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Trends in mortality related to unintentional poisoning in the South Asian region from 1990 to 2019: analysis of data from the Global Burden of Disease Study

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ABSTRACT

Objective This study aimed to estimate the burden of unintentional poisoning in South Asian countries from 1999 to 2019.

Design An ecological study conducted at the regional level for South Asian countries, based on data from the Global Burden of Disease Study 2019.

Setting We extracted unintentional poisoning data from the Global Burden of Disease Study data set from 1990 to 2019 to assess trends in mortality, disability-adjusted life-years (DALYs), years of life lost, years lived with disability (YLDs) and causative agents in South Asian countries (Bangladesh, Bhutan, India, Nepal and Pakistan).

Outcome measures We determined the per cent change and 95% CI for the period between 1990 and 2019 by age, gender and country. We also conducted Poisson regression to measure the percentage change in the rate per year.

Results The absolute number of deaths due to unintentional poisoning in South Asia decreased (−32.6%) from 10 558 deaths in 1990 to 7112 deaths in 2019. The age standardised death rate from unintentional poisoning in South Asia has seen a downward trend (−55.88%), declining from 0.87 (0.67–1.01) age-standardised per 100 000 population in 1990 to 0.41 (0.34–0.47) in 2019. Among age groups, under 9 years and 10–19 years have seen downward trends for death and DALYs, accounting for −93.5% and −38.3%, respectively. YLDs have seen an upward trend (5.9%), increasing from 10 461.7 per 100 000 in 1990 to 11 084 per 100 000 in 2019. YLDs in women increased by 7.4%, from 11 558.2 per 100 000 to 12 418.3 per 100 000. The incidence rate ratios (IRRs) adjusted by all age groups and gender for DALYs in all South Asian countries has reduced significantly (IRR 0.97, 95% CI 0.96 to 0.97) from 1990 to 2019.

Conclusion This study showed reduction in death and DALYs due to unintentional poisoning in South Asia except YLDs which is showing an increasing trend. Public health systems should continue efforts to minimise and prevent disabilities arising from unintentional poisoning in South Asia.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This analysis provides a comprehensive description of trends in unintentional poisoning disability-adjusted life-years, years lived with disability and mortality in South Asia.
⇒ The data used in the study were not adequate to determine specific risk factors for unintentional poisoning in South Asian countries.
⇒ The accuracy and robustness of the estimates depend on the quality and quantity of data used in the source data from the Global Burden of Disease Study.

INTRODUCTION

Unintentional poisoning is a global public health concern.[1–3] The WHO estimated that unintentional poisoning caused 84 278 deaths in 2019 worldwide and a loss of five million disability-adjusted life-years (DALYs).[4] This may be attributed largely to an exponential growth of industrialisation[5] that leads to increase of various chemicals.[6 7] The abundance of such chemicals has important implications for health across the globe. Poisoning is one of the main causes of emergency visits in hospitals in many countries.

More than 90% of the unintentional poisoning-related deaths occur in lower middle-income countries (LMICs)[8] with a greater proportion of deaths in children.[9 10] Socioeconomic patterns, new development of drugs (opioids and psychotropics) and substances (domestic fuels, halogenated hydrocarbons and other solvents), agricultural modernisation, green revolution in various regions, and easy access to over-the-counter (OTC) drugs[11–14] have been noted as some reasons underlying the higher rates of poisonings in LMICs. In addition, carbon

monoxide exposure is frequent in LMICs as a result of fuels emitted by autos, stoves and furnaces, all of which are widely used and pose substantial health risks.[15] The precise burden of unintentional poisoning may be higher than that is reported due to variability in exposure and nature of poisoning and unavailability of robust poisoning information mechanisms in many developing countries. Previous studies from South Asian countries reported limited capacity to prevent and control unintentional poisoning, including a lack of functional poison control centres and toxicovigilance, ineffective communication systems to increase public awareness of poison impact, prevention, and control, and poor implementation of poison prevention policies and services.[16–18]

The Global Burden of Disease (GBD) Study proposed a summary metric, DALYs, to quantify the burden of disease and injury to determine priorities in public health policy and evaluate the effectiveness of public health interventions.[1] Unintentional poisonings can be indicative of exposures that may lead to chronic health outcomes and need greater public health attention.[1 19] Estimating the burden of unintentional poisoning is important for targeting specific preventive measures and planning healthcare interventions. Comprehensive and systematic assessment of the mortality trends of unintentional poisoning among South Asian countries has been limited. This study aimed to estimate the burden of unintentional poisoning and its trends in South Asian countries from 1990 to 2019 using the GBD methodology.

METHODS

Study design

This was an ecological study conducted at the regional level for South Asian countries.

