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An Empirical Analysis of Safe Drinking Water and Quality of Life

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Abstract

Increasing water stress has become a global concern as it has severe consequences for the quality of human life. The available studies suggest links between water and the quality of life, but do not provide empirical evidence. Particularly, empirical evidence using the global panel data approaches is ignored. This study fills this gap by analytically exploring and empirically testing the effect of safely managed water on the quality of life for 71 United Nation member countries over the period 1990-2019. The results obtained from cross-sectional and panel data approaches suggest that safely managed drinking water significantly improves the quality of life. The study offers important policy implications.

Key Words: Quality of Life, Safe Drinking Water, United Nation Development Program, World Bank
JEL Codes: O15, Q25.

1 Introduction

Achieving a better quality of life (QoL) is the goal of every economy across the globe. The United Nations (2015) introduced Sustainable Development Goals (SDG's) for their 2030 agenda which is based on 17 goals. These goals cover an array of socio-economic, equality, health, and environmental issues. It starts from the eradication of poverty to the improvement in health, towards clean water and attainment of better education and

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carbon-free environment that affects the life of the individuals directly or indirectly. Thus, SDGs focus on those dimensions which are closely connected with the betterment of the QoL (UNESCO, 2015).

According to UNDP (1998), QoL involves the fulfillment of basic needs which include health, education, and standard of living while Sirgy et al., (2004) called it a qualitative measure of well-being which includes consumer, health, social, economic and physical well-being. Previously, scholars and economists measured QoL through GDP per capita (Nussbaum & Sen, 1993; Majeed & Mumtaz, 2017) but Anand and Sen (1999) and Majeed (2019) stated that QoL is not only affected by income rather there are also some other major sociological, physiological and human dimensions of individual's life which were being ignored previously. Therefore, Sirgy et al., (2004) stated that QoL is a subjective measure, and to empirically measure it, the best proxy is the "Human Development Index (HDI)".

QoL is the core aspect of economic development therefore, it is required to identify the factors affecting it. To ensure a better QoL, sustainable development is required which is impossible without safely managed drinking water. According to UNESCO (2019) better QoL, social progress, economic as well as human benefits can be achieved through better water, sanitation, and hygiene services (WASH). Safely managed drinking water along with sanitation services are considered as one of the fundamental human rights because attaining healthy livelihoods and better QoL is impossible without safe drinking water and developed sanitation services. But as stated by Goswami and Bisht (2017) that economic growth and continuous increase in population have put huge pressure on the availability of fresh and affordable water sources. Most of the countries around the globe are facing uncertainty in the water availability that can harm the economic development of the countries and hence QoL. This serious water challenge and its linkages with economic development have several dimensions. One of these is the availability of safe and affordable drinking water. Improved drinking water sources influence individuals and societies which leads to social, environmental, and economic development. This is the best explanation of why there was a separate goal placed in

the "Millennium Development Goals (MDG's)" that was "to reduce the half of population that has no access to safe and affordable drinking water and sanitation by 2015".

To achieve sustainable development, reduction in scarcity increased accessibility, and sound management of affordable and safe drinking water and sanitation is required. Water scarcity theaters a vital role in every aspect of life therefore, target 6 of SDGs is solely about water. The goal is to increase efficient water usage across all the sectors and to guarantee the sustainable supply and withdrawal of water to reduce its shortage and increase its accessibility to the population which lacks it. Water stress has negative consequences on food security, QoL, human as well as economic development. Therefore, these problems call for sound and effective management of water. Water availability is also necessary for the maintenance of the health and resilience of the ecosystem (FAO, 2018).

The increasing water demand along with the risk of water pollution has led to extreme water stress across the globe which is further intensified by global climate change over the past few decades (Majeed & Luni, 2019). The frequency of the local water crisis has been increasing which has serious impacts on environmental sustainability, public health, food security, energy crisis, human development which ultimately harms QoL. Water is one of the unignorable factors of production in many types of goods and services such as food, industrial goods, energy as well as construction. The reliability and predictability of water supply at the desired places must be ensured for sustainable investment which leads to the achievement of economic growth. As it is the necessary condition for economic development which further improves QoL (UNESCO, 2015).

