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Research Paper

Health impact and economic burden of alcohol consumption in India

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ABSTRACT

Background: The health and economic consequences of alcohol consumption have been assessed mainly in developed countries. This study aims to estimate health impact and economic burden attributable to alcohol use in India.

Methods: A combination of decision tree and mathematical markov model was parameterized to assess the health effects and economic cost attributable to alcohol consumption. Health effect of alcohol was modelled for a time period of 2011 to 2050 on three sets of conditions – liver disease, cancers and road traffic accidents. Estimates of illness, death, life years lost and quality adjusted life years (QALYs) gained were estimated as a result of alcohol consumption. Both direct and indirect costs were estimated to determine economic burden. Future costs and consequences were discounted at 3% for time preferences of cost and utility. Uncertainties in parameters were assessed using probabilistic sensitivity analysis.

Results: Between 2011 and 2050, alcohol attributable deaths would lead to a loss of 258 million life years. In contrast, 552 million QALYs would be gained by eliminating alcohol consumption. Treatment of these conditions will impose an economic burden of INR 3127 billion (US$ 48.11 billion) on the health system. Societal burden of alcohol, inclusive of health system cost, out of pocket expenditure and productivity losses will be INR 121,364 billion (US$ 1867 billion). Even after adjusting for tax receipts from sale of alcohol, alcohol poses a net economic loss of INR 97,895 billion (US$ 1506 billion). This amounts to an average loss of 1.45% of the gross domestic product (GDP) per year to the Indian economy.

Conclusion: Alcohol causes significant negative health impact and economic burden on Indian society and evidence informed policy interventions are needed to control alcohol attributable harm.

Introduction

Consumption of alcohol creates significant health, economic and social burden. In 2016, 2·8 million deaths were attributed to alcohol use globally (Alcohol use & burden for 195 countries & territories, 2018). This corresponds to 2·2% of total age-standardised deaths among females and 6·8% among males (Alcohol use & burden for 195 countries & territories, 2018). In terms of overall disease burden, alcohol use resulted in 132.6 million disability adjusted life years (DALYs), i.e., 5.1% of all DALYs in that year (World Health Organization, 2018). Alcohol use was the seventh leading risk factor for both deaths and DALYs in 2016 (Alcohol use & burden for 195 countries & territories, 2018).

Alcohol has been described as a component cause for more than 200 disease and injury conditions (Anderson, Chisholm, & Fuhr, 2009). The evidence of a causal impact of average volume of alcohol consumption with various diseases has been established (Rehm et al., 2010). Among the long list, cancer, liver cirrhosis and injury are the three conditions which constitute the majority of mortality caused by alcohol (Rehm & Shield, 2013). Cancer, liver cirrhosis and injuries account for 18.5%, 14.6% and 38.7% of alcohol attributable deaths and 7.6%, 8.9% and 36.1% of alcohol attributable DALYs in men (Rehm et al., 2009). Similarly, these three conditions account for 25%, 17.1% and 33.8% of alcohol attributable deaths and 13.5%, 12.7% and 34.6% of alcohol attributable DALYs in women (Rehm et al., 2009).

In addition to the health effects, alcohol also poses significant economic burden on society. (Casswell & Thamarangsi, 2009; Rehm et al., 2009; Thavorncharoensap et al., 2010). This burden is in the form of health system cost and out of pocket (OOP) expenditure for treatment of morbidities resulting from alcohol consumption, loss of productivity because of premature mortality and reduced productivity because of alcohol related health conditions (Casswell & Thamarangsi, 2009; Rehm et al., 2009; Thavorncharoensap et al., 2010). High and middle income countries are estimated to spend more than one per cent of their gross domestic product on economic costs attributable to alcohol

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(Casswell & Thamarangsi, 2009). This figure is approximately two per cent for developing countries (Thavorncharoensap et al., 2010). However, most of the studies assessing the health impact and economic burden of alcohol use are from developed countries (Thavorncharoensap et al., 2010) and to the best of our knowledge, there has been no such study in India.

Alcohol related health impact and economic burden obtained from the studies conducted in developed countries cannot be generalized to India because of the different socioeconomic milieu and drinking patterns of India and the western world (Smyth et al., 2015; World Health Organization, 2014), hence the present study was conducted. Our findings can be used to highlight the magnitude of harm caused by alcohol in India and to help inform policy to control alcohol consumption.

Methods

A mathematical model was developed to explore the potential health impact and economic burden posed by alcohol consumption on the population of India. Key health consequences of alcohol consumption were modelled using markov processes and decision tree, and included alcohol related liver diseases, cancers and road traffic accidents.

Model overview

A combination of decision tree and markov model was parameterised on an MS Excel spreadsheet. Firstly, decision tree was used to have the choice between those who consume alcohol and those who do not, and then to model those who develop health consequences and those who do not. Thereafter, markov model was used to simulate the progression of a person to different health states after development of an alcohol related health outcome. The conceptual framework of the model (Fig. 1) is based on likelihood of developing (or not) an alcohol attributable condition and existing knowledge of subsequent disease progression. Three ‘conditions’ were chosen to model the impact of alcohol on health, namely, liver diseases, cancers and road traffic accidents. They not only constitute the majority of morbidity and mortality caused by alcohol, but also the evidence of causality is much more robust for these three conditions (Rehm & Shield, 2013; Rehm et al., 2009). Only head and neck cancers were modelled, as it is on such cancers that the effect of alcohol is most profound (Bagnardi et al., 2015).

The population of India was modelled in two parallel scenarios: scenario 1 assumes that nobody consumes alcohol and scenario 2 accounts for the current rate of alcohol consumption. To assess the health impact and economic burden, both the scenarios were compared in terms of life years and QALYs lived by the population and subsequent economic loss resulting from alcohol consumption. Both scenarios were modelled for a time horizon of 40 years, ranging from 2011 to 2050. We did not consider modelling beyond 2050 because potential population level change in the pattern of economic, demographic, and epidemiological parameters, as well as alcohol consumption over the next three decades would mean predicting any further into the future could raise uncertainty about study results. The analysis is concerned with the summation of costs and benefits over time and future costs and consequences were discounted at 3% for time preferences of cost and utility. This is recommended in the draft Indian reference case for undertaking economic evaluation for health technology assessments in India (Rajsekar, 2019). Consequences were valued in terms of life years and QALYs. Both direct and indirect costs were accounted for. In calculation of direct cost, we included cost of providing curative treatment for alcohol related health conditions, comprising health system cost and OOP expenditure. In the calculation of indirect cost, productivity losses caused by premature mortality and reduced productivity as a result of illness were accounted for. Both discounted and undiscounted costs have been reported. Discounted costs seek to account for the impact of time on the cost of resources and implies that costs occurring at different points in time are valued differently. In other words, while calculating discounted costs, future costs are given less value than their current equivalent. Undiscounted costs, however, are not adjusted for the time and all the costs are calculated at their current face value. The revenue generated as a result of excise tax collection was also assessed in scenario-2. Results are presented in both provider or government perspective and societal perspective.