Study data sources

We extracted data from the GBD 2019 results tool which is a global health database. The Institute for Health Metrics and Evaluation (IHME) conducted the GBD 2019 study in the most comprehensive manner to measure the level and trends of global epidemiology. We extracted the annual deaths and age-standardised mortality rates for unintentional poisoning from 1990 to 2019 grouped by sex, age and country (Bangladesh, Bhutan, India, Nepal and Pakistan) from the GBD 2019 Study.[20] The GBD uses International Classification of Diseases, Tenth Revision coding to map the poisoning by and exposure to noxious substances.[21] The GBD collects data on poisoning in two categories: poisoning by carbon monoxide and poisoning by other means. Analgesics, narcotics, antiepileptics, psychotropics, drugs acting on autonomic nervous system, biological substances, organic solvents, pesticides and unspecified drugs and chemicals are included in poisoning by other means. However, it disregards poisoning by and exposure to alcohol. The GBD methodology for estimating the burden of unintentional poisoning has been described in previous studies.[2 15] The GBD generates point estimates and 95% uncertainty intervals for every cause in the cause list, every country/location, all ages, each sex separately and aggregated, and every year from 1990 to the current round of 2019. The complete data set used for the analysis in this research is publicly available from the GBD 2019 Study by the IHME and it can be extracted from the Global Health Data Exchange query tool (http://ghdx.healthdata.org/gbd-results-tool).[22]

The GBD Study estimates disease burdens using a variety of data sources, including disease registries, population-level surveys, health facility data and disease surveillances. The GBD research evaluates data quality such as completeness, missing data rates and accuracy, and then uses robust modelling techniques to capture patterns in the data and minimise estimation error. Previous studies have explained the modelling of these data in great detail.[23] The GBD uses latest population estimates for WHO Member States to estimate the age-specific death rates by sex. The total number of deaths for every sex-age group must equal to the total number of deaths for that age-sex group estimated by the data sources.[24] Complete or partial vital registration data, together with sample registration methods, account for 74% of global mortality estimates. For the remaining 26% of estimated global mortality, survey data and indirect demographic techniques give information on child and adult mortality. Adult mortality rates were computed from expected trends in child death in countries lacking vital registry data using the modified Brass Logit Life Table technique.[25]

Variables

The main variables selected for this study were mortality rate per 100 000, DALYs, years lived with disability (YLDs), and years of life lost for all age groups, sex and country. Mortality included deaths due to unintentional poisoning from carbon monoxide and due to other means.

Statistical analysis

Data analysis was done using Microsoft Excel V.2013 and R-programming software V.4.3.2 (R software, USA). The percentage change over 30 years in deaths, DALYs and YLDs was calculated for 2019 against 1990 as the benchmark. We also used Poisson regression to evaluate the trends in deaths and DALYs due to unintentional poisoning for all countries in South Asia and reported the incidence rate ratio (IRR) along with 95% CI as an indicator of change per year.

Patient and public involvement

None.

RESULTS

The absolute number of deaths due to unintentional poisoning has seen a downward trend from 10 558 deaths in 1990 to 7112 deaths in 2019 in South Asia (figure 1).

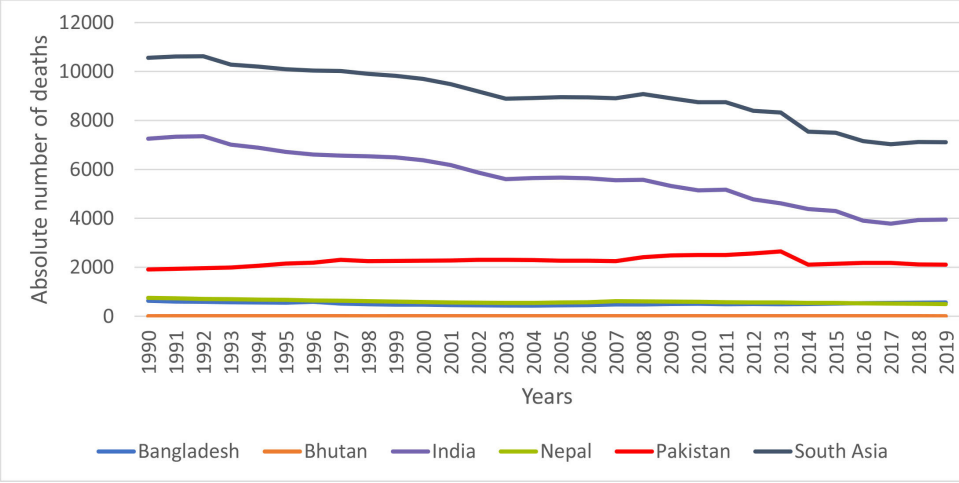

Figure 1 Absolute number of deaths due to unintentional poisoning by countries in South Asia from 1990 to 2019. The absolute number of deaths was determined by estimating the total number of deaths that occurred due to poisoning in a specific year. The absolute number of deaths due to unintentional poisoning has been decreasing from 1990 to 2019.