Easy accessibility to safe water is the basic right of every human being across the globe. According to UNESCO (2003) fresh and reasonable drinking water is one of the core fundamentals for socio-economic development and it is not easy to strengthen these foundations because it not only requires political leadership rather it also has a huge monetary cost. But the failure to invest in these fundamentals will impose a high cost for achieving human development as well as economic growth and development.

Water unavailability affects QoL through several channels. For example, if safe drinking water is not readily available at the household level, then it needs time and resources to fetch water from long distances. This fetching of water not only requires time but also needs resources and it is at the cost of lost time which could be used for productive services. Women and young girls suffer the most from the unavailability of safe water because they are the one who sacrifices their time and resources to fetch water from distant places (UNDP, 2006).

Likewise, safe water plays a dynamic role in the health of individuals around the globe. The provision and availability of safe water prevent the spread of infectious diseases including the Novel Coronavirus disease 2019 (COVID-19) outbreak. COVID-19 pandemic is not only affecting health rather it has severe consequences on the socio-economic aspects of the countries which ultimately affect the QoL of individuals. UNDP (2020) stated that ongoing lockdown because of COVID-19 outbreak will likely increase poverty and inequalities globally and therefore, creating hurdles in achieving SDG's. Furthermore, OECD (2020), documented that the COVID-19 pandemic has prompted the utmost severe economic downturn in approximately a century and is affecting human health, jobs and in due course wellbeing. How to keep everyone safe from the deadly virus has been a global concern. In this regard, WHO (2020) stated that guaranteeing good and constantly applying WASH (Water, Sanitation and Hygiene) practices in homes, schools, offices, communities, hospitals, marketplaces will help to prevent human to human transmission of COVID-19 virus. Furthermore, WHO (2020) emphasized on frequent and proper washing of hands to avert infection with the COVID-19 outbreak. The spread of this virus has startled the economies around the world. The downturn in economic activities has exacerbated the problem of poverty thus having negative consequences for QoL and development.

Hence, it can be inferred from the above discussion that water is not only essential for human lives but is also an important component of development. As QoL is a key aspect of development as stated by UNDP (2006) therefore, it is important to highlight the factors affecting QoL. Therefore, the current study explores how the availability of safe drinking water affects the

QoL by using both panel data and cross-sectional data of 71 UN member countries. The study used "pooled OLS, fixed and random effects models and instrumental variable fixed effects techniques" for panel data analysis. While for cross-sectional analysis the study used "Ordinary Least Square and two-stage least square estimation techniques".

The remaining study is systematized as follows: The 2nd section incorporates the review of the literature. The 3rd section includes methodology and data. The 4th section comprises of results and discussion while the 5th section concludes the study.

2 Literature Review

Safe and affordable drinking water helps in achieving a better quality of life. WHO (2007) stated that many economic aspects that lead to improved QoL are interlinked with safe drinking water, hygiene, and sanitation. Unavailability of safe water increases poverty by deteriorating the health of individuals which reduces productivity and hence low standard of living. Easy water accessibility has a key role in improving the health of individuals. Mangyo (2008), tried to find out the relationship between water accessibility on the child's health and analyzed whether in-yard water resources and mother's education are counterparts or alternatives in China? The study found out that easy accessibility to safe and improved water sources improves the health of the child.

Access to improved drinking water sources decreases infectious diseases and malnutrition. Furthermore, it also avoids health related issues caused by water contamination from arsenic and fluoride. According to UNESCO (2009) "Lack of access to adequate, safe food, partly related to water resources management, is one cause of malnutrition, but up to 50% of malnutrition is related to repeated diarrhea or intestinal nematode infections as a result of unclean water, inadequate sanitation or poor hygiene".