Health impact of alcohol consumption

The development of alcohol related health consequences was

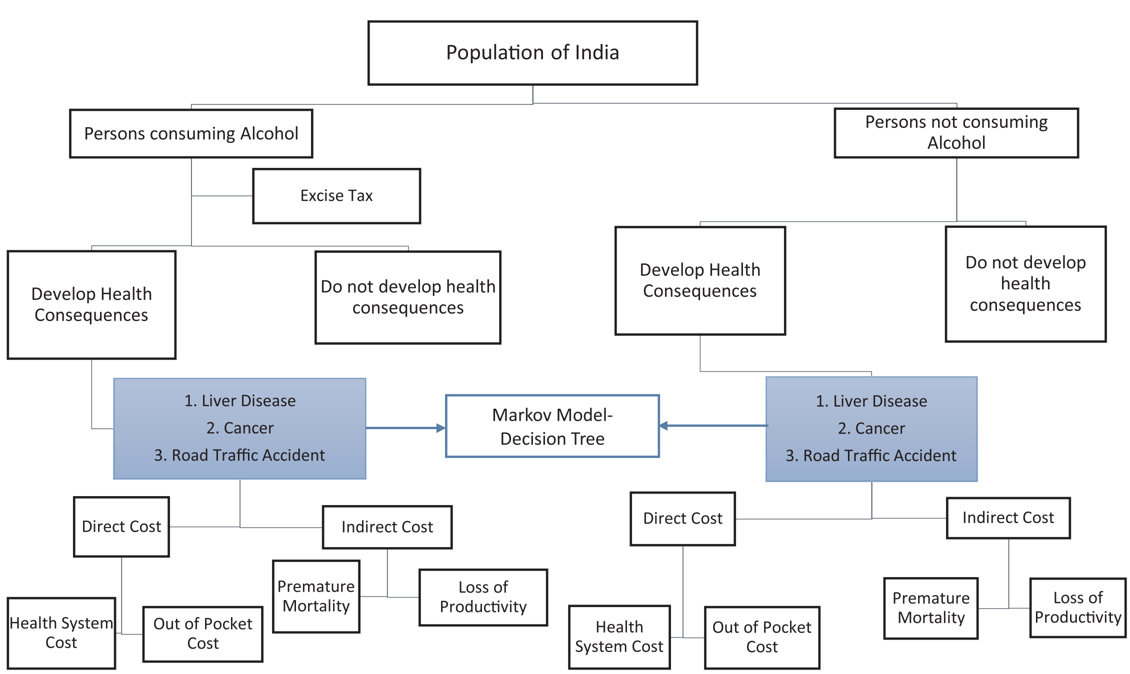

Fig. 1. Conceptual framework of the model to estimate health impact and economic burden of alcohol related health conditions.

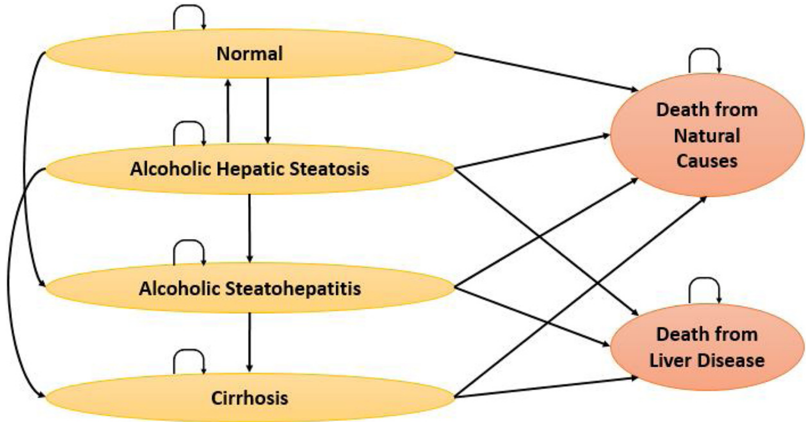

Fig. 2. Markov model depicting progression of liver disease.

interpreted as a series of events occurring over time, e.g., incidence of health consequence, progression in severity, and mortality. Markov model for liver diseases (Fig. 2) represents progression from no alcohol related liver disease, to alcoholic hepatic steatosis, alcoholic steatohepatitis, cirrhosis, along with two absorbing states, viz., death from liver disease and death from natural causes (Bruha, Dvorak, & Petrtyl, 2012; Lefkowitch, 2005). Stage specific utility scores and transition probabilities of moving from one state of disease severity to another (or death) were calculated from published literature (Alvarez et al., 2011; Chong et al., 2003; Kim et al., 2012; Palmer et al., 2000; Soto et al., 2017; Teli, Day, Burt, Bennett, & James, 1995; Torok, 2015; Wong et al., 2014). (Table 1). Age-specific all-cause mortality from each health state was obtained from the sample registration system life tables (Registrar General & Census Commissioner of India, 2016). We assumed a markov cycle length of one year. Once a person develops head and neck cancer, life years and QALYs were calculated based on a previously developed probabilistic markov model assessing lifetime costs and consequences (Chauhan, 2018). Road traffic accident and future health consequences, being a condition of acute onset, was modelled with the help of decision tree alone (Fig. 1).

A 29.5% prevalence of alcohol use among males and 1.5% in females, as reported in the 4th round of the National Family Health Survey, was used (International Institute for Population Sciences (IIPS) and ICF (2017)). These prevalence rates were applied on the projected population for males and females in India till 2050, to obtain the number of people who would consume alcohol over the respective years (The World Bank Group, 2016). Of total persons consuming alcohol, the percentage of beer, wine and spirit consumers was taken as 6.5%, 0.5% and 93%, respectively (World Health Organization, 2014).

Economic burden of alcohol consumption

The output of events obtained from markov model and decision tree analysis was used to calculate total economic cost attributed to alcohol use. Three types of costs were calculated to measure the economic burden – health system cost, OOP expenditure and productivity losses. An outline of the decision tree used in measurement of costs is given in Fig. 3. The calculation of health system cost accounted for those seeking treatment at public health facilities, whereas assessment of cost incurred in getting treatment at private facilities was based on OOP expenditure. Data on care seeking for illnesses and corresponding OOP expenditures in private sector health facilities was obtained by analysis of the 71st National Sample Survey data. (National Sample Survey Office, 2015) These data comprise a nationally representative household survey undertaken to assess disease burden, care seeking patterns and OOP expenditures. The proportion of liver disease, cancer and road traffic accident patients not taking treatment was estimated as 2.8%, 2.9% and 0.04%, respectively (National Sample Survey Office, 2015). In relation to OOP expenditure in public health facilities, because the number of relevant cases in the survey were low, previously published studies which reported on the health system cost and OOP expenditures in public facilities were used (Chauhan, Prinja, Ghoshal, Verma, & Oinam, 2018; Prinja, Bahuguna, Duseja, Kaur, & Chawla, 2018; Sangwan et al., 2017). Total cost for treatment of a health condition was calculated as a function of unit cost of treatment of the respective ailment at the respective facility and the number of patients with that particular ailment seeking care at that facility. All costs are reported in Indian National Rupee (INR) and US Dollars (USD) using the average conversion of 1 USD = 65 INR in 2017 (US dollar to Indian Rupee spot exchange rates, 2019). Various input cost parameters used in the model are given in Table 1.