Bangladesh, Nepal and Bhutan have seen a constant trend of deaths from 1990 to 2019. In India, similarly, the number of deaths due to unintentional poisoning has decreased substantially from 7275 in 1990 to 3945 in 2019.

Table 1 shows the death rates from unintentional poisoning in countries in South Asia, with regard to gender and age groups from 1990 to 2019. The death rates from unintentional poisoning in South Asia has seen a downward trend (−32.9%) over 30 years, declining from 986.2 per 100 000 population in 1990 to 661.3 per 100 000 population in 2019. There has been considerable reduction in death rates from unintentional poisoning in Bangladesh than in other South Asian countries (−48.3), reducing from 1032 per 100 000 population in 1990 to 533.4 per 100 000 population in 2019. Both men and women have seen a similar percentage change in death reduction, accounting for −31.5% and −34.4%, respectively. Among age groups, the under 9 years group has seen the largest reduction in death rates (−93.5%) over 30 years from 1401.5 per 100 000 population in 1990 to 90.9 per 100 000 population in 2019. The deaths caused by carbon monoxide poisoning followed an upward trend (16%), whereas deaths by other means saw a downward trend (−53%).

Table 2 shows standardised death rates from unintentional poisoning in countries in South Asia with regard to gender and causative agents from 1990 to 2019. The age-standardised death rate from unintentional poisoning in South Asia has seen a downward trend (−55.88%) over 30 years, declining from 0.87 (0.67–1.01) per 100 000 population in 1990 to 0.41 (0.34–0.47) per 100 000 population in 2019. Both men and women have seen a similar decline in the age-standardised rate in death reduction, accounting for −52.22% and −53.26%, respectively. The age-standardised death rate due to causative agents such as carbon monoxide and other means of unintentional poisoning in South Asia has shown a downward trend accounting for −33.1% and −63.8%, respectively.

Table 3 shows DALYs from unintentional poisoning in countries in South Asia with regard to gender and age groups from 1990 to 2019. Over the last 30 years, DALYs from unintentional poisoning in South Asia have decreased (−32.9%), reducing from 64 589.4 per 100 000 population in 1990 to 34 053.8 per 100 000 population in 2019. Bangladesh and Nepal have seen the greatest reduction in DALYs over 30 years, accounting for −61.8% and −61.5%, respectively. DALYs in both men and women caused by unintentional poisoning have decreased, accounting for −46% and 48.6%, respectively. Among age groups, the under 9 years and 10–19 years groups have seen a −38.3% downward trend, decreasing from 18 806.6 per 100 000 in 1990 to 11 609.1 per 100 000 in 2019.

Table 4 shows YLDs from unintentional poisoning in countries in South Asia with regard to gender and age groups from 1990 to 2019. The YLDs in South Asia have seen an upward trend (5.9%) over 30 years, increasing from 10 461.7 per 100 000 in 1990 to 11 084 per 100 000 in 2019. Bangladesh has the highest upward trend for YLDs (14%), increasing from 9086.7 per 100 000 in 1990 to 10 360 per 100 000 in 2019. YLDs in women increased by 7.4% over 30 years, from 11 558.2 per 100 000 to 12 418.3 per 100 000 in 2019. Children under 9 years saw the highest reduction in YLDs (−15.8%), decreasing from 5942.3 per 100 000 in 1990 to 5005.8 per 100 000 in 2019. The YLDs caused by carbon monoxide and other means followed an upward trend, accounting for 72% and 68%, respectively.

The IRRs adjusted for all age groups and gender for the measurement of deaths in all South Asian countries were statistically insignificant (IRR 0.96, 95% CI 0.91 to 1.02). However, the trend for death in Nepal increased significantly (IRR 0.97, 95% CI 0.94 to 1). Table 5 shows the IRR trend for all age groups and gender with regard

Table 1 Death rates of unintentional poisoning in South Asian countries, with regard to gender, age groups and causative agents (1990–2019)

