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ECONOMIC IMPLICATIONS OF UNSAFE DRINKING WATER: EVIDENCE FROM HOUSEHOLDS IN VIJAYAWADA CITY OF ANDHRA PRADESH

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ABSTRACT

Access to safe drinking water remains one of the most economically consequential development challenges facing urban India, with the household-level cost burden falling unevenly across socioeconomic strata. The present study examines the economic implications of unsafe drinking water among households in Vijayawada, with special reference to differences between slum and non-slum households in water access, defensive expenditure and health-related costs. The study is based on primary data collected from 210 households, using a structured household interview schedule, comprising 90 slum households and 120 non-slum households drawn from selected wards across the city. The analysis focuses on the primary source of drinking water, perceived quality of drinking water, monthly expenditure on water purchase, monthly expenditure on household water treatment, monthly health expenditure due to waterborne illnesses and the total water-related economic burden as a percentage of monthly household income. Descriptive statistical tools such as percentage analysis were used for data interpretation. The findings reveal that slum households have substantially lower access to municipal piped supply and rely disproportionately on public taps and tanker water, perceive their drinking water quality as significantly poorer and incur a markedly higher incidence of waterborne illness costs. Non-slum households invest considerably more in defensive expenditure on treatment technologies but record lower health expenditure as a consequence. The total water-related economic burden as a share of monthly household income is sharply regressive, with more than one-third of slum households spending in excess of 10 per cent of their monthly income on water-related costs compared with less than eight per cent of non-slum households. The study concludes that unsafe drinking water functions as a regressive economic burden that disproportionately constrains the welfare of poorer urban households in Vijayawada.

KEYWORDS: *Unsafe Drinking Water, Averting Expenditure, Cost of Illness, Slum Households, Vijayawada*

At the global level, access to safe drinking water has long been recognised as one of the most critical determinants of human development, public health and economic productivity. The World Health Organization and the United Nations Children's Fund Joint Monitoring Programme estimate that more than two billion people worldwide continue to lack access to safely managed drinking water services, with the burden concentrated in low- and middle-income countries. International evidence consistently demonstrates that the absence of reliable, safe drinking water generates substantial economic costs through three primary channels: direct expenditure on alternative water sources, defensive or averting expenditure on household treatment technologies and the cost of illness associated with waterborne diseases. The Sustainable Development Goal 6 framework, which calls for universal and equitable access to safe and affordable drinking water by 2030, has placed renewed policy attention on the economic dimensions of household water access in developing countries.

In the Indian context, the provision of safe drinking water has been a central concern of public policy for several decades, with major national programmes including the Accelerated Urban Water Supply Programme, the Jawaharlal Nehru National Urban Renewal Mission, the Atal Mission for Rejuvenation and Urban Transformation and, most recently, the Jal Jeevan Mission Urban. Census of India 2011 data and the National Sample Survey Office's 76th Round on drinking water, sanitation, hygiene and housing condition document significant progress in extending piped water access, though substantial inequalities persist between urban and rural areas, across states and between formal residential settlements and notified slum areas. The Andhra Pradesh state government, through the Vijayawada

Municipal Corporation, supplies treated water drawn primarily from the Krishna river, yet documented concerns persist regarding distribution losses, intermittent supply, seasonal turbidity and uneven coverage of peri-urban and slum settlements.

The behavioural and economic response of households to unsafe drinking water differs markedly from the response to most other consumption goods. Where the municipal supply is unreliable or perceived as unsafe, households respond through a combination of three private adaptations: substitution toward alternative water sources such as bottled water, can water and tankers; investment in averting technologies such as candle filters, reverse osmosis units and ultraviolet purifiers; and the absorption of medical and lost-wage costs when these protective measures fail. Each of these adaptations carries an economic cost, and the cost mix varies substantially across households depending on income, dwelling tenure, supply reliability and risk perception. The classical environmental economics framework therefore conceptualises the total economic burden of unsafe water not merely as expenditure on water itself, but as the sum of purchase, averting and illness costs borne by the household.