Unsafe drinking water has adverse effects on the QoL as it adversely affects health. Every year about 2 million children die due to unsafe water and poor sanitation-related diseases while the health of some becomes weak and worsens due to illness, discomfort, and pain. Unavailability of water also decreases the

opportunities available to older children by reducing their spare or free time. Many children spend most of their time fetching water for their daily use which increases their absentee rate in the school which ultimately affects their education level which is one of the important aspects of HDI (Tarrass & Benjelloun, 2012). Moreover, the availability of safe water prevents individuals and communities from infectious diseases like diarrhea, malaria, and other deadly viral infection like the COVID-19 outbreak. Therefore, WHO (2020) emphasized on the frequent washing of hands and practicing WASH may be one of the preventive measures from the COVID-19 pandemic. UNDP (2020) also is stressing on the use of safe water and sanitation to stop the human-to-human transmission of the deadly virus (COVID-19). Other water-borne diseases can also be cured by the easy availability of safe and affordable water because, in Africa, poor sectors spend almost one-third of their income on the treatment of water-borne diseases such as diarrhea and malaria (Tropp, 2015).

Investment in upgraded water services and management may help in the reduction of poverty and the achievement of economic growth. It can help and make a difference for billions of populations that obtain straight and thorough benefits from enhanced water services such as through healthier and improved health, it reduced the cost of health, time-cost and also increases productivity which will lead to a better standard of living and hence better QoL (UNESCO, 2015). It is also worth mentioning that all human rights are interdependent therefore the improvement in one right will lead to an improvement in the other while the deprivation of one will adversely affect others. Unsafe drinking water and poor sanitation along with unhygienic conditions adversely affect the QoL. Thus, it should be the ultimate policy objective to secure the availability of safe drinking water for all to improve human life which serves as the cornerstone for sustainable development (UNESCO, 2016).

The provision of unswerving, fresh, and clean water and sanitation facilities must be the topmost priority of all the leaders across the globe. One of the important goals of economic development is to improve household water quality. Economic development requires human development which is possible through improvement in the QoL. QoL is being affected by water

quality. Its importance has also been highlighted at all international forums (UNESCO, 2009; Bhattacharya & Banerjee, 2015; ADB, 2016).

Availability to safe drinking water is a matter of life and death". Earth is covered with about 70 percent of water but only 4 percent is freshwater and only 0.5 percent is suitable for human consumption. At the same time, this critical resource (freshwater) for human survival is often undervalued, misused, and misallocated and leaving far too many people having to struggle to obtain water for themselves and their families (SIWI, 2018).

From the above discussion, it can be concluded that most of the studies provide theoretical linkages between safe drinking water and quality of life however there is dearth of empirical evidence. Therefore, the objective of the study is to fill this gap by empirically investigating the effect of safe drinking water on the quality of life.

3 Model, Data, and Methodology

3.1 Theoretical Model

The importance of water can be realized from its meaning given by the "Holy Quran", "We give life to everything" (Quran 21:30). This simple teaching was given by "the Holy book (of religion Islam)" which holds a deeper meaning and understanding. Water is as important for human survival as oxygen. Without water, life cannot exist. Water affects all dimensions of life from improving health to economic activities, from absorbing carbon to supporting ecosystems and from food production to recreational use thus survival of life without water is not possible. As water is connected with all the dimensions of human life therefore, it is an important component of development. When people lack access to clean water and sanitation it has adverse effects on their freedom to choose because most of their time will be utilized for water fetching and will decrease their participation in the market and it will lead to a "vicious circle of poverty". Furthermore, the lack of access to safe drinking water increases the risk of infectious diseases such as malaria, diarrhea, scabies, cholera and worm infection thus altogether they deteriorate QoL (UNDP, 2006). QoL being a subjective measure cannot be empirically estimated (Sirgy et al., 2006), therefore the current study used the

"Human Development Index (HDI)" to measure QoL. Therefore, the relationship between QoL and water can be expressed as below,

$$QoL_{it} = f(Safe\ Drinking\ Water)_{it}$$

Along with water, income is another important factor contributing to QoL. Income increases the purchasing power of the individual, hence giving them access to better health and educational facilities. Income supports quality of life and studies have argued that income per capita is the best measure for QoL (Nussabaum & Sen, 1993; Majeed & Mumtaz, 2017) however as pointed out by Anand and Sen (1999) and Majeed (2019) that although GDP per capita positively affects QoL but it is not the only factor as it does not capture the sociological and psychological aspects of human life. Among these factors are health, education, capabilities of individuals, provision of opportunities, freedom to choose, and live their life accordingly which enhances their standard of living and thus improves human development.