Productivity losses were measured for premature mortality and reduced productivity because of disease. Although we elected to use the human capital approach to assess indirect costs, we included a sensitivity analyses that employed the friction cost method. Years of life lost due to premature mortality in a respective year were calculated by multiplying number of deaths due to a particular disease with the difference between average life expectancy at birth and average age of dying due to that disease. Average age of dying due to liver disease, head and neck cancer and road traffic accidents was taken as 47.19 years, 54.63 years and 42.38 years respectively (Registrar General and Census Commissioner of India, 2013). Average life expectancy at birth was taken as 68.41 years (Ministry of Health & Family Welfare, 2011). Reduced productivity due to a disease was derived from the quality of life of a person living with that particular disease. The utility scores that were applied for quality of life valuation for health effects assessment were used. Total productive life years lost due to a disease were obtained by adding up years lost due to premature mortality and years lost due to reduced productivity. Taking the human capital approach, we used per capita GDP as a proxy of productivity to get the value of productivity loss in economic terms. A separate sensitivity analysis was undertaken to assess indirect costs using friction cost approach, considering a friction period of 3 months (Koopmanschap, Rutten, van Ineveld, & van, 1995).

Total excise tax generated by states through the sale of alcohol in the year 2014-15 was obtained from the report released by Reserve bank of India (Abraham, 1995; Reserve Bank of India, 2015). Excise tax collection in the subsequent years was calculated based on the estimated number of people consuming beer, wine and spirit in the respective years, which were obtained by modelling. Gross economic burden of alcohol related health conditions was calculated by adding together health system cost, OOP expenditure and productivity losses. In calculation of net economic burden, excise tax collection was deducted from the gross economic burden.

Table 1
Input parameters used in the base analysis of the model to estimate health impact and economic burden of alcohol consumption.

Parameter	Value used in base analysis	Ranges used in sensitivity analysis	Reference
Annual transition probabilities			
Normal to alcoholic hepatic steatosis	0.167	0.137–.2	(Palmer et al., 2000)
Normal to alcoholic steatohepatitis	0.1	0.08–0.12	(Palmer et al., 2000)
Alcoholic hepatic steatosis to normal	0.26	0.208–0.312	(Soto et al., 2017), (Kim et al., 2012)
Alcoholic hepatic steatosis to alcoholic steatohepatitis	0.0187	0.015–0.022	(Teli et al., 1995)
Alcoholic hepatic steatosis to cirrhosis	0.0099	0.0079–0.0118	(Teli et al., 1995)
Alcoholic steatohepatitis to cirrhosis	0.1127	0.0901–0.1352	(Torok, 2015)
Alcoholic steatohepatitis to death from liver disease	0.0524	0.0419–0.0628	(Wong et al., 2014)
Cirrhosis to death from liver disease	0.175	0.14–0.21	(Soto et al., 2017), (Alvarez et al., 2011)
Probabilities of all-cause mortality in different age groups			
25–30	0.0083	0.0066–0.0099	(Registrar General & Census Commissioner of India, 2016)
30–35	0.0101	0.0081–0.0121	(Registrar General & Census Commissioner of India, 2016)
35–40	0.0136	0.0109–0.0163	(Registrar General & Census Commissioner of India, 2016)
40–45	0.0186	0.0149–0.0223	(Registrar General & Census Commissioner of India, 2016)
45–50	0.0266	0.0212–0.0319	(Registrar General & Census Commissioner of India, 2016)
50–55	0.0423	0.0338–0.0508	(Registrar General & Census Commissioner of India, 2016)
55–60	0.0614	0.0491–0.0736	(Registrar General & Census Commissioner of India, 2016)
60–65	0.0934	0.0747–.1121	(Registrar General & Census Commissioner of India, 2016)
65–70	0.1407	0.1126–0.1689	(Registrar General & Census Commissioner of India, 2016)
70–75	0.2081	0.1665–0.2497	(Registrar General & Census Commissioner of India, 2016)
75–80	0.2979	0.2383–0.3575	(Registrar General & Census Commissioner of India, 2016)
80+	0.4442	0.3554–0.5530	(Registrar General & Census Commissioner of India, 2016)
Utility scores (liver diseases)			
Alcoholic hepatic steatosis	0.98	0.882–1	(Chong et al., 2003)
Alcoholic steatohepatitis	0.76	0.68–0.83	(Chong et al., 2003)
Cirrhosis	0.74	0.66–0.83	(Chong et al., 2003)
Utility scores (head and neck cancers)			
Stage- I	0.76	0.732–0.787	(Kularatna, Whitty, Johnson, Jayasinghe, & Scuffham, 2016)
Stage- II	0.69	0.645–0.734	(Kularatna et al., 2016)
Stage- III	0.57	0.535–0.605	(Kularatna et al., 2016)
Stage- IV	0.48	0.406–0.553	(Kularatna et al., 2016)
Utility score of road traffic injury patient	0.98	0.882–1	(Prinja et al., 2019)
Proportion of males consuming alcohol	0.295	0.266–0.324	(International Institute for Population Sciences (IIPS) and ICF (2017))
Proportion of females consuming alcohol	0.012	0.01–0.0132	(International Institute for Population Sciences (IIPS) and ICF (2017))
Proportion of patients seek treatment at public sector health facilities	0.306	0.245–0.367	(National Sample Survey Office, 2015)
Proportion of patients seek treatment at private sector health facilities	0.694	0.555–0.832	(National Sample Survey Office, 2015)
Health system cost at primary care centre	**(INR)**	**(INR)**	
Alcoholic hepatic steatosis	172.3	126.3–229.1	(Prinja et al., 2016b)
Alcoholic steatohepatitis	172.3	126.3–229.1	(Prinja et al., 2016b)
Cirrhosis	172.3	126.3–229.1	(Prinja et al., 2016b)
Health system cost at secondary care centre			
Alcoholic hepatic steatosis	639	511.2–766.8	(Prinja et al., 2016e)
Alcoholic steatohepatitis	5957	4765–7148	(Prinja et al., 2016e)
Cirrhosis	49229	39383–59075	(Prinja et al., 2016e)
Road traffic accident	8887	7110–10663	(Sangwan et al., 2017)
Health system cost at tertiary care centre			
Alcoholic hepatic steatosis	25394	24000–29040	(Prinja et al., 2018)
Alcoholic steatohepatitis	88879	84000–101640	(Prinja et al., 2018)
Cirrhosis	150586.42	142320–172207	(Prinja et al., 2018)
Stage-I head and neck cancer	35151	28121–42182	(Chauhan et al., 2018)
Stage-II head and neck cancer	36675	29340–44010	(Chauhan et al., 2018)
Stage-III head and neck cancer	37390	29912–44868	(Chauhan et al., 2018)
Stage-IV head and neck cancer	37743	30195–45292	(Chauhan et al., 2018)

(*continued on next page*)

Table 1 (*continued*)