Looking ahead, the economic burden of household water management in urban India is expected to evolve further with the expansion of point-of-use treatment markets, the diffusion of digital water-quality monitoring tools and the gradual rollout of metered piped supply under the Jal Jeevan Mission Urban framework. Climate variability, including monsoon irregularities affecting reservoir levels and rising summer demand pressures in tier-2 cities, may amplify supply disruptions and intensify defensive expenditure. Simultaneously, the proliferation of private water markets — including bottled water suppliers, tanker operators and household treatment vendors — raises new questions about affordability, regulatory oversight and the distributional consequences of private water provisioning at the household level.

The persistence of unsafe drinking water has substantial implications at the household level, particularly in tier-2 urban centres where formal infrastructure coverage remains uneven. Vijayawada, as a rapidly growing urban centre in Andhra Pradesh with both established residential neighbourhoods and substantial notified slum populations, provides a relevant setting in which to examine the household economics of unsafe drinking water. The question of how slum and non-slum households differ in their access to safe water sources, in their expenditure on water purchase and treatment, in their experience of waterborne illness and in the overall economic burden borne as a share of household income therefore merits systematic empirical examination at the city level.

REVIEW OF LITERATURE

Howard and Bartram (2003) developed an influential framework for the World Health Organization on domestic water quantity, service level and health, linking the volume and accessibility of household water to a spectrum of health outcomes. The study establishes that beyond a minimum threshold of access, additional volumes and improved service levels generate measurable reductions in waterborne disease incidence. The framework provides the analytical foundation for subsequent household-level studies of the economic burden of unsafe water.

Ahmad, Goldar and Misra (2005) estimated the value of arsenic-free drinking water to rural households in Bangladesh using stated preference techniques. The study found substantial household willingness to pay for safer water, varying systematically with income, education and risk perception. The findings demonstrate that the economic burden of unsafe water includes not only direct expenditure but also the implicit welfare loss reflected in households' valuation of safer alternatives.

Pattanayak, Yang, Whittington and Bal Kumar (2005) studied averting expenditure on coping with unreliable public water supplies among households in Kathmandu, Nepal. The study found that households spend significant amounts on substitute water sources, storage, treatment and coping behaviours when public supply is unreliable, with substantial heterogeneity by income and dwelling type. The findings reinforce that the welfare cost of poor water service quality includes a substantial private defensive expenditure component.

Hutton, Haller and Bartram (2007) conducted a global cost-benefit analysis of water supply and sanitation interventions. The study estimated that the global economic returns to safe water and sanitation investment substantially exceed their costs, with benefit-cost ratios particularly high in developing-country contexts. The findings

provide a strong economic rationale for public investment in safe water access and highlight the magnitude of the avoidable burden borne by households in inadequately served settings.

Whittington, Hanemann, Sadoff and Jeuland (2009) reviewed the challenge of improving water and sanitation services in less developed countries within a comprehensive welfare-economics framework. The study identifies that household coping costs, including averting expenditures and health costs, often substantially exceed the financial cost of public service provision. The analysis underscores the importance of measuring the full household economic burden of unsafe water rather than only direct service expenditure.

Pattanayak, Poulos, Yang and Patil (2010) evaluated the value of environmental health interventions through a study of water and sanitation programmes in India. The study found that household investment in averting behaviours such as water treatment substantially reduces the health and economic burden of unsafe water, with returns concentrated among lower-income households where baseline risks are highest. The findings suggest that even partial improvements in water quality generate substantial household-level economic benefits.

Devoto, Duflo, Dupas, Parienté and Pons (2012) examined piped water adoption in urban Morocco through a randomised experiment. The study found that connection to piped water generated measurable improvements in household welfare and time use, though the health gains were smaller than the welfare gains. The findings highlight the multi-dimensional nature of the household economic burden of unsafe water and the importance of considering time, convenience and household production effects alongside direct expenditure.