Year	1990	1995	2000	2005	2010	2015	2019	30 years %Δ
Death rate per 100 000 (×1000 cases)								
Country (region)								
South Asia	986.2 (10 825)	882.7 (10 660)	825.5 (10 952)	748.4 (10 889)	696.7 (11 059)	666.6 (11 421)	661.3 (11 939)	–32.90%
India	967.5 (8278)	869.7 (8171)	828 (8545)	743.8 (8411)	701.7 (8641)	677.2 (8970)	675.3 (9392)	–30.20%
Pakistan	1058 (1194)	1048.8 (1324)	965.4 (1373)	919.9 (1485)	789.8 (1445)	725.4 (1492)	669.4 (1500)	–36.70%
Bangladesh	1032 (1125)	801.8 (959)	665.7 (852)	603.1 (821)	550.5 (796)	498.2 (762)	533.4 (850)	–48.30%
Nepal	1136.3 (222)	927.2 (201)	743.9 (178)	647.8 (168)	623.1 (172)	660.6 (193)	635.6 (193)	–44.10%
Gender								
Male	1014.7 (5790)	915.1 (5745)	863.9 (5942)	795.3 (5971)	754.2 (6147)	701.7 (6148)	694.8 (6402)	–31.50%
Female	955.4 (5035)	847.6 (4914)	784.1 (5010)	698.4 (4918)	635.9 (4912)	629.9 (5273)	626.5 (5536)	–34.40%
Age groups								
Under 9 years	1401.5 (4371)	166.7 (3850)	164.9 (3312)	148.4 (2904)	125.7 (2399)	95.4 (1898)	90.9 (1481)	–93.50%
10–19 years	161.1 (381)	139.8 (370)	138.8 (409)	125.9 (397)	102.8 (346)	80.2 (283)	72.5 (259)	–55.00%
20–29 years	262.1 (484)	243.7 (495)	250.8 (560)	217.9 (546)	194.3 (540)	140.4 (423)	139.8 (448)	–46.70%
30–39 years	346 (474)	324 (506)	340.4 (610)	311 (625)	280.4 (619)	228.8 (561)	218.7 (585)	–36.80%
40–49 years	638.4 (612)	587.6 (639)	571 (714)	527.3 (754)	497.1 (814)	437.9 (812)	410.5 (832)	–35.70%
50–59 years	1453.1 (950)	1346.3 (958)	1293.7 (992)	1094.6 (986)	1060.2 (1149)	1085.8 (1372)	978.5 (1398)	–32.70%
60–69 years	3543.1 (1397)	3218.4 (1516)	2992.7 (1622)	2658.3 (1638)	2623.8 (1846)	2311.8 (1974)	2206.6 (2150)	–37.70%
70+ years	9845.3 (2156)	9248 (2326)	8941.4 (2732)	7955.9 (3040)	7011.2 (3345)	6986 (4099)	6922.7 (4785)	–29.70%
Causative agents of unintentional poisoning in South Asia								
Carbon monoxide	0.28 (3126)	0.27 (3266)	0.25 (3630)	0.27 (3549)	0.24 (3802)	0.2 (3494)	0.2 (3630)	16%
Other means	0.68 (7431)	0.57 (6824)	0.37 (5318)	0.46 (6151)	0.31 (4941)	0.23 (4006)	0.19 (3482)	–53%

*Rate per 100 000 (counts ×1000). Δ=relative change.

Table 2 Age-standardised death rate due to unintentional poisoning by South Asian countries with regard to gender, age groups and causative agents (1990–2019)

Year	1990	1995	2000	2005	2010	2015	2019	30 years % Δ
Age-standardised death rate per 100 000								
Country (region)								
South Asia	0.87 (0.67–1.01)	0.78 (0.62–0.91)	0.71 (0.56–0.81)	0.61 (0.5–0.71)	0.56 (0.46–0.64)	0.45 (0.37–0.52)	0.41 (0.34–0.47)	–52.88%
India	0.75 (0.48–0.9)	0.66 (0.44–0.79)	0.59 (0.4–0.69)	0.49 (0.33–0.57)	0.42 (0.28–0.49)	0.34 (0.24–0.39)	0.3 (0.21–0.35)	–60.65%
Pakistan	1.46 (1.03–2.28)	1.55 (1.13–2.32)	1.5 (1.16–2.16)	1.39 (1.08–1.99)	1.35 (1.05–1.93)	1.02 (0.74–1.4)	0.95 (0.7–1.28)	–35.35%
Bangladesh	0.57 (0.46–0.69)	0.48 (0.41–0.57)	0.41 (0.35–0.48)	0.37 (0.32–0.43)	0.38 (0.32–0.45)	0.36 (0.27–0.45)	0.37 (0.27–0.47)	–34.70%
Nepal	3.72 (2.54–4.92)	3.13 (2.32–4.05)	2.58 (1.98–3.26)	2.34 (1.82–2.88)	2.28 (1.71–2.91)	2.01 (1.51–2.56)	1.77 (1.34–2.27)	–52.35%
Gender								
Male	1.02 (0.7–1.23)	0.9 (0.65–1.11)	0.83 (0.61–0.97)	0.72 (0.53–0.84)	0.67 (0.5–0.76)	0.54 (0.42–0.62)	0.49 (0.39–0.58)	–52.22%
Female	0.71 (0.54–0.86)	0.65 (0.49–0.78)	0.59 (0.47–0.69)	0.5 (0.42–0.6)	0.44 (0.37–0.53)	0.36 (0.29–0.45)	0.33 (0.26–0.42)	–53.26%
Causative agents of unintentional poisoning in South Asia								
Carbon monoxide	0.31 (0.18–0.44)	0.3 (0.18–0.41)	0.29 (0.19–0.38)	0.27 (0.17–0.35)	0.25 (0.17–0.32)	0.21 (0.14–0.26)	0.21 (0.14–0.26)	–33.1%
Other means	0.56 (0.41–0.7)	0.48 (0.37–0.61)	0.42 (0.33–0.54)	0.34 (0.28–0.44)	0.3 (0.25–0.38)	0.24 (0.2–0.31)	0.2 (0.17–0.27)	–63.8%