Besides income, education is the major determinant of QoL which is also highlighted by Anand & Sen (1999). Education plays an important role in the improvement of QoL by increasing the knowledge and skills which support access to jobs and enhanced productivity (Majeed and Khan, 2019). Education also equips with the power to decide and freedom to choose among different alternatives (Nourzad & Powell, 2003; Majeed, 2019).

Adverse health status also affects the QoL. The lack of medical facilities and the number of physicians available per person has a determinantal effect on QoL. For human development, the number of physicians per person is important as it reflects the development of a country (Nourzad & Powell, 2003; Asongu, 2013).

Urbanization has both positive and negative effects on quality of life. Urbanization improves QoL through the availability of better facilities, such as health, education, improved infrastructure, and employment opportunities. The effect of urbanization on human development has been discussed by Nourzad and Powell (2003). Urbanization negatively affects QoL because of overpopulation as it increases the pressure on the limited resources available in urban areas. The rural-urban

migration leads to overcrowding and overexploitation of resources and thus having adverse effects on QoL.

Another factor documented in the literature that contributes to human development is gross capital formation. Gross capital formation represents the level of investment in an economy. Higher investment in a country leads to higher employment opportunities. The increase in employment level supports a better standard of living which will lead to improved QoL. Therefore, the model constructed can be represented as below,

$$QoL_{it} = f(Safe\ Drinking\ Water_{it}, GDP_{it}, Secondry\ School\ Enrollment_{it}, Urbanization_{it}, Gross\ Capital\ Formation_{it}, Physicians_{it})$$

3.2 Empirical Model

As water affects QoL therefore it is important to empirically investigate its potential in improving QoL. Therefore, the empirical model constructed for investigating the relationships is mentioned below,

$$QoL_{it} = \alpha_0 + \alpha_1 safe\ drinking\ water_{it} + \alpha_2 education_{it} + \alpha_3 GDP_{it} + \alpha_4 urbanization_{it} + \alpha_5 gross\ capital\ formation_{it} + \alpha_6 physicians_{it} + \theta_i + \mu_t + \varepsilon_{it} \quad (1)$$

Where "i" represents "cross sections while", "t" represents "time". QoL is quality of life that is measured by "HDI (range 0-1, 0 is for the lowest HDI while 1 is for the highest HDI rank)", safe drinking water is "safely managed drinking water (% of total population)", education represents "secondary school enrollment (% net)", "GDP (constant 2010 US$)" is used to capture the effect of income on QoL, urbanization (% of total population) is used to analyze the effect of urbanization on QoL, "gross capital formation (constant 2010 US$)" is used to capture the effect of investment on QoL while "physicians (Per 1000 people)" are used to capture the effect of health expenditures on QoL. α_0 represents the intercept terms while θ_i and μ_t represents country-specific unobservable effects and time effects, respectively. The term ε_{it} is an error term.

3.3 Data and Methods

The current study has taken the data from World Bank (2019) and UNDP (2019). The analysis is based on the panel of

71 UNDP member countries from 1990-2019. The decision about the countries and the time frame is based on the availability of the data. The GDP, urbanization, and gross capital formation are transformed into logarithmic form as it controls heteroscedasticity and provides consistent findings.