World Health Organization (2017), in the fourth edition of its Guidelines for Drinking-water Quality, consolidated international evidence on microbial, chemical and radiological hazards in drinking water and recommended a framework for water safety planning at the supply level. The guidelines emphasise that even where treated supply exists, household-level recontamination during storage and handling represents a significant residual risk, particularly in low-income urban settings.

The National Sample Survey Office (2019), in its 76th Round survey on drinking water, sanitation, hygiene and housing condition in India, documented substantial inequalities in access to safe drinking water across states, between urban and rural areas and across dwelling types. The survey reports that a significant share of urban households continues to rely on unimproved or partially improved water sources, with implications for household expenditure and waterborne disease incidence.

Census of India (2011), through the Houselisting and Housing Census, provides the most comprehensive baseline data on household drinking water sources in India. The data reveal that despite substantial expansion of piped supply, significant proportions of urban households remain dependent on public taps, hand pumps, tube wells and other shared or non-piped sources. The data form the empirical foundation for slum-based and ward-level household water access studies in Indian cities.

WHO and UNICEF Joint Monitoring Programme (2023) reported on global progress on household drinking water, sanitation and hygiene between 2000 and 2022. The report documents continued but uneven progress, with substantial populations still lacking access to safely managed drinking water services. The findings reaffirm the importance of household-level evidence in tier-2 urban contexts where aggregate indicators may mask significant within-city inequalities.

STATEMENT OF THE PROBLEM

Despite substantial public investment in urban water infrastructure over the past three decades, the household economic burden of unsafe drinking water remains inadequately studied at the city level, particularly in tier-2 urban centres of Andhra Pradesh. While national and metropolitan studies have provided important aggregate insights, evidence specific to cities such as Vijayawada is limited, despite documented concerns regarding intermittent supply, seasonal quality variations and uneven coverage of notified slum areas. The question of whether and to what extent unsafe drinking water generates differential economic burdens across socioeconomic strata — and how these burdens

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are distributed across direct expenditure, defensive expenditure and health costs — therefore forms the central concern of this study (Pattanayak et al., 2005; Whittington et al., 2009).

The economic burden of unsafe drinking water in urban Indian households operates through multiple structural channels. Unreliable or unsafe municipal supply leads households to substitute toward alternative water sources, including bottled water, can water and tanker supply, each carrying recurring expenditure. Households also invest in defensive technologies such as candle filters, reverse osmosis units, ultraviolet purifiers and boiling fuel, generating an averting expenditure component that may be substantial for households able to afford it. Where these protective measures are absent or fail, the consequence is increased incidence of waterborne illnesses including diarrhoea, typhoid, gastroenteritis and other diseases, generating medical expenditure and lost wages. Vijayawada, drawing its municipal supply primarily from the Krishna river, faces the additional pressures of urban expansion, seasonal turbidity, distribution-stage contamination and uneven supply coverage in peri-urban and slum settlements.

The burden of unsafe drinking water, however, is unlikely to be uniformly distributed across urban households. Variations are expected to be particularly pronounced between slum and non-slum households, given documented differences in housing tenure, infrastructure connectivity, income, education and access to public services. Slum households typically face poorer infrastructure quality, higher reliance on shared or public water sources and greater susceptibility to waterborne illness, while non-slum households are more likely to invest in defensive treatment technologies that mitigate health risks. The relative composition of direct expenditure, averting expenditure and health expenditure within the total water-related economic burden therefore differs systematically across these two household categories, with important implications for equity and policy.

In this context, it becomes essential to systematically examine how slum and non-slum households in Vijayawada differ in their primary source of drinking water, their perception of water quality, their expenditure on water purchase and household treatment, their experience of waterborne illness costs and their overall water-related economic burden as a share of monthly household income. Understanding these differences is important for assessing the regressivity of current water infrastructure arrangements, for identifying segments of the urban population most vulnerable to catastrophic water-related expenditure and for informing locally appropriate investments in piped water expansion, water quality monitoring and household-level public health support.

OBJECTIVES AND METHODOLOGY

The main objective of the study is to examine the economic implications of unsafe drinking water among households in Vijayawada, with special reference to differences between slum and non-slum households in water access, perceived quality, purchase expenditure, defensive expenditure, health expenditure and the overall water-related economic burden as a share of monthly household income.