*Age-standardised death rate per 100 000. Δ=relative change.

to death and DALYs due to unintentional poisoning in South Asian countries from 1990 to 2019. The DALYs for all South Asian countries has reduced significantly (IRR 0.97; 95% CI 0.96 to 0.97) from 1990 to 2019.

DISCUSSION

In this study we estimated the burden of unintentional poisoning including death, DALYs and YLDs in five South Asian countries using GBD data from 1990 to 2019. Overall, we found that the death rates and DALYs followed a decreasing trend in all these countries due to unintentional poisoning from 1990 to 2019. Bangladesh had the highest reduction in death rate and DALYs caused by unintentional poisoning compared with other countries in South Asia, whereas the incidence of unintentional poisoning in Nepal increased. Moreover, women had higher YLDs than men. In terms of age categories, children under 9 years and 10–19 years had the highest reduction in deaths, DALYs and YLDs caused by unintentional poisoning over 30 years.

There could be several reasons for the decreasing trend of death and DALYs due to unintentional poisoning in South Asia. Healthcare might have improved resulting in reduced morbidity and mortality acutely but increased long-term disability. This could be driven by better access to healthcare services due to increasing urbanisation.[26] Larger proportions of populations have started living in cities compared with rural areas, making it easy to access healthcare and other essential infrastructure services necessary to prevent deaths due to poisoning. World Bank data show that just between 2001 and 2011, the urban population of South Asia increased by 130 million, and by 2030, it is expected to increase by over 250 million.[27 28] In addition, an overall improvement in health systems services delivery and increased health-seeking behaviour of people in South Asian countries may have also indirectly decreased the mortality rates in due to unintentional poisoning. As supported by literature, in the past few decades public health has improvement in these countries, although universal health coverage and equity is still a concern.[27 29–34] Furthermore, establishment and functioning of national poisoning control centres, influencing the availability, labelling and packing of poisons in the market, and addressing the issue at the community level in some of these South Asian countries may have helped in early detection of acute poisoning cases leading to a coherent response to avoid mortalities.[35–39] Although over the past few decades, new poisoning control centres may have been established, but still only 47% of WHO Member States had poisons centres as of 1 January 2021.[40]

Table 3 Disability-adjusted life-years due to unintentional poisoning in South Asian countries with regard to gender and age groups (1990–2019)