Parameter	Value used in base analysis	Ranges used in sensitivity analysis	Reference
Road traffic accident	13332	10665–15997	(Sangwan et al., 2017)
OOP expenditure at primary care centre			
Alcoholic hepatic steatosis	116.29	71.5–161	(Prinja et al., 2015)
Alcoholic steatohepatitis	407	250–564	(Prinja et al., 2015)
Cirrhosis	689.57	425–954	(Prinja et al., 2015)
OOP expenditure at secondary care centre			
Alcoholic hepatic steatosis	3482.57	2911–4054	(Prinja et al., 2015)
Alcoholic steatohepatitis	13449	11450–15448	(Prinja et al., 2015)
Cirrhosis	22709.6	19334–26085	(Prinja et al., 2015)
Road traffic accident	17830	16662–18997	(Prinja et al., 2019)
OOP expenditure at tertiary care centre			
Alcoholic hepatic steatosis	86448	53943–118953	(Prinja et al., 2018)
Alcoholic steatohepatitis	115668	39065–192271	(Prinja et al., 2018)
Cirrhosis	127899	104926–150872	(Prinja et al., 2018)
Stage-I head and neck cancer	27378	21902–32853	(Chauhan et al., 2018)
Stage-II head and neck cancer	31376	25100–37651	(Chauhan et al., 2018)
Stage-III head and neck cancer	30436	24348–36523	(Chauhan et al., 2018)
Stage-IV head and neck cancer	34099	27279–40918	(Chauhan et al., 2018)
Road traffic accident	17830	16662–18997	(Prinja et al., 2019)
OOP expenditure at private health facility			
Liver disease	23933	19146–28718	(National Sample Survey Office, 2015)
Cancer	78050	62440–93660	(National Sample Survey Office, 2015)
Road traffic accidents	36255	29004–43506	(National Sample Survey Office, 2015)

Sensitivity analysis

Uncertainties in parameters and model structure were assessed in a series of sensitivity analyses in MS Excel. Effect of joint parameter uncertainty was analysed by applying a probabilistic sensitivity analysis (PSA) (Drummond, Sculpher, Claxton, Stoddart, & Torrance, 2015; Fox-Rushby & Cairns, 2005). Upper and lower bounds were computed based upon measures of dispersion reported along with the base estimate in the published literature. Prevalence of alcohol use was varied by 10% on either side of the base estimate. We assumed a variation of 20% on either side of base estimate for age specific, all-cause mortality rates, transition probabilities of markov model, treatment seeking behaviour of the population and cost parameters for which ranges were not reported with base estimate. Ranges used in PSA have been presented in Table 1. Monte Carlo method was used for simulating the results for 999 times. Median was computed along with 2.5th and 97.5th percentile to estimate 95% confidence interval.

The Guidelines for Accurate and Transparent Health Estimates Reporting (the GATHER statement) were used to describe different aspects of methods used in the study (Stevens et al., 2016).

Results

A total of 593 million life years would be lost in India between 2011 and 2050 as a result of these three alcohol related health conditions. If alcohol consumption is eliminated, there would be a gain of 1.07 billion QALYs in the respective period. Discounting the future consequences at 3%, the number of life years lost due to alcohol consumption and QALYs gained by eliminating alcohol in India would be 258 million and 552 million, respectively (Table 2). It amounts to per capita loss of 75.60 discounted and 173.65 undiscounted days of life because of alcohol consumption in the general population by the year 2050.

For the treatment of alcohol related health conditions, gross economic burden on the government by the year 2050 would be INR 5421 billion (US$ 83.4 billion) (Table 2). Discounting the future costs at 3%, this value is INR 3127 billion (US$ 48.11 billion). Gross societal economic burden of alcohol related health conditions, comprising of all the costs (health system cost, OOP expenditure and productivity losses), would be INR 209,840 billion (US$ 3228 billion), and after discounting, this figure is INR 121,364 billion (US$ 1867 billion).

In India, net societal economic burden of alcohol related health

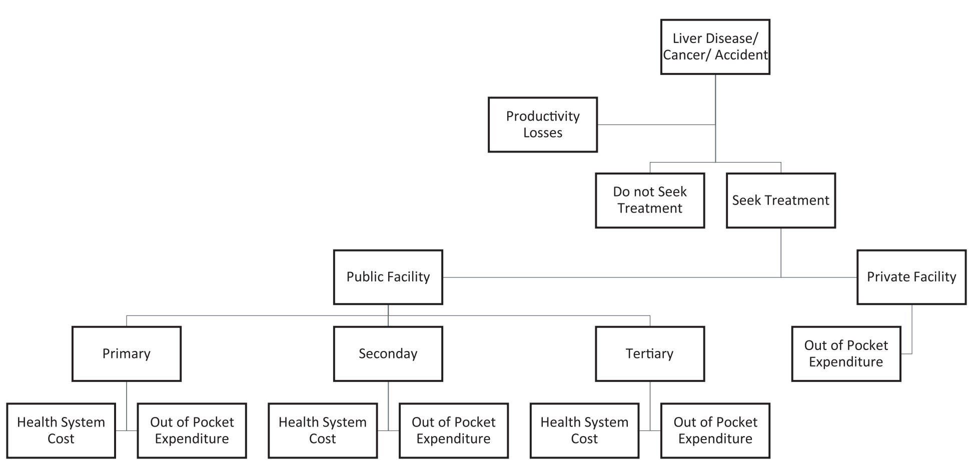

Fig. 3. Decision tree used for calculation of economic cost attributable to alcohol related health conditions.

Table 2
Health impact and economic burden (in billions) of alcohol consumption in India.2011–2050.

Impact of alcohol	Value	95% ci
Life years lost		
Undiscounted	593 million	587 million–599 million
Discounted	258 million	211 million–293 million
QALYs gained by eliminating alcohol		
Undiscounted	1.07 billion	1.061 billion–1.082 billion
Discounted	552 million	482 million–616 million
Gross economic burden on the government		
Undiscounted	INR 5421 (US$ 83.4)	INR 4,855–5,793 (US$ 74.70–89.13)
Discounted	INR 3127 (US$ 48.11)	INR 2,570–3,561 (US$ 39.54–54.78)
Gross economic burden on the society		
Undiscounted	INR 209,840 (US$ 3228)	INR 190,421–225,586 (US$ 2929–3470)
Discounted	INR 121,364 (US$ 1867)	INR 101,276–137,891 (US$ 1558–2121)
Net economic burden on society		
Undiscounted	INR 168,892 (US$ 2598)	INR 149,472–184,638 (US$ 2299–2840)
Discounted	INR 97,895 (US$ 1506)	INR 79,497–112,205 (US$ 1223–1726)

conditions by the year 2050, after deducting gain in tax revenues, is INR 168,892 billion (US$ 2598 billion). If future costs are discounted at 3%, net societal economic burden of alcohol related health conditions on society would be INR 97,895 billion (US$ 1506 billion). Hence, if current drinking patterns prevails, The Indian economy would be losing 1.45% [95% Confidence Interval (CI) = 1.17%–1.66%] of the GDP per year (discounted) because of alcohol consumption.

In the current scenario, by the year 2050, undiscounted and discounted health system cost for the treatment of alcohol related health conditions would be INR 5326 billion (US$ 82 billion) and INR 3085 billion (US$ 47.5 billion), respectively. OOP expenditure for the same would be INR 52,577 billion (US$ 809 billion; undiscounted) and INR 30,445 billion (US$ 468 billion; discounted). Indirect cost of alcohol consumption, which comprise economic loss due to premature mortality and reduced productivity, would be INR 135,164 billion (US$ 2079 billion; undiscounted) and INR 78,268 billion (US$ 1204 billion; discounted). Indirect costs account for 70% of the total cost attributed to alcohol consumption.

