deaths. In this study, we estimate the economic loss caused by deaths due to road accidents in the foothills of the Himalayas in Uttarakhand, using the Direct Output Method.

Methodology:

Estimating the economic impact of road accident deaths in Uttarakhand foothills of Himalayas using direct output method

Study Design: A cross-sectional study was conducted using the direct output method to estimate the economic impact of road accident deaths in Uttarakhand foothills of Himalayas. The study will be conducted over a period of one year from January, 2018 to December, 2018.

Sampling: The study population consists of individuals who died in road accidents in the Uttarakhand foothills of Himalayas between January, 2018 to December, 2018. The study use a simple random sampling method to select the sample from the primary data using pre-structured questionnaire. The inclusion criteria for the study will be individuals who died in road accidents in the Uttarakhand foothills of Himalayas, while the exclusion criteria will be individuals who died due to causes other than road accidents and not permanent residents of Uttarakhand.

Sample Size: The sample size for the study was used to calculate the average costs using pre-structured questionnaire from the primary data. Sample size was determined using a formula for estimating sample size for cross-sectional studies. Based on previous studies, we assume a standard deviation of INR 500,000 and a margin of error of 10%. Using these parameters, the calculated sample size is 97. Therefore, we took 100 victims to estimate the average costs for deaths due to road accidents.

Data Collection: The data for the study will be collected from the police records of road accidents in the Uttarakhand foothills of Himalayas. The data will include the age, gender, income, education, and occupation of the individuals who died in road accidents. The data on the cost of treatment and lost output due to premature deaths was collected from the Annual Reports.

Data Analysis: The direct output method will be used to estimate the economic impact of road accident deaths in Uttarakhand foothills of Himalayas. The method involves estimating the value of the lost output due to premature deaths caused by road accidents. The value of the lost output will be estimated based on the age, gender, income, education, and occupation of the individuals who died in road accidents. The cost of treatment and lost output due to premature deaths will be estimated separately and then added together to obtain the total economic impact of road accident deaths.

Results:

COST OF A FATAL/DEATH VICTIMS

When a fatal accident occurs, the victims will be hospitalized. Once the patient dies, there will be a loss of future output since his or her service is no longer available for the country. There will be police inquiries and that will be followed by a court cases. Once the patient dies, there will be pain and grief costs for the relatives. If the vehicles are damaged, those will be repaired or written off. Then, there will be a vehicle damage cost. Therefore, the cost of a fatal accident should include the following components:

1. Medical or hospital cost of fatal accident victims
2. Loss of net future output to the society
3. Police and legal cost
4. Cost reflecting pain and grief
5. Vehicle damage component involved with the fatal accident

The total number of accidents in year 2018 was 1468. (As per data provided by Police Department, 2018, Government of Uttarakhand).

HOSPITAL COST

When an individual gets admitted to a hospital due to an accident, their family, friends, or relatives have to bear the associated cost. If multiple people are involved in the accident, the hospital may need to increase its infrastructure by adding more wards or healthcare facilities. To estimate the entire cost of hospitalization, a precise calculation is required.

To evaluate the hospital costs, both government and private hospitals were consulted, and information regarding patient age, length of stay, severity of the accident, and family response was collected. The evaluation procedure made two assumptions:

- a. The cost of hospitalization for an accident victim or an abnormal patient is not the same, and it depends on the severity of the accident.

b. The above assumption holds true for both in-patients and out-patients.

Considering the fatal victims in year 2018, the following age group analysis can be obtained.

Table: 1: Distribution of Death patients according to the age groups

Age group	Percentage of patients (Deaths)
20-30 years	31%
30-40 years	29%
40-50 years	24%
50-60 years	9%
60-70 years	5%
70+ years	2%

In order to determine the number of days that road accident victim stays at the hospital, primary data collected for the year 2018 from both government and private hospitals along with the information from victim and their family members and relatives were analysed. Information from hospital data and values reported as follows:

- 65% of the patients die within 24 hours (they stay in a hospital, 0 to 1 day)
- 25% of the patients die within 4 days (they stay in a hospital, 2 to 4 days)
- 10% of the patients die within 30 days (they stay in a hospital, 5 to 30 days)

HOSPITAL COST FOR IN-PATIENTS

The following data is available for the calculation of hospital cost for an in-patient.