Year	1990	1995	2000	2005	2010	2015	2019	30 years %Δ
DALYs (disability-adjusted life-years) 100 000 (×1000 cases)								
Country (region)								
South Asia	64 589.4 (708 949)	56 661.9 (684 290)	50 894.3 (675 230)	45 333.9 (659 636)	40 491.5 (642 753)	36 248.2 (621 044)	34 053.8 (614 740)	–47.3%
India	62 717.5 (536 602)	55 195 (518 569)	50 174.2 (517 795)	44 348.4 (501 505)	39 994.4 (492 474)	35 647.4 (472 191)	33 643 (467 876)	–46.4%
Pakistan	70 086.2 (79 083)	67 978.2 (85 813)	62 618.4 (89 033)	59 706.2 (96 359)	51 264.8 (93 819)	46 501.7 (95 647)	42 059.1 (94 239)	–40.0%
Bangladesh	70 934.8 (77 357)	55 103.5 (65 901)	44 082.8 (56 388)	37 563 (51 155)	32 206.2 (46 572)	28 166.2 (43 100)	27 077.1 (43 123)	–61.8%
Nepal	79 274.8 (15 488)	62 970.9 (13 678)	48 827.6 (11 713)	39 897.5 (10 367)	34 887.7 (9656)	33 813.2 (9883)	30 538.4 (9289)	–61.5%
Bhutan	68 570.4 (420)	54 911.7 (328)	46 473.2 (301)	37 189.9 (250)	31 806.5 (233)	29 339.5 (224)	28 369.2 (214)	–58.6%
Gender								
Male	63 666.8 (363 306)	56 054.3 (351 935)	50 875.4 (349 906)	45 886.9 (344 548)	41 426.5 (337 609)	36 596.8 (320 660)	34 382.8 (316 835)	–46.0%
Female	65 588.3 (345 643)	57 319.9 (332 355)	50 914.8 (325 324)	44 744.3 (315 087)	39 505 (305 143)	35 883.4 (300 384)	33 710.9 (297 906)	–48.6%
Age groups								
Under 9 years	18 806.6 (44 420)	17 116.8 (45 311)	16 880.7 (49 763)	15 802.5 (49 867)	13 971.6 (46 962)	12 238.9 (43 161)	11 609.1 (41 498)	–38.3%
10–19 years	18 806.6 (44 420)	17 116.8 (45 311)	16 880.7 (49 763)	15 802.5 (49 867)	13 971.6 (46 962)	12 238.9 (43 161)	11 609.1 (41 498)	–38.3%
20–29 years	26 567.4 (49 053)	25 385.1 (51 579)	25 612.5 (57 291)	23 344.7 (58 589)	21 355.7 (59 483)	17 831.4 (53 797)	17 700 (56 758)	–33.4%
30–39 years	31 394.3 (43 175)	30 276.7 (47 448)	30 912.9 (55 625)	29 135.4 (58 654)	26 925.6 (59 606)	24 095.3 (59 383)	23 474.7 (63 014)	–25.2%
40–49 years	43 547.1 (42 028)	41 364.5 (45 465)	40 334.9 (50 875)	38 263.1 (55 141)	36 487.3 (60 271)	33 898.6 (63 274)	32 672.4 (66 625)	–25.0%
50–59 years	69 149.8 (45 561)	65 495.3 (46 898)	63 276.2 (48 894)	56 363 (51 331)	54 860.4 (59 965)	55 726.3 (71 007)	52 042.4 (75 007)	–24.7%
60–69 years	113 498.6 (45 593)	105 211.8 (50 377)	99 024.3 (54 427)	90 690.2 (56 510)	89 439.6 (63 789)	81 694.3 (70 740)	78 995.3 (77 834)	–30.4%
70+ years	176 773.3 (38 711)	166 869 (41 970)	162 530.2 (49 658)	147 155.1 (56 223)	133 369.4 (63 632)	128 320.2 (75 289)	126 016.9 (87 108)	–28.7%
Causative agents of unintentional poisoning in South Asia								
Carbon monoxide	19.11 (209 802)	17.71 (213 845)	15.99 (232 643)	17.24 (228 738)	15.09 (239 578)	12.61 (216 050)	12.27 (221 526)	6%
Other means	53.57 (587 998)	44.43 (536 575)	27.86 (405 335)	35.67 (473 223)	23.33 (370 315)	17.18 (294 315)	14.12 (254 805)	–57%

*Rate per 100 000 (counts ×1000). Δ=relative change.

Table 4 Years lived with disability due to unintentional poisoning in South Asian countries with regard to gender and age groups (1990–2019)