Sensitivity analysis shows that if friction cost approach is used for measurement of indirect costs instead of human capital approach, indirect cost of alcohol consumption in the current scenario would be INR 26,486 billion (US$ 407.48 billion; undiscounted) and INR 15,537 billion (US$ 236 billion; discounted). Consequently, net societal burden of alcohol use would be INR 47,266 billion (US$ 727 billion; undiscounted) and INR 27,370 billion (US$ 421 billion; discounted). This amounts to an average loss of 0.41% of the GDP per year (discounted).

Although base case analysis has used stable prevalence of alcohol consumption in the future years, different sensitivity analyses were conducted to project the effect of changing alcohol consumption over time (Table 3).

Discussion

These findings provide a quantitative testimony to the health and economic burden posed by alcohol consumption in India. Our analysis shows that between 2011 and 2050, alcohol attributable deaths would lead to a loss of 258 million life years. This amounts to a loss of 75.60 days of life (discounted) per capita by the year 2050. India would gain 552 million quality adjusted life years (discounted) if alcohol is eliminated. Moreover, we found that even after tax receipts on sale of alcohol are adjusted for, alcohol related health conditions will impose a net economic burden of INR 97,895 billion (US$ 1506 billion) on Indian society by the year 2050. This amounts to an average loss of 1.45% of the GDP per year to the Indian economy.

Assessment of the health and economic impact of alcohol consumption has been done in various countries, but most studies are from high income country settings; we find very little evidence available from developing countries (Thavorncharoensap et al., 2010). Further, these studies are not generalizable owing to differences in the extent and pattern of alcohol consumption, health burden, health care delivery systems and cost of healthcare services across countries. Here we have estimated costs for India using in-country data wherever possible. A major factor limiting generalizability of studies conducted in developed countries to India is that healthcare costs for alcohol related health conditions, as well as indirect costs in India are very different from western countries. Therefore, all the cost related parameters used in the study were obtained from recent studies conducted in India (Chauhan et al., 2018; Prinja, Sharma, Katoch, Kaur, & Jagnoor, 2016; Prinja et al., 2016c; Prinja, Bahuguna, & Chauhan, 2016; Prinja, Chauhan, & Bahuguna, 2016; Prinja, Gupta, & Kumar, 2015; Prinja et al., 2018; Sangwan et al., 2017). For effectiveness estimates also, country specific evidence was used (Chauhan, 2018; de C Cancela et al., 2009), however, in absence of country specific estimates, survival estimates of disease conditions had to be assumed based on findings of studies conducted outside India.

Global evidence suggests that high and middle income countries always spend more than 1% of their annual GDP on economic costs attributable to alcohol (Casswell & Thamarangsi, 2009). This cost turns out to be in the range of 2% for developing countries (Thavorncharoensap et al., 2010). Studies conducted in France, USA, South Korea and Thailand have reported that economic cost attributable to alcohol use is in the range of 1.7%, 2.7%, 3.3% and 1.99% of the annual GDP (Rehm et al., 2009; Thavorncharoensap et al., 2010). Our findings (1.45% of GDP) are comparable to these estimates. It is worth mentioning here that among the full spectrum of alcohol related health consequences, we accounted for three conditions, making our projections slightly conservative.

If the constituents of the economic burden of alcohol related health conditions are analysed, indirect costs account for 70% of the total cost attributed to alcohol consumption in our study. Indirect costs constitute 49.9%, 72.7% and 72% of the economic cost attributable to alcohol in France, USA and South Korea respectively (Rehm et al., 2009).

In order to validate the model used here, we compared the intermediate outputs of our model with available epidemiological evidence. In an epidemiological study estimating liver cirrhosis mortality in 187 countries, it was reported that the number of deaths due to liver cirrhosis in India was 188,575 in 2010 (95% CI, 109748–303989) (Mokdad et al., 2014). Our model predicted 167,046 deaths due to liver cirrhosis in India in 2011. Global burden of disease cancer collaboration has reported 185,000 cases of head and neck cancer in India in 2015 (Global Burden of Disease Cancer Collaboration & Fitzmaurice et al., 2017). Whereas, based on the incidence data generated from population based cancer registries in India, the number of cases of head and neck cancer in India has been estimated as 196,065 in 2015 (Takiar, Nadayil, & Nandakumar, 2010). Our model predicted 188,670 cases of head and neck cancer in India in 2015.

There are some limitations of the current analysis. Firstly, protective effects of low levels of alcohol consumption on ischaemic heart disease, diabetes, etc. have not been modelled (Di Castelnuovo et al., 2006; Howard, Arnsten, & Gourevitch, 2004; Ronksley, Brien, Turner, Mukamal, & Ghali, 2011). However, we considered this appropriate as recent studies have challenged such a view by use of mendelian randomisation and meta-analyses, and found that no level of alcohol consumption improves health (Alcohol use & burden for 195 countries & territories, 2018; Chikritzhs et al., 2015; Fillmore, Kerr, Stockwell, Chikritzhs, & Bostrom, 2006; Holmes et al., 2014; Naimi et al., 2005). Another limitation of our study is that we have chosen three types of condition to model the impact of alcohol on health consequences,

Table 3
Impact of changing prevalence of alcohol consumption on Indian population.

Impact of alcohol	Static prevalence of alcohol consumption (Base Case)	Alcohol consumption increases 0.5% per year relatively	Alcohol consumption increases 1% per year relatively	Alcohol consumption decreases 0.5% per year relatively	Alcohol consumption decreases 1% per year relatively
Life years lost					
Undiscounted	593 million	658 million	731 million	536 million	486 million
Discounted	258 million	289 million	323 million	233 million	209 million
QALYs gained by eliminating alcohol					
Undiscounted	1.07 billion	1.19 billion	1.32 billion	970 million	879 million
Discounted	552 million	616 million	686 million	494 million	438 million
Gross economic burden on the government					
Undiscounted	INR 5421 (US$ 83.4)	INR 5813 (US$ 89.4)	INR 6464 (US$ 99.4)	INR 4740 (US$ 72.9)	INR 4298 (US$ 66.1)
Discounted	INR 3127 (US$ 48.11)	INR 3302 (US$ 50.8)	INR 3602 (US$ 55.4)	INR 2798 (US$ 43.04)	INR 2586 (US$ 39.8)
Gross economic burden on the society					
Undiscounted	INR 209,840 (US$ 3228)	INR 239,064 (US$ 3678)	INR 265,828 (US$ 4090)	INR 194,927 (US$ 2999)	INR 176,754 (US$ 2719)
Discounted	INR 121,364 (US$ 1867)	INR 135,805 (US$ 2089)	INR 148,148 (US$ 2279)	INR 115,061 (US$ 1770)	INR 106,343 (US$ 1636)
Net economic burden on society					
Undiscounted	INR 168,892 (US$ 2598)	INR 194,550 (US$ 2993)	INR 217,303 (US$ 3343)	INR 157,150 (US$ 2418)	INR 141,802 (US$ 2182)
Discounted	INR 97,895 (US$ 1506)	INR 110,518 (US$ 1700)	INR 121,105 (US$ 1863)	INR 92,762 (US$ 1427)	INR 85,314 (US$ 1312)