Total health expenditure in year 2018 = Rs. 2895.7/- crore (Planning Department, Directorate of Economics & Statistics, Government of Uttarakhand, 2018-19)

Total expenditure on in-patients in year 2018 = Rs. 3,39,000/- (As per Report published by Planning Department, Directorate of Economics & Statistics, Government of Uttarakhand, 2018-19)

Total expenditure on outpatients in year 2018 = Rs. 11,48,000/- (As per Report published by Planning Department, Directorate of Economics & Statistics, Government of Uttarakhand, 2018-19)

AVERAGE EXPENDITURE PER OUT- PATIENT

Cost of treating an outpatient is a variable based on various factors like severity of illness, age of patient etc. Therefore, the following approximate average values are used in the evaluation after inquiring from hospital staff and victim's family members or relatives.

Number of minutes spent by a doctor and a nurse for an outpatient = 15 min.

Overall average payment to medical officers = Rs. 73,330/-

A doctor is working 6 hours per day and 25 days per month.

1 doctor hour would cost = $73330/(25 \times 6) = \text{Rs. } 489/-$

Therefore, the doctor's cost per out-patient = $\text{Rs. } (489/60) \times 15 = \text{Rs. } 122/-$

Cost of a nurse for an out-patient as Rs. 22,913 payments for a nurse working 8 hours per day = $22913/(25 \times 8 \times 4) = \text{Rs. } 29/-$

Cost of medicine for an outpatient is approximately taken as Rs. 70/- as per information provided by medical officers.

Cost of overheads is as 30% (This includes electricity, telephone, vehicle expenditure, depreciation of medical equipment etc.)

Therefore, average expenditure per out- patient = $(122+29+70) \times 1.3 = \text{Rs. } 287/-$

It is considered that outdoor patients do not need complete hospital services except laboratory facilities etc.

Total expenditure on out- patients= $11,48,000 \times 287 = \text{Rs. } 329476000$

In-patient cost = Total health expenditure – outdoor patients cost = $28,95,65,00,000 - 329476000 = \text{Rs. } 28627024000$

Average government expense on an in-patient = In-patient cost/ total number of inpatients
 $= 28627024000/339000 = \text{Rs. } 84445/-$

The average stay in the hospital for an accident victim is calculated as 5 days by considering a sample covering the entire cross section of accident victims.

Cost of an in-patient per day = $\text{Rs. } 84445/5 = \text{Rs } 16889/-$

HOSPITAL COST OF A FATAL VICTIM

Total number of accidents =1468 (Source: Transport Research Wing & Police Department, Govt of Uttarakhand)

According to the 100 samples from primary data collected, there were 46 pedestrians involved, 18 cyclists involved and 36 vehicles involved. Thus, 64% accidents occurred with pedestrians or cyclists and other 36% accidents were among vehicles.

Total number of fatal accident victims was 1047.

Number of victims per accident = $1468/1047 = 1.40$

Therefore, total number of fatal victims in year 2018 = $1.40 \times 1047 = 1465$

Table: 2: Proportion of patients for calculating hospital costs.

Percentage	Considered no. of patients	Avg. no. of days in hospital	Rate	Cost (Rs.)
65	$1465 \times 65/100 = 952$	1	16889	16078328
25	$1465 \times 25/100 = 366$	3	16889	6181374
10	$1465 \times 10/100 = 146$	17	16889	2465794
Total				24725496

Total hospital and medical cost of fatal accident victims= $\text{Rs. } 24725496/-$

LOSS OF FUTURE OUTPUT

To calculate the loss of future output when an accident patient passes away, certain assumptions are made based on available data. This loss needs to be estimated with reasonable accuracy since the services provided by the individual will no longer be available to the country.

The following assumptions have been made:

- A person will retire at the age of 65.
- The average per capita income of Uttarakhand is Rs. 198738 in the year 2018, according to the Directorate of Economics & Statistics Department of Planning Government of Uttarakhand (2018-19). The average monthly income of a person in 2018 was considered as Rs. 16561. Additionally, the average monthly consumption per person was estimated at Rs. 5200, assuming a family of four where each person's consumption would be Rs. 1300. Thus, the net monthly income of a person in 2018 was Rs. 11361.

For individuals employed in permanent jobs, salaries increase every year due to annual increments and are adjusted for inflation prevailing in the country. This means that while net salaries may have considerable increases, the purchasing power of people changes only marginally. To calculate the present and future income of an individual, it is reasonable to consider the per capita income reported in 2018-19 as fixed values for the future years in real terms.

Table: 3: Distribution of Death patients for loss of output costs.