The study is based on primary data collected from households residing in Vijayawada city of Andhra Pradesh. A structured household interview schedule was used to gather information relating to the primary source of drinking water, the household head's perception of water quality, average monthly expenditure on purchasing drinking water from external sources, average monthly expenditure on household water treatment including filter maintenance and boiling fuel, average monthly health expenditure attributed to waterborne illnesses including medical consultations, medicines, laboratory tests and lost wages, and the total water-related economic burden expressed as a percentage of monthly household income. The respondents were selected through a multi-stage stratified sampling design covering selected wards in Vijayawada, with stratification based on the Census of India 2011 classification of notified slum and non-slum residential areas. Within each stratum, households were selected randomly through a household-listing exercise. Only households that had resided in the selected dwelling for at least one year and that consented to participate were included. The total sample size consists of 210 households, comprising 90 slum households and 120 non-slum households. The slight oversampling of slum households relative to their share in the broader urban population was adopted to ensure adequate analytical cell sizes for the comparative analysis. The data collected were systematically coded, tabulated and analysed using simple percentage analysis to examine distribution patterns and differences between slum and non-slum households across the variables studied.

RESULTS AND DISCUSSION

Primary Source of Drinking Water

Table – 1 presents the distribution of households by primary source of drinking water across two strata, namely slum and non-slum households. At the overall level, it is observed from the table that 46.19 per cent of the households rely on municipal piped supply as their primary source of drinking water, while 17.14 per cent rely on bottled or can water, 16.19 per cent on public taps or standposts and 12.38 per cent on tanker water. About 8.10 per cent depend on private bore wells. This indicates that municipal piped supply remains the dominant source of drinking water in Vijayawada, although a substantial share of households depends on alternative or supplementary sources.

Across the strata, with regard to slum households, only 24.44 per cent rely primarily on municipal piped supply, while 31.11 per cent depend on public taps or standposts and 20.00 per cent on tanker water. About 15.56 per cent rely on bottled or can water and 8.89 per cent on private bore wells. In the case of non-slum households, a substantially higher 62.50 per cent rely on municipal piped supply as their primary source, while 18.33 per cent rely on bottled or can water and 7.50 per cent on private bore wells. Only 6.67 per cent depend on tanker water and 5.00 per cent on public taps or standposts. A comparison between the two strata reveals a sharp infrastructure gradient: non-slum households are nearly two and a half times more likely to be connected to municipal piped supply, while slum households are more than six times more likely to rely on public taps and nearly three times more likely to depend on tanker water.

It can be concluded that access to municipal piped supply in Vijayawada is markedly unequal across slum and non-slum households, with slum households compelled to rely on a fragmented mix of shared and informal water sources that carry substantial implications for both quality and household expenditure.

Table – 1
Distribution of the Households by Primary Source of Drinking Water

Household Category	Municipal Piped	Public Tap / Standpost	Tanker Water	Bottled / Can Water	Private Bore Well	Total
Slum	22 (24.44)	28 (31.11)	18 (20.00)	14 (15.56)	8 (8.89)	90 (100.00)
Non-Slum	75 (62.50)	6 (5.00)	8 (6.67)	22 (18.33)	9 (7.50)	120 (100.00)
Total	97 (46.19)	34 (16.19)	26 (12.38)	36 (17.14)	17 (8.10)	210 (100.00)

Note: Figures in the parenthesis represent row percentages.
Source: Computed from the Primary Data.

Perceived Quality of Drinking Water

Table – 2 presents the distribution of households by their perception of the quality of their primary source of drinking water, classified into slum and non-slum strata. On the whole, it is evident from the table that 33.33 per cent of the households perceive the quality of their drinking water as average, while 23.81 per cent rate it as good, 23.33 per cent as poor and 10.95 per cent as very good. About 8.57 per cent rate the quality of their drinking water as very poor. This indicates that the perceived quality of drinking water in Vijayawada is concentrated in the average to poor range, with fewer than thirty-five per cent of households expressing positive assessments.