Year	1990	1995	2000	2005	2010	2015	2019	30 years %Δ
YLDs (years lived with disability) rate per 100 000 (×1000 cases)								
Country (region)								
South Asia	10 461.7 (114 831)	10 532.3 (127 195)	10 496.4 (139 259)	10 570.3 (153 804)	10 564.7 (167 702)	10 815.6 (185 304)	11 084 (200 088)	5.9%
India	10 835.3 (92 705)	10 957 (102 943)	10 913.9 (112 631)	10 988.2 (124 258)	10 975.7 (135 150)	11 216.1 (148 570)	11 485 (159 723)	6.0%
Pakistan	9092 (10 259)	9042 (11 414)	8992.7 (12 786)	8981.5 (14 495)	8905 (16 297)	9025 (18 563)	9213.7 (20 645)	1.3%
Bangladesh	9086.7 (9909)	8943 (10 695)	8974.9 (11 480)	9168.1 (12 486)	9343.5 (13 511)	9903.1 (15 154)	10 360.2 (16 500)	14.0%
Nepal	9717 (1898)	9595.2 (2084)	9582.2 (2299)	9619 (2499)	9652.5 (2671)	10 056 (2939)	10 322.8 (3140)	6.2%
Bhutan	9626.8 (59)	9713.4 (58)	9702.1 (63)	9853.9 (66)	9908.7 (72)	10 261.7 (78)	10 682.4 (81)	11.0%
Gender								
Male	9449.2 (53 920)	9473.8 (59 481)	9456.8 (65 041)	9489.3 (71 252)	9407.5 (76 667)	9598.7 (84 104)	9804.4 (90 347)	3.8%
Female	11 558.2 (60 910)	11 678.4 (67 714)	11 615.4 (74 217)	11 722.9 (82 552)	11 785.7 (91 035)	12 089.3 (101 201)	12 418.3 (109 741)	7.4%
Age groups								
Under 9 years	5942.3 (18 532)	5761.6 (18 714)	5615.2 (18 813)	5473.5 (18 971)	5288.4 (18 614)	5098.2 (17 701)	5005.8 (16 873)	–15.8%
10–19 years	6944.2 (16 402)	6815.5 (18 042)	6666.4 (19 652)	6541.7 (20 643)	6407.9 (21 538)	6341.8 (22 365)	6288 (22 477)	–9.4%
20–29 years	9771.8 (17 961)	9786 (19 838)	9589 (21 419)	9419.3 (23 589)	8947.6 (24 887)	8864.7 (26 713)	8767.4 (28 074)	–10.3%
30–39 years	12 748.3 (17 543)	12 794.4 (20 047)	12 549.5 (22 586)	12 361.7 (24 889)	11 836.2 (26 237)	11 795.5 (29 119)	11 708.2 (31 462)	–8.2%
40–49 years	15 524.1 (15048)	15 576.3 (17228)	15 273.9 (19359)	15 090.1 (21830)	14 675.5 (24356)	14 694.9 (27526)	14 658.1 (29976)	–5.6%
50–59 years	19 243.7 (12733)	19 231.4 (13818)	18 913.5 (14700)	18 782.1 (17210)	18 460.2 (20265)	18 407.8 (23547)	18 451 (26706)	–4.1%
60–69 years	24 212.2 (9801)	24 187.3 (11671)	23 940.1 (13277)	23 815.9 (14910)	23 678.9 (17040)	23 382.5 (20321)	23 464.5 (23216)	–3.1%
70+ years	31 099.4 (6810)	31 161.5 (7838)	30 940.1 (9453)	30 785.9 (11762)	30 946.1 (14765)	30 698.7 (18012)	30 820.9 (21305)	–0.9%
Causative agents of unintentional poisoning in South Asia								
Carbon monoxide	0.66 (7262)	0.57 (6900)	0.57 (8233)	0.57 (7564)	0.57 (9022)	0.58 (9998)	0.69 (12 520)	72%
Other means	1.32 (14 446)	1.14 (13 804)	1.12 (16 333)	1.13 (14 945)	1.12 (17 826)	1.13 (19 328)	1.35 (24 312)	68%

*Rate per 100 000 (counts ×1000). Δ=relative change.

Table 5 Incidence rate ratio (IRR) trend for all age groups and gender with regard to death and DALYs due to unintentional poisoning in South Asian countries from 1990 to 2019

Measures	IRR (95% CI)	P value
Death		
Bangladesh	0.983 (0.91 to 1.05)	0.611
Bhutan	0.967 (0.90 to 1.02)	0.303
India	0.962 (0.90 to 1.01)	0.193
Nepal	0.973 (0.94 to 0.99)	0.049*
Pakistan	0.981 (0.94 to 1.01)	0.287
South Asia	0.969 (0.91 to 1.02)	0.246
DALYs (disability-adjusted life-years)		
Bangladesh	0.978 (0.97 to 0.986)	<0.001*
Bhutan	0.963 (0.956 to 0.97)	<0.001*
India	0.958 (0.951 to 0.965)	<0.001*
Nepal	0.966 (0.962 to 0.969)	<0.001*
Pakistan	0.979 (0.975 to 0.983)	<0.001*
South Asia	0.966 (0.96 to 0.972)	<0.001*

*Significant at 5%

In contrast, the mortality rate due to unintentional poisoning, particularly opioid overdose causing three epidemics in the USA from 1990 to 2019, claimed 500 000 lives,[41–48] while in these five South Asian countries we have seen decreasing death rates over the years. Deaths due to overdosing are increasing in the USA due to the increased availability of illegally manufactured synthetic drugs such as fentanyl and methamphetamine, toxic drug supply in which drugs are frequently contaminated or adulterated by multiple psychoactive substances, and polysubstance use.[49] However, the declining trend in unintentional poisoning mortality in South Asian countries may be linked to a weak to non-existent surveillance system for poison exposures, and poisoning-related data may be under-reported due to the inadequate capacity of health professionals to characterise poisoning in hospitals and communities.[50 51]