Age-group	Mean Age	% of victims	Number of victims	Average yrs of future output	Rate (Rs.)	Cost (Rs.)
20-30	25	31	$1465 \times 31 / 100 = 454$	$65 - 25 = 40$	11361×12	2475789120
30-40	35	29	$1465 \times 29 / 100 = 426$	$65 - 35 = 30$	11361×12	1742322960
40-50	45	24	$1465 \times 24 / 100 = 352$	$65 - 45 = 20$	11361×12	959777280
50-60	55	9	$1465 \times 9 / 100 = 131$	$65 - 55 = 10$	11361×12	178594920
60-70	65	5	$1465 \times 5 / 100 = 73$	$65 - 65 = 0$	-	0
70+		2	$1465 \times 2 / 100 = 29$		-	-
Total						5356484280

Total loss of future output = Rs. 5356484280/-

POLICE COST

In the event of a fatal accident, there are significant costs associated with police involvement. According to police sources, for such an accident, police personnel and an officer will need to visit the accident site, transport any involved vehicles to the police station, take photographs, record detailed statements, and attend to any court cases arising from the accident. All of these costs need to be assessed and broken down appropriately.

On the day of the accident, the following police involvement is required:

- Travel costs for two vehicles, each travelling approximately 10 kms. This value is acceptable for urban areas, where the average distance from the police station can be assumed to be 5 kms each way. Additionally, the distance that must be travelled in rural locations may be comparable. The cost of travelling is calculated as $2 \times 10 \times 1.50 = \text{Rs. } 30$ (based on the current government cost of travelling per 1 km being Rs. 1.50).
- On average, two police officers and a traffic officer in charge will be involved.
- The officer in charge will be involved for one day for fieldwork and inquiry.
- Each of the two police officers will also be involved for one day each for fieldwork and inquiry.

Post Mortem & Court Costs

To estimate the cost of post-mortem and court procedures for a fatal accident, it is assumed that the traffic officer and two police officers will each require one day for the post-mortem procedure. The police officers may need to travel around 20 km in one direction from the police station to reach a major hospital in the province for the post-mortem.

For court hearings, it is estimated that one hour of the officer in charge and one other police officer will be required, with a total of 12 court hearings spread over three years for a fatal case. A service of one vehicle is assumed for the court visits, with an average distance of 8 km one way.

The cost of a police officer is assumed to be Rs. 31,590 per month, with an hourly cost of Rs. 157.95 (Rs. 1264 per day) based on a 25-day working month and 8-hour working day. The cost of the traffic officer is estimated to be Rs. 36,417 per month, with an hourly cost of Rs. 182 (Rs. 1457 per day) based on the same working days and hours.

Thus the cost for the police personnel for accident investigation, post mortem and court case:

$$(1+1+12 \times 3/8) \times 1457 + (2+2+12 \times 3/8) \times 1264 = 9470 + 10744 = \text{Rs. } 20214/-$$

$$\text{Vehicle cost} = 30 + (20 \times 2 \times 1.50) + (16 \times 12 \times 1.50) = \text{Rs. } 378/-$$

$$\text{Police cost} = 20214 + 378 = \text{Rs. } 20592/-$$

$$\text{Considering } 30\% \text{ overheads} = 20592 \times 0.3 = \text{Rs. } 6178/-$$

$$\text{Total police cost} = 26770 \times 1047 = 28028190/-$$

VEHICLE DAMAGE COMPONENT INCLUDED IN FATAL ACCIDENTS

Out of 100 fatal accident as victims sample from primary data in 2018, 64% involved pedestrians or cyclists, with only a remote chance of vehicle damage. Therefore, 36% of other accidents are expected to result in vehicle damage claims. Of the 100 samples, 14 were vehicle-vehicle accidents and 22 were single vehicle accidents, accounting for 14% and 22% of accidents, respectively. Only vehicle-vehicle accidents would include vehicle damage costs.

The Insurance companies paid an average claim of Rs. 30,000/- for a vehicle in 2018, but some claims exceeded Rs. 500,000. In the previous year (2017-18), out of a total of 952 vehicle claims, 396 claims were above Rs. 50,000/-, with 258 claims between Rs. 50,000 to Rs. 100,000, 64 claims from Rs. 100,000 to Rs. 200,000, 34 claims from Rs. 200,000 to Rs. 300,000, 17 claims from Rs. 300,000 to Rs. 400,000, 9 claims from Rs. 400,000 to Rs. 500,000 and 14 claims of Rs. 500,000 and above (assuming a maximum claim of Rs. 10,00,000/- for the value of a vehicle in India). Then, the average can be calculated as follows:

$$\frac{((258 \times 75,000) + (64 \times 150,000) + (34 \times 250,000) + (17 \times 350,000) + (9 \times 450,000) + (14 \times 750,000))}{396}$$

Therefore the average for claims over Rs. 50,000 is Rs. 157046/-

This figure is for 2017-18 prices. In order to convert this figure to 2018 prices, an inflation rate of 10% is used. It should be noted that during this period, the inflation remained as a two-digit number with certain fluctuation.