Gender wise — that is, across the strata — among slum households, 35.56 per cent rate the quality of their drinking water as poor, while 31.11 per cent rate it as average and 14.44 per cent as very poor. About 13.33 per cent rate it as good and only 5.56 per cent as very good. In the case of non-slum households, 35.00 per cent rate the quality of their drinking water as average, while 31.67 per cent rate it as good and 15.00 per cent as very good. About 14.17 per cent rate it as poor and only 4.17 per cent as very poor. A comparison between the two strata reveals a sharp perceptual divide: among slum households, a combined 50.00 per cent rate the quality as poor or very poor, compared with only 18.34 per cent of non-slum households, while a combined 46.67 per cent of non-slum households rate the quality as good or very good, compared with only 18.89 per cent of slum households.

The findings indicate that slum households not only have inferior structural access to drinking water but also experience and perceive substantially poorer water quality, suggesting that the quality dimension of the inequality is at least as significant as the access dimension itself.

Table – 2
Distribution of the Households by Perceived Quality of Drinking Water

Household Category	Very Good	Good	Average	Poor	Very Poor	Total
Slum	5 (5.56)	12 (13.33)	28 (31.11)	32 (35.56)	13 (14.44)	90 (100.00)
Non-Slum	18 (15.00)	38 (31.67)	42 (35.00)	17 (14.17)	5 (4.16)	120 (100.00)
Total	23 (10.95)	50 (23.81)	70 (33.33)	49 (23.33)	18 (8.58)	210 (100.00)

Note: Figures in the parenthesis represent row percentages.
Source: Computed from the Primary Data.

Monthly Expenditure on Drinking Water Purchase

Table – 3 presents the distribution of households by their average monthly expenditure on purchasing drinking water from external sources, including bottled water, can water and tanker water. By and large, 31.90 per cent of the households report monthly expenditure of Rs. 100 to Rs. 500 on water purchase, while 28.57 per cent report Rs. 501 to Rs. 1,000 and 19.05 per cent report less than Rs. 100. About 14.29 per cent report monthly expenditure of Rs. 1,001 to Rs. 2,000 and 6.19 per cent report expenditure exceeding Rs. 2,000. This indicates that a substantial majority of households in Vijayawada incur recurring monthly expenditure on purchased drinking water, with nearly half spending more than Rs. 500 per month.

Among slum households, 38.89 per cent report monthly expenditure of Rs. 100 to Rs. 500, while 24.44 per cent report Rs. 501 to Rs. 1,000 and 20.00 per cent report less than Rs. 100. About 11.11 per cent report monthly expenditure of Rs. 1,001 to Rs. 2,000 and 5.56 per cent report expenditure exceeding Rs. 2,000. In the case of non-slum households, 31.67 per cent report monthly expenditure of Rs. 501 to Rs. 1,000, while 26.67 per cent report Rs. 100 to Rs. 500 and 18.33 per cent report less than Rs. 100. About 16.67 per cent report monthly expenditure of Rs. 1,001 to Rs. 2,000 and 6.66 per cent report expenditure exceeding Rs. 2,000. The comparison reveals that non-slum households are more concentrated in the higher expenditure brackets, reflecting their greater reliance on bottled water and packaged sources, while slum households cluster in lower expenditure brackets reflecting their use of cheaper tanker and public sources.

These findings suggest that purchase expenditure on drinking water in absolute terms is higher among non-slum households, but the affordability implications must be evaluated relative to household income, an aspect taken up in the final table of the analysis.

Table – 3
Distribution of the Households by Monthly Expenditure on Drinking Water Purchase (in Rs.)

Household Category	< 100	100–500	501–1,000	1,001–2,000	> 2,000	Total
Slum	18 (20.00)	35 (38.89)	22 (24.44)	10 (11.11)	5 (5.56)	90 (100.00)
Non-Slum	22 (18.33)	32 (26.67)	38 (31.67)	20 (16.67)	8 (6.66)	120 (100.00)
Total	40 (19.05)	67 (31.90)	60 (28.57)	30 (14.29)	13 (6.19)	210 (100.00)

Note: Figures in the parenthesis represent row percentages.
Source: Computed from the Primary Data.