namely, liver disease, cancer and road traffic accidents, although there is evidence that alcohol is causally linked to as many as 200 diseases, conditions and injuries (Rehm & Shield, 2013). While modelling liver disease, we included steatosis, steatohepatitis and cirrhosis, as alcoholic liver disease is expressed mainly in these three clinico-pathologic settings (Bruha et al., 2012; Ishak, Zimmerman, & Ray, 1991; Lefkowitch, 2005). While there may be some other manifestations of the alcoholic liver disease, including hepatocellular carcinoma, cholestasis, chronic active hepatitis and fetal alcohol syndrome, these have not been modelled as they manifest in relatively small number of persons consuming alcohol. Among cancers, we have modelled head and neck cancers only as the evidence of causality was strongest for these (Bagnardi et al., 2015), and among injuries, we have modelled road traffic injuries only. Hence the health and economic burden of alcohol related health conditions as estimated by our study is in fact an underestimate of the true burden. Although the relative risk of developing a health consequence is dependent on the amount of alcohol intake, this dose-response relationship has not been modelled in the current analysis due to lack of data on local alcohol consumption disaggregated by the volume of alcohol. However, the risk of developing health consequences has been derived from a population which is representative of the general population and thus we have accounted for the effect of different levels of alcohol consumption.

While assessing the economic burden of alcohol related health conditions, we calculated the cost incurred by health system, OOP expenditure, and indirect costs due to premature mortality and reduced productivity because of morbidity. However, there are certain other costs which are also associated with the consumption of alcohol, viz., cost of vehicle and property damage, law enforcement costs, harm resulting from consumption of counterfeit alcohol etc. These costs were not accounted for while calculating the total economic burden of alcohol related health conditions on Indian society. However, in a study conducted in Thailand, Thavorncharoensap et al. (2010) found that of the total alcohol attributable economic burden, the cost of property damage and of law enforcement accounted for 0.49% and 0.16% respectively (Thavorncharoensap et al., 2010). This is not a substantial proportion of the overall economic cost and hence its omission is not likely to significantly affect our estimates.

We estimated indirect costs using the human capital approach. Despite its widespread use, the human capital approach is criticised for imposing a single linear pathway on the complex process of heterogeneous work profiles of the population, as it is based on calculating potential production loss, which may over-estimate actual production loss (Ratcliffe, 1995). In contrast, the friction cost approach captures lost productivity only for a period in which the worker is replaced by someone (Lofland, Locklear, & Frick, 2001). Friction cost implies the cost imposed upon an organization as a result of worker absence until replaced by another worker from the pool of unemployed. Therefore, we conducted a separate sensitivity analysis for assessing indirect costs using friction cost approach. Results of the sensitivity analysis show that although productivity losses are much lower using the friction cost approach, nevertheless alcohol poses significant economic burden on society. Indirect cost estimates of our analysis can be improved by deriving data on level of sickness absence, worker replacement policies and the economic situation at a micro level and specific to the people who are developing these effects.

Conclusion and policy implications

Health risks are in transition owing to changing patterns of physical activity and food, alcohol and tobacco consumption (World Health Organization, 2009). It warrants understanding the role of these risk factors for developing clear and effective strategies for improving global health. Using the country specific evidence, we have estimated the magnitude of health and economic harm caused by alcohol consumption in India. The economic aspects hold increasing significance due to rising healthcare costs and limited healthcare resources in the country, as they highlight the potential to reduce the incidence and cost of health consequences if alcohol use can be minimized. Given the range of uncertainties and the limitations of the analysis, our estimates of health and economic burden of alcohol use should be interpreted in the context of the analytic purpose of this work, i.e., to leverage country specific data to generate estimates of alcohol attributable harm, thus presenting a strong case for alcohol control policy. The findings of our study endorse that even under conservative assumptions, alcohol use is both clinically and economically unfavourable for Indian society.

Both ‘alcohol’ and ‘health’ are state subjects in India and hence subject to state specific policies. To shield its people from the financial hardship of treatment costs, although some states are opting for strategies directed towards decreasing the OOP expenditure resulting from curative care (Mukh Mantri Punjab Cancer Raahat Kosh Scheme, 2017), there should also be focus on addressing social determinants of health and preventive aspects of the disease. Both policy domains should go hand in hand as they are the means to achieve the goal of Universal Health Coverage (UHC). While the Indian Government has launched the world’s largest health insurance scheme (Horton, 2018), preventive action on social determinants such as alcohol use should not be ignored. Alcohol use not only negatively influences the health of the population, it also poses significant health care costs - in turn pushing high numbers of households into poverty. In pursuit of UHC, provision of free diagnosis and treatment is an important aspect, however, it must also focus on preventive aspects of disease. Government should explore and embark upon policies to reduce the negative health, economic and social consequences of alcohol consumption (World Health Organization, 2010). Such policies may entail regulating and restricting availability of alcoholic beverages, reducing demand through taxation and pricing policies, regulating the marketing of alcoholic beverages, enacting appropriate drink driving policies and raising awareness and support for effective alcohol control policies, thus ensuring complete mental, physical and social well-being of the individuals.

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Declaration of interests

None.

CRediT authorship contribution statement

Gaurav Jyani: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing - original draft. **Shankar Prinja:** Conceptualization, Methodology, Validation, Formal analysis, Resources, Writing - review & editing, Supervision. **Atul Ambekar:** Conceptualization, Validation, Resources, Writing - review & editing. **Pankaj Bahuguna:** Software, Formal analysis, Writing - review & editing. **Rajesh Kumar:** Conceptualization, Validation, Resources, Writing - review & editing.

References

Abraham, J. (1995). *Impact of prohibition on state excise-study of four southern states [Internet]. Economic and political weekly* (Accessed 16 August 2018). Available from:http://www.epw.in/journal/1995/48/commentary/impact-prohibition-state-excise-study-four-southern-states.html.

Alcohol use and burden for 195 countries and territories (2018). Alcohol use and burden for 195 countries and territories, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet*.

Alvarez, M. A., Cirera, I., Solà, R., Bargalló, A., Morillas, R. M., & Planas, R. (2011). Long-term clinical course of decompensated alcoholic cirrhosis: A prospective study of 165 patients. *Journal of Clinical Gastroenterology, 45*, 906–911.

Anderson, P., Chisholm, D., & Fuhr, D. C. (2009). Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. *Lancet, 373*(June (9682)), 2234–2246.

Bagnardi, V., Rota, M., Botteri, E., Tramacere, I., Islami, F., Fedirko, V., et al. (2015). Alcohol consumption and site-specific cancer risk: A comprehensive dose-response meta-analysis. *British Journal of Cancer, 112*(February (3)), 580–593.

Bruha, R., Dvorak, K., & Petrtyl, J. (2012). Alcoholic liver disease. *World Journal of Hepatology, 4*(March (3)), 81–90.

Casswell, S., & Thamarangsi, T. (2009). Reducing harm from alcohol: Call to action. *Lancet, 373*(June 9682)), 2247–2257.