On a global level, there is high variability in the mortality rate attributed to unintentional poisoning ranging from 2.2% annual increase in mortality in Lesotho to −6.4% annual decrease in mortality in Mongolia.[52] However, the absolute number of deaths is still high. An important factor which may have increased the prevalence of poisoning could be the rapid rise of industrialisation, and consequently an increase in the amount and types of chemical exposures to the population.[53–57] Therefore, it is critical not to ignore the public health importance of preventing unintentional poisoning across all age groups in all socioeconomic profiles, specially addressing the health disparity and equity issues surrounding poisoning prevention, as various studies have shown that the lower socioeconomic class and the poor are more prone to unintentional poisoning as compared with the well-off population.[45 58–63] Furthermore, the COVID-19 pandemic has contributed to unintentional poisoning events as people throughout the world have started using a variety of chemical and pharmaceutical substances to prevent and treat COVID-19 infections.[64 65] This situation may be worst in South Asian countries due to unregulated manufacturing and use of environmental cleansers and alcohol-based hand sanitisers in combination with some of the population self-medicating with OTC medications and traditional or herbal medicines.

Most importantly, in this study we noticed that there are variations in the trends and burden of unintentional poisoning among five South Asian countries. For instance, Bangladesh has experienced the highest reduction in deaths and DALYs caused by unintentional poisoning over the years. This could be due to pesticide legislation that ban use of highly hazardous pesticides in 2000.[66] This legislation on pesticide ban caused a 37% reduction in the case fatality rate for pesticide poisoning in Bangladesh over two decades. The incidence of unintentional poisoning in Nepal has been increasing. There could be multiple socioeconomic and public health factors affecting this increasing trend. On the global air pollution index, Nepal is on the 10th number which is attributable to carbon emissions from vehicles, industries, and power plants with poor regulations.[67] The difference in trends of unintentional posioing in south asian countries needa a comparative policy analysis along with overall understanding of development of socio economic determinants of health.

The WHO global health estimates that mortality attributed to unintentional poisoning is high in men with 1.4 deaths per 100 000 population. However, in our study, the mortality rate due to unintentional poisoning among men and women was equivalent. It is inconsistent with the previous studies from China, Korea, Iran and Turkey which have reported higher mortality rates among men.[2 68–73] Our finding is intriguing because there is a combination of factors which could put men at greater risk of unintentional poisoning than women such as a greater tendency towards risk-taking behaviours and higher exposure to poisoning, including occupational risks and higher consumption of alcohol among men. For example, men may have greater exposure to carbon monoxide because they are more likely to use fuel-burning equipment in their jobs.[15 74 75] Literature has also recorded higher alcohol consumption among men than women.[76 77] In addition, in the South Asian culture men have more opportunities of socialising as compared with women and alcohol consumption is highly associated with socialisation which puts more men at greater risk of poisoning.[78–82] This study also found that women had higher YLDs than men. This might be because women tend to live longer than men but with disabilities.

Another noticeable difference in terms of mortality reduction due to unintentional poisoning was among children under 18 years. This could be due to a number

of interventions which aim to address unintentional injuries in children including unintentional poisoning.[83–86] However, some studies have reported that children younger than 5 years could have been at higher risk of unintentional poisoning due to their curiosity and hand-to-mouth behaviours leading to ingestion of poisonous objects.[87 88]

Although this study used the most extensive epidemiological data of South Asians from 1990 to 2019 based on analytical methods of GBD, it still has some possible limitations associated with the GBD data.[89–92] First, the GBD data are based on existing data sources, which may be inaccurate in and of itself. The quality and completeness of reporting difficulties may be more common in these five South Asian developing countries which could explain why death rates are lower than in developed and industrialised countries like USA, Israel and so on, where poisoning surveillance and data monitoring technologies to assist data accuracy may be more readily available. In addition, the accuracy and robustness of estimates are highly dependent on the quality and quantity of data used in the modelling. Second, the prediction and explanation of the GBD model is subject to the intentionality principle which is often difficult to report and needs to be taken into consideration. Third, we have not computed risk factors of unintentional poisoning specific to South Asian countries in this paper due to scarcity of the data, although, risk factors are elaborated from the literature in the discussion section. Another limitation is that these data do not point to any specific causes for the decrease in mortality and prevalence of poisoning in South Asian countries.

Conclusion

In summary, there is a declining trend in the unintentional poisoning death rates in the five South Asian countries over the years since 1990. Bangladesh has experienced the highest decline in this burden while, Nepal is still experiencing an increase in the burden of unintentional poisoning. Children under 18 years of age had seen significant reduction in mortality due to unintentional poisoning. To further lessen the burden of unintentional poisoning in South Asian countries, continued attention and public health action are needed to focus on preventing unintentional poisoning, limiting the widespread self-medication, preventing use of alcohol and drugs, and increasing regulatory controls for hazardous chemical availability and access.

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