Monthly Expenditure on Household Water Treatment

Table – 4 presents the distribution of households by their average monthly expenditure on household water treatment, including the operating and maintenance costs of candle filters, reverse osmosis units and ultraviolet purifiers, the cost of boiling fuel and the cost of purification chemicals or tablets. Of the sample surveyed, 27.14 per cent of the households report monthly treatment expenditure of less than Rs. 200, while 25.24 per cent report Rs. 201 to Rs. 500 and 21.90 per cent report no expenditure on treatment at all. About 17.14 per cent report monthly treatment expenditure of Rs. 501 to Rs. 1,000 and 8.57 per cent report expenditure exceeding Rs. 1,000. This indicates that household-level defensive investment in water treatment is widely distributed but uneven, with more than one in five households undertaking no treatment expenditure whatsoever.

Across the strata, among slum households, 35.56 per cent report monthly treatment expenditure of less than Rs. 200, while 31.11 per cent report no expenditure on treatment and 20.00 per cent report Rs. 201 to Rs. 500. Only 8.89 per cent report monthly treatment expenditure of Rs. 501 to Rs. 1,000 and 4.44 per cent report expenditure exceeding Rs. 1,000. In the case of non-slum households, 29.17 per cent report monthly treatment expenditure of Rs. 201 to Rs. 500, while 23.33 per cent report Rs. 501 to Rs. 1,000 and 20.83 per cent report less than Rs. 200. About 15.00 per cent report no expenditure on treatment and 11.67 per cent report expenditure exceeding Rs. 1,000. The comparison reveals that defensive expenditure on water treatment is markedly higher among non-slum households, who are nearly three times more likely to spend in excess of Rs. 500 per month on treatment than slum households.

Overall, the pattern reflects a clear class gradient in averting behaviour: non-slum households mobilise substantially greater private expenditure to protect themselves from water quality risks, while slum households, constrained by income and dwelling type, rely on more limited and lower-cost treatment options that may afford weaker protection.

Table – 4
Distribution of the Households by Monthly Expenditure on Household Water Treatment (in Rs.)

Household Category	Nil	< 200	201–500	501–1,000	> 1,000	Total
Slum	28 (31.11)	32 (35.56)	18 (20.00)	8 (8.89)	4 (4.44)	90 (100.00)
Non-Slum	18 (15.00)	25 (20.83)	35 (29.17)	28 (23.33)	14 (11.67)	120 (100.00)
Total	46 (21.90)	57 (27.14)	53 (25.24)	36 (17.14)	18 (8.58)	210 (100.00)

Note: Figures in the parenthesis represent row percentages.
Source: Computed from the Primary Data.

Monthly Health Expenditure due to Waterborne Illnesses

Table – 5 presents the distribution of households by their average monthly health expenditure attributable to waterborne illnesses, including expenditure on medical consultations, prescription medicines, laboratory tests and the estimated value of lost wages or work days due to illness episodes within the household. On the whole, 43.81 per cent of the households report no health expenditure on waterborne illnesses during the reference period, while 24.76 per cent report expenditure of less than Rs. 500 and 17.14 per cent report Rs. 500 to Rs. 1,500. About 10.00 per cent report expenditure of Rs. 1,501 to Rs. 3,000 and 4.29 per cent report expenditure exceeding Rs. 3,000. This indicates that more than half of all surveyed households incurred some form of measurable waterborne illness expenditure, suggesting a substantial and recurring health cost dimension to unsafe water at the city level.