Chauhan, A. S. (2018). *Cost effectiveness of intensity modulated radiotherapy (IMRT) versus conventional Radiotherapy for the treatment of head and neck cancers in India [Ph.D. Thesis]*. Chandigarh, India: Postgraduate Institute of Medical Education and Research.

Chauhan, A. S., Prinja, S., Ghoshal, S., Verma, R., & Oinam, A. S. (2018). Cost of treatment for head and neck cancer in India. *PloS One, 13*(1), e0191132.

Chikritzhs, T., Stockwell, T., Naimi, T., Andreasson, S., Dangardt, F., & Liang, W. (2015). Has the leaning tower of presumed health benefits from 'moderate' alcohol use finally collapsed? *Addiction, 110*, 726–727.

Chong, C., Gulamhussein, A., Heathcote, E., Lilly, L., Sherman, M., Naglie, G., et al. (2003). Health-state utilities and quality of life in hepatitis C patients. *The American Journal of Gastroenterology, 98*(3), 630–638.

de C Cancela, M., Ramadas, K., Fayette, J.-M., Thomas, G., Muwonge, R., Chapuis, F., et al. (2009). Alcohol intake and oral cavity cancer risk among men in a prospective study in Kerala, India. *Community Dentistry and Oral Epidemiology, 37*, 342–349.

Di Castelnuovo, A., Costanzo, S., Bagnardi, V., Donati, M. B., Iacoviello, L., & de Gaetano, G. (2006). Alcohol dosing and total mortality in men and women: An updated meta-analysis of 34 prospective studies. *Archives of Internal Medicine, 166*(December (22)), 2437–2445.

Drummond, M., Sculpher, M., Claxton, K., Stoddart, G., & Torrance, G. (2015). *Methods for the economic evaluation of health care programmes* (4th ed.). New York: Oxford University Press.

Fillmore, K. M., Kerr, W. C., Stockwell, T., Chikritzhs, T., & Bostrom, A. (2006). Moderate alcohol use and reduced mortality risk: Systematic error in prospective studies. *Addiction Research & Theory, 14*, 101–132.

Fox-Rushby, J., & Cairns, J. (2005). *Economic evaluation.* New York: Open University Press.

Global Burden of Disease Cancer Collaboration, Fitzmaurice, C., et al. (2017). Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: A systematic analysis for the global burden of disease study. *JAMA Oncology, 3*(April (4)), 524–548.

Holmes, M. V., Dale, C. E., Zuccolo, L., Silverwood, R. J., Guo, Y., Ye, Z., et al. (2014). Association between alcohol and cardiovascular disease: Mendelian randomisation analysis based on individual participant data. *BMJ, 349*(July), g4164.

Horton, R. (2018). Offline: The new politics of health in India. *The Lancet, 392*(10151), 902.

Howard, A. A., Arnsten, J. H., & Gourevitch, M. N. (2004). Effect of alcohol consumption on diabetes mellitus: A systematic review. *Annals of Internal Medicine, 140*(February (3)), 211–219.

International Institute for Population Sciences (IIPS), & ICF (2017). *National family health survey (NFHS-4) report, 2015-16. Mumbai*Available from:http://rchiips.org/nfhs/NFHS-4Report.shtml.

Ishak, K. G., Zimmerman, H. J., & Ray, M. B. (1991). Alcoholic liver disease: pathologic, pathogenetic and clinical aspects. *Alcoholism, Clinical and Experimental Research, 15*(February (1)), 45–66.

Kim, M. Y., Cho, M. Y., Baik, S. K., Jeong, P. H., Suk, K. T., Jang, Y. O., et al. (2012). Beneficial effects of candesartan, an angiotensinblocking agent, on compensated alcoholic liver fibrosis - a randomized open-label controlled study. *Liver International, 32*, 977–987.

Koopmanschap, M. A., Rutten, F. F., van Ineveld, B. M., & van, R. L. (1995). The friction cost method for measuring indirect costs of disease. *Journal of Health Economics, 14*(2), 171–189.

Kularatna, S., Whitty, J. A., Johnson, N. W., Jayasinghe, R., & Scuffham, P. A. (2016). A comparison of health state utility values associated with oral potentially malignant disorders and oral cancer in Sri Lanka assessed using the EQ-5D-3 L and the EORTC-8D. *Health and Quality of Life Outcomes, 14*(July), 101. https://doi.org/10.1186/s12955-016-0502-y.

Lefkowitch, J. H. (2005). Morphology of alcoholic liver disease. *Clinical Liver Disease, 9*(February (1)), 37–53.

Lofland, J. H., Locklear, J. C., & Frick, K. D. (2001). Different approaches to valuing the lost productivity of patients with migraine. *PharmacoEconomics, 19*(9), 917–925.

Ministry of Health and Family Welfare (2011). *Family welfare statistics in India 2011 [Internet]*. [Accesses 21 August 2018]. Available from:New Delhi: Statistics Division, Ministry of Health and Family Welfare, Government of India. http://mohfw.nic.in/WriteReadData/l892s/3503492088FW%20Statistics%202011%20Revised%2031%2010%2011.pdf.

Mokdad, A. A., Lopez, A. D., Shahraz, S., Lozano, R., Mokdad, A. H., Stanaway, J., et al. (2014). Liver cirrhosis mortality in 187 countries between 1980 and 2010: A systematic analysis. *BMC Medicine, 12*(September), 145.

Mukh Mantri Punjab Cancer Raahat Kosh Scheme (2017). *Mukh mantri Punjab cancer raahat kosh scheme [Internet]*. Pbhealth.gov.in. [Accessed 20 September 2018]. Available from:http://pbhealth.gov.in/cancer.html.

Naimi, T. S., Brown, D. W., Brewer, R. D., Giles, W. H., Mensah, G., Serdula, M. K., et al. (2005). Cardiovascular risk factors and confounders among nondrinking and moderate-drinking U.S. adults. *American Journal of Preventive Medicine, 28*(May (4)), 369–373.

National Sample Survey Office (2015). *Key indicators of social consumption in India- Health. NSS 71st round (January-June 2014).* New Delhi: National Sample Survey Office, Ministry of Statistics and Programme Implementation, Government of India.

Palmer, A. J., Neeser, K., Weiss, C., Brandt, A., Comte, S., & Fox, M. (2000). The long-term cost-effectiveness of improving alcohol abstinence with adjuvant acamprosate. *Alcohol and Alcoholism, 35*(September-October (5)), 478–492.

Prinja, S., Gupta, R., & Kumar, R. (2015). *Concurrent evaluation of national rural health mission 2012-15 final report*Chandigarh, India: School of Public Health, Postgraduate Institute of Medical Education and Research.

Prinja, S., Sharma, D., Katoch, S., Kaur, M., & Jagnoor, J. (2016a). *Final Report 2016: Evaluation of cashless scheme for road accident victims*Chandigarh: School of Public Health, Postgraduate Institute of Medical Education and Research December 123p.

Prinja, S., Gupta, A., Verma, R., Bahuguna, P., Kumar, D., Kaur, M., et al. (2016b). Cost of Delivering Health Care Services in Public Sector Primary and Community Health Centres in North India. *PloS One, 11*(August (8)), e0160986.