Thus the average figure for 2018 is = Rs. 172751/-

In order to ensure that the accident costs are not inflated, Rs. 175000/- was used for the motor vehicle accidents. The following figures are used for other accidents involving the motor vehicles.

Total number of accidents in year 2018 = 1468

Out of these 1047 fatal accidents, 36% need vehicle damages out of which 14% are vehicle - vehicle accidents that involve two or more vehicles and 22% are single vehicle accidents.

Total number of vehicles need damage claims = $(14/100 \times 1468 \times 2) + (22/100 \times 1468 \times 1) = (411.04 + 322.96) = 734/-$

Total claimed amount = $175000 \times 734 = \text{Rs. } 128450000/-$

COST REFLECTING PAIN AND GRIEF

It is challenging to measure the cost of pain, sorrow, and suffering inflicted on the family and friends of the accident victims using monetary units. In the United States, this cost has been calculated as 65% of the gross output value. In the United Kingdom, the cost has been increased by 50% to include the emotional impact of road accidents. A study on accident costs in India has estimated this cost to be 20% of the quantifiable costs to account for grief and pain. Therefore, in this present study, 20% of the total quantifiable cost was allocated as the subjective cost of pain and grief.

COST OF A FATAL ACCIDENT

Total cost of a fatal accident = Hospital cost + Police cost + Loss of future output + Vehicle damage cost + cost of pain and grief

Quantifiable cost = $24725496 + 28028190 + 5356484280 + 128450000$
= Rs. 5537687966/-

20% of quantifiable cost to allow for pain and grief = Rs. 1107537593/-

Total cost of fatal accidents in 2018 = Rs. 6645225559/-

Total average cost per fatal accident = $6645225559/1047 = \text{Rs. } 6346920/-$

It is shown with detailed calculations, that the average cost per fatal accident will be Rs 6346920/- in 2018.

It should also be noted that this cost covers only the fatal victims and their related costs. However, there are serious, moderate and slight injured victims in these accidents were not included. Therefore, this total cost should be adjusted appropriately to take account of such victims.

Discussion:

Road accidents are a significant cause of death and disability in India. Many studies have estimated the economic impact of road accidents in India. However, there is limited research on the economic impact of road accident deaths in the Uttarakhand foothills of Himalayas using direct output method. This study aims to fill this gap by estimating the economic impact of road accident deaths in the Uttarakhand foothills of Himalayas using direct output method.

The study found that the total economic impact of road accident deaths in the Uttarakhand foothills of Himalayas was INR 6645225559. The cost of treatment was INR 24725496, while the cost of lost output due to premature deaths was INR 5356484280, Police and legal costs as INR 28028190, Vehicle damage costs as INR 128450000 and Pain and grief costs as INR 1107537593. The study also found that the economic impact of road accident deaths was higher for males than females and higher for individuals in the age group of 25-44 years.

The results of this study are consistent with previous studies conducted in India. Study conducted by Dhingra and Kumar (2020) estimated the economic losses due to road traffic accidents in India using direct output method and found that the economic impact was higher for males and individuals in the age group of 25-44 years. Similarly, Ramakrishnan and Raghavan (2016) estimated the economic cost of road accidents in India and found that the cost of lost output due to premature deaths was the highest among all costs. Rajan S.I (2019) and Chakraborty, A. (2018) also found almost similar GDP loss of the state in Tamil Nadu and West Bengal respectively.

According to the Ministry of Statistics and Programme Implementation, Government of India, the Gross State Domestic Product (GSDP) of Uttarakhand in the financial year 2018-19 (which is the closest available data to the year 2018) was Rs. 2.61 trillion (or Rs. 2,61,519 crore) at current prices. The total costs of fatal accidents in the year are 6645225559 which is 0.2546% of the GDP of Uttarakhand.

Our study highlights the significant economic losses that can result from road accidents in the foothills of the Himalayas in Uttarakhand. These losses can have a major impact on the region's economy and development and should be taken into account in policy and decision-making related to road safety. Our study also demonstrates the usefulness of the Direct Output Method in estimating the economic loss caused by premature deaths due to road accidents, which can be used to inform interventions and policies aimed at reducing these losses.

In conclusion, this study highlights the significant economic impact of road accident deaths in the Uttarakhand foothills of Himalayas. The findings of this study can be used to develop policies and interventions to reduce the economic impact of road accidents in the region. However, the study has some limitations, including the use of police records for data collection, which may not be comprehensive, and the use of a convenience sampling method, which may not be representative of the entire population. Therefore, future research should consider using a more comprehensive data collection method and a larger sample size to increase the generalizability of the findings.

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