Across the strata, among slum households, 33.33 per cent report no health expenditure on waterborne illnesses, while 24.44 per cent report expenditure of less than Rs. 500 and 20.00 per cent report Rs. 500 to Rs. 1,500. About 15.56 per cent report expenditure of Rs. 1,501 to Rs. 3,000 and 6.67 per cent report expenditure exceeding Rs. 3,000. In the case of non-slum households, a notably higher 51.67 per cent report no health expenditure on waterborne illnesses, while 25.00 per cent report expenditure of less than Rs. 500 and 15.00 per cent report Rs. 500 to Rs. 1,500. Only 5.83 per cent report expenditure of Rs. 1,501 to Rs. 3,000 and 2.50 per cent report expenditure exceeding Rs. 3,000. A comparison between the two strata reveals that slum households are nearly three times more likely than non-slum households to incur waterborne illness expenditure exceeding Rs. 1,500 per month.

The evidence indicates that the health-cost component of unsafe drinking water falls disproportionately on slum households, both because of higher illness incidence and because of weaker prior defensive investment, reflecting the cumulative welfare consequences of unequal water access in tier-2 urban India.

Table – 5
Distribution of the Households by Monthly Health Expenditure due to Waterborne Illnesses (in Rs.)

Household Category	Nil	< 500	500–1,500	1,501–3,000	> 3,000	Total
Slum	30 (33.33)	22 (24.44)	18 (20.00)	14 (15.56)	6 (6.67)	90 (100.00)
Non-Slum	62 (51.67)	30 (25.00)	18 (15.00)	7 (5.83)	3 (2.50)	120 (100.00)
Total	92 (43.81)	52 (24.76)	36 (17.14)	21 (10.00)	9 (4.29)	210 (100.00)

Note: Figures in the parenthesis represent row percentages.
Source: Computed from the Primary Data.

Total Water-Related Economic Burden as Percentage of Monthly Household Income

Table – 6 presents the distribution of households by the total water-related economic burden expressed as a percentage of monthly household income, aggregating expenditure on water purchase, household water treatment and waterborne illness costs. It is revealed from the table that 33.33 per cent of the households bear a total water-related burden of 2 to 5 per cent of monthly household income, while 26.67 per cent bear a burden of 5 to 10 per cent and 20.48 per cent bear a burden of less than 2 per cent. About 12.86 per cent bear a burden of 10 to 15 per cent of monthly household income and 6.66 per cent bear a burden exceeding 15 per cent. This indicates that for nearly one in five households in Vijayawada, water-related costs absorb more than 10 per cent of monthly household income — a threshold widely used in health-economics literature to indicate a substantial or catastrophic level of household expenditure.

Among slum households, 31.11 per cent bear a total water-related burden of 5 to 10 per cent of monthly household income, while 24.44 per cent bear a burden of 2 to 5 per cent and 22.22 per cent bear a burden of 10 to 15 per cent. About 13.33 per cent bear a burden exceeding 15 per cent of monthly income and only 8.89 per cent bear a burden of less than 2 per cent. In the case of non-slum households, 40.00 per cent bear a total water-related burden of 2 to 5 per cent of monthly household income, while 29.17 per cent bear a burden of less than 2 per cent and 23.33 per cent bear a burden of 5 to 10 per cent. Only 5.83 per cent bear a burden of 10 to 15 per cent and 1.67 per cent bear a burden exceeding 15 per cent. A comparison between the two strata reveals a sharply regressive pattern: more than one-third (35.55 per cent) of slum households bear a water-related burden exceeding 10 per cent of monthly household income, compared with only 7.50 per cent of non-slum households.

The findings reveal that the economic burden of unsafe drinking water in Vijayawada is profoundly regressive, falling disproportionately on poorer households whose lower absolute spending nonetheless constitutes a substantially larger share of their monthly income, with significant welfare implications for consumption, savings and household resilience.

Table – 6

Distribution of the Households by Total Water-Related Economic Burden as Percentage of Monthly Household Income

Household Category	< 2%	2–5%	5–10%	10–15%	> 15%	Total
Slum	8 (8.89)	22 (24.44)	28 (31.11)	20 (22.22)	12 (13.33)	90 (100.00)
Non-Slum	35 (29.17)	48 (40.00)	28 (23.33)	7 (5.83)	2 (1.67)	120 (100.00)
Total	43 (20.48)	70 (33.33)	56 (26.67)	27 (12.86)	14 (6.66)	210 (100.00)

Note: Figures in the parenthesis represent row percentages.
Source: Computed from the Primary Data.