Prinja, S., Jagnoor, J., Chauhan, A. S., Aggarwal, S., Nguyen, H., & Ivers, R. (2016c). Economic burden of hospitalization due to injuries in North India: A cohort study. *International Journal of Environmental Research and Public Health, 13*(July (7)) pii: E673.

Prinja, S., Bahuguna, P., Chauhan, A. S., et al. (2016d). *Final report 2016: Impact evaluation of Rastriya Swasthya Bima Yojana in Himachal Pradesh*Chandigarh, India: Postgraduate Institute of Medical Education and Research.

Prinja, S., Chauhan, A. S., Bahuguna, P., et al. (2016e). *Final report 2016: Costing of public sector health facilities in Himachal Pradesh, India*Chandigarh: Postgraduate Institute of Medical Education and Research.

Prinja, S., Bahuguna, P., Duseja, A., Kaur, M., & Chawla, Y. K. (2018). Cost of intensive care treatment for liver disorders at tertiary care level in India. *Pharmacoeconomics Open Access, 2*(June (2)), 179–190.

Prinja, S., Jagnoor, J., Sharma, D., Aggarwal, S., Katoch, S., Lakshmi, P. V. M., et al. (2019). Out of pocket expenditure and financial risk protection for hospitalization due to injuries in public sector hospitals in north India. Under review in: *PloS One*.

Rajsekar, K. (2018). *Indian reference case for undertaking economic evaluation for Health Technology Assessment in India.* [Personal Communication]New Delhi: Department of Health Research, Ministry of Health and Family Welfare, Government of India.

Ratcliffe, J. (1995). The measurement of indirect costs and benefits in health care evaluation: A critical review. *Impact Assess Project Appraisal, 10*(1), 13–18. https://doi.org/10.1080/02688867.1995.9726969.

Registrar General and Census Commissioner of India (2013). *Report on medical certification of cause of death 2013. [Internet]*[Accessed 21 August 2018]. Available from:. New Delhi: Vital statistics division, Ministry of Home Affairs, Government of India. http://www.censusindia.gov.in/2011-Documents/mccd_Report1/Mccd_2013.pdf.

Registrar General & Census Commissioner of India (2016). *SRS life table 2011-2015. [Internet]* (Accessed 12 August 2018). Available at:http://www.censusindia.gov.in/Vital_Statistics/SRS_Life_Table/Srs_life_Table_2011-15.html.

Rehm, J., & Shield, K. D. (2013). Global alcohol-attributable deaths from cancer, liver cirrhosis, and injury in 2010. *Alcohol Research, 35*(2), 174–183.

Rehm, J., Mathers, C., Popova, S., Thavorncharoensap, M., Teerawattananon, Y., & Patra, J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet, 373*(June (9682)), 2223–2233.

Rehm, J., Baliunas, D., Borges, G. L. G., Graham, K., Irving, H., Kehoe, T., et al. (2010). The relation between different dimensions of alcohol consumption and burden of disease: An overview. *Addiction, 105*(May (5)), 817–843.

Reserve Bank of India (2015). *State finances a study of budgets of 2014-15 [Internet]. Mumbai: Reserve bank of India.* [Accessed 16 August 2018] Available from:https://rbi.org.in/Scripts/AnnualPublications.aspx?head=State+Finances+%3a+A+Study+of+Budgets.

Ronksley, P. E., Brien, S. E., Turner, B. J., Mukamal, K. J., & Ghali, W. A. (2011). Association of alcohol consumption with selected cardiovascular disease outcomes: A systematic review and meta-analysis. *BMJ, 342*(February), d671.

Sangwan, A., Prinja, S., Aggarwal, S., Jagnoor, J., Bahuguna, P., & Ivers, R. (2017). Cost of trauma care in secondary- and tertiary-care public sector hospitals in North India. *Applied Health Economics and Health Policy, 15*(October (5)), 681–692.

Smyth, A., Teo, K. K., Rangarajan, S., O'Donnell, M., Zhang, X., Rana, P., et al. (2015). Alcohol consumption and cardiovascular disease, cancer, injury, admission to hospital, and mortality: A prospective cohort study. *Lancet, 386*(November (10007)), 1945–1954.

Soto, M., Sampietro-Colom, L., Lasalvia, L., Mira, A., Jiménez, W., & Navasa, M. (2017). Cost-effectiveness of enhanced liver fibrosis test to assess liver fibrosis in chronic hepatitis C virus and alcoholic liver disease patients. *World Journal of Gastroenterology, 23*(May (17)), 3163–3173.

Stevens, G. A., Alkema, L., Black, R. E., Boerma, J. T., Collins, G. S., Ezzati, M., et al. (2016). (The GATHER Working Group). Guidelines for accurate and transparent health estimates reporting: The GATHER statement. *Lancet, 388*(December (10062)), e19–e23. https://doi.org/10.1016/S0140-6736(16)30388-9.

Takiar, R., Nadayil, D., & Nandakumar, A. (2010). Projections of number of cancer cases in India (2010-2020) by cancer groups. *Asian Pacific Journal of Cancer Prevention, 11*(4), 1045–1049.

Teli, M. R., Day, C. P., Burt, A. D., Bennett, M. K., & James, O. F. (1995). Determinants of progression to cirrhosis or fibrosis in pure alcoholic fatty liver. *Lancet, 346*(October (8981)), 987–990.

Thavorncharoensap, M., Teerawattananon, Y., Yothasamut, J., Lertpitakpong, C., Thitiboonsuwan, K., Neramitpitagkul, P., et al. (2010). The economic costs of alcohol consumption in Thailand, 2006. *BMC Public Health, 10*(June), 323.

The World Bank Group (2016). *Health Nutrition and population statistics: Population estimates and projections [internet]*[Accessed 10 September 2018]. Available from. Washington, DC: The World Bank Group. http://databank.worldbank.org/data/reports.aspx?source=Health-Nutrition-and-Population-Statistics:-Population-estimates-and-projections#.

Torok, N. J. (2015). Update on alcoholic hepatitis. *Biomolecules, 5*(November (4)), 2978–2986.

US dollar to Indian Rupee spot exchange rates US dollar to Indian Rupee spot exchange rates [Internet] (Accessed 2 September 2018). Available from: https://www.poundsterlinglive.com/bank-of-england-spot/historical-spot-exchange-rates/usd/USD-to-INR-2017.

Wong, R. J., Chou, C., Bonham, C. A., Concepcion, W., Esquivel, C. O., & Ahmed, A. (2014). Improved survival outcomes in patients with non-alcoholic steatohepatitis and alcoholic liver disease following liver transplantation: An analysis of 2002-2012 United Network for Organ Sharing data. *Clinical Transplantation, 28*(June (6)), 713–721.

World Health Organization (2009). *Global health risks: Mortality and burden of disease attributable to selected major risks [Internet]*[Accessed 20 September 2018]. Available from:. Geneva: World Health Organization. http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf.

World Health Organization (2010). *Global strategy to reduce the harmful use of alcohol.* Geneva: World Health Organization.

World Health Organization (2014). *Global status report on alcohol and health 2014*Geneva: World Health Organization.

World Health Organization (2018). *Global status report on alcohol and health 2018*(Accessed 2 October 2018). Available from:. Geneva: World Health Organization. http://www.who.int/substance_abuse/publications/global_alcohol_report/en/.