CONCLUSION

The findings reveal that access to safe drinking water in Vijayawada is sharply unequal across slum and non-slum households. While municipal piped supply serves as the dominant source for non-slum households at 62.50 per cent, only 24.44 per cent of slum households enjoy similar piped access, with the bulk of slum residents depending on public taps, tanker water and bottled or can water. This indicates that infrastructure connectivity, despite decades of public investment in urban water supply, remains a fundamental dimension of inequality in tier-2 Indian cities and forms the structural basis on which all subsequent economic implications of unsafe water rest.

Regarding perceived water quality, a sharp perceptual divide exists between the two strata. While nearly half of non-slum households rate the quality of their drinking water as good or very good, a similar proportion of slum households rate the quality as poor or very poor. The evidence indicates that slum households face not only inferior structural access but also substantially poorer experienced quality, indicating that the qualitative and quantitative dimensions of water inequality reinforce one another rather than offset.

In terms of monthly expenditure on water purchase, non-slum households spend more in absolute terms than slum households, reflecting their greater reliance on bottled and packaged water sources. A majority of households in both strata, however, incur some recurring monthly water purchase expenditure, indicating that purchase costs are a

widespread feature of urban water consumption regardless of dwelling type. The affordability burden of these purchase costs, however, can only be evaluated meaningfully when normalised against household income.

The study further indicates that defensive expenditure on household water treatment exhibits the clearest class gradient of all the variables examined. Non-slum households are nearly three times more likely than slum households to spend in excess of Rs. 500 per month on treatment, reflecting their greater capacity to invest in reverse osmosis units, ultraviolet purifiers and other averting technologies. This pattern implies that wealthier households substantially mitigate their water quality risks through private investment, while poorer households remain disproportionately exposed.

With respect to monthly health expenditure due to waterborne illnesses, slum households bear a markedly higher burden than non-slum households, with nearly three times the proportion of slum households incurring monthly health expenditure exceeding Rs. 1,500. This pattern reflects both the higher incidence of waterborne illness episodes in slum settings and the weaker defensive investments that precede them. The cost-of-illness component of the total water-related burden therefore concentrates among the segment of the population already constrained by limited income and weaker infrastructure access.

Finally, when the three components of water-related expenditure — purchase, treatment and health — are aggregated and expressed as a percentage of monthly household income, the regressive nature of the burden becomes unmistakable. More than one-third of slum households spend in excess of 10 per cent of their monthly income on water-related costs, compared with fewer than one in twelve non-slum households. Overall, the study concludes that unsafe drinking water in Vijayawada operates as a regressive economic burden, with its incidence shifting from defensive expenditure in wealthier households toward cost-of-illness expenditure in poorer households, and with the proportional weight of the total burden falling disproportionately on those least able to bear it.

It is suggested that the expansion of municipal piped water supply be prioritised in notified slum areas of Vijayawada, with explicit equity-targeted investments under the Jal Jeevan Mission Urban and AMRUT frameworks. Strengthening water quality monitoring at distribution points and at the household level may help to bridge the perceptual gap between supply quality and household experience, particularly during seasonal turbidity episodes. Subsidised access to household water treatment technologies such as candle filters and purification tablets, distributed through Anganwadi centres, urban primary health centres and ration shops, can help reduce the defensive expenditure gap between slum and non-slum households. Improved public health surveillance for waterborne illnesses, combined with targeted financial protection for low-income households experiencing acute illness episodes, would mitigate the regressive cost-of-illness burden documented in this study. Finally, future research may extend the present analysis through longitudinal designs that track seasonal variations in water quality and household expenditure, comparative studies across tier-2 cities in Andhra Pradesh and Telangana, and integrated examinations of how water, sanitation and air quality jointly shape the environmental economic burden borne by urban Indian households.

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