The study has conducted both panel and cross-sectional analysis. For panel analysis, the study employed different novel techniques which include pooled OLS, random effects, fixed effects, and IV-Fixed effect (for controlling endogeneity). The incorporation of different methodologies is justified through their specific characteristics. As pooled OLS does not account for country-specific and time-specific characteristics therefore, random effects and fixed effects were employed to control these effects. Random effects give meaningful results if there is no correlation between country-specific characteristics and regressors while fixed effect assumes that there exists a correlation between country-specific effects and the regressors. However, the fixed effect cannot deal with the endogeneity problem therefore, to tackle this problem, IV-Fixed effects have been employed. For cross-sectional analysis, OLS and Two-SLS have been employed. The study conducted a sensitivity analysis to confirm the consistency and robustness of the findings.

4 Results and Discussion

4.1 Panel Analysis

Table 1 incorporate the results obtained from panel analysis. The techniques used are pooled OLS, random effects, fixed effects, and IV-Fixed effects, presented in Column 1-4, respectively. Column 1 shows the results of the pooled OLS technique. The results indicate that the regression coefficient of safe drinking water positively contributes to a better QoL. The coefficient depicts that 1 percent increase in the availability of safe and affordable drinking water boosts the QoL by 0.0012 percent. It means that an increase in the availability of safe drinking water prevents individuals from time cost that one bears while fetching safe water from distant places. This fetching of water not only requires time but also needs resources and it is at the cost of lost time which could be used for productive services. Easier access to safe water reduces demands on women's time and opens income-

generating opportunities. Results are consistent with the study of UNESCO (2019), ADB (2016), and UNDP (2006). Moreover, the increase in urbanization and gross capital formation negatively contribute to the quality of life. It specifies that an increase in urban population leads to overcrowding, exploitation of the resources, and an increase in pollution which adversely affects the quality of life.

Table 1
Panel Analysis

	1	2	3	4
Variables	Pooled OLS	Random Effects	Fixed Effects	IV-Fixed Effects
	Dependent Variable is QoL (HDI)			
Safe Drinking Water	0.00019***	0.00161***	0.0509***	0.428***
	-(0.0003)	-(0.0002)	-(0.0076)	(0.0608)
Education	0.00128***	0.00172***	0.00137***	0.0976***
	-(0.0001)	-(0.0001)	-(0.0001)	(0.00631)
GDP	0.114***	0.0800***	0.114***	-0.0271***
	-(0.0044)	-(0.0034)	-(0.0046)	(0.00235)
Gross Capital Formation	-0.0116***	-0.004	-0.0257***	-0.00977
	-(0.0023)	-(0.0026)	-0.006	(0.00684)
Urbanization	-0.0276***	-0.0639***	-0.0256***	0.00215
	-(0.0063)	-(0.0038)	-(0.0024)	(0.00148)
Physicians	0.00536***	0.00936***	0.00537***	0.000356***
	-(0.0016)	-(0.0016)	-(0.0014)	(0.0011)
Constant	-1.786***	-0.551***	-1.977***	-1.840***
	-(0.0811)	-(0.0408)	-(0.0812)	(0.0839)
Observations	520	520	520	520
F-Statistics	564.73	-	421.14	564.73
Wald Chi2	-	1550.11	-	-
R-Square	0.864	0.9374	0.952	0.828
LM Test	0.0000	-	-	-
Hausman Test	-	0.0000	-	--

Note: Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

Moreover, the regression coefficient of gross capital formation is -0.0116 percent depicting decrease in quality of life. While the coefficient of GDP, secondary school enrollment, and

number of physicians indicates an improvement in the quality of life.

The value of R-square is 0.86 percent, indicating that explanatory variables explain 86 percent of the variation in the quality of life while, F-statistics states that the explanatory power of the variables in the model is strong.

In pooled OLS technique, individual as well as country-specific characteristics are being ignored which leads to violation of assumptions related to the error term. Random effects solve those violation by incorporating separate intercepts in the model which is assumed to be random. This assumption of separate intercepts states that the model is exogenous. Column 2 of Table 1 displays the result obtained by applying random effects technique which deals with country-specific characteristics. All the variables are significant and possess the correct sign according to the theory. The LM test is applied to choose between pooled OLS and random effects technique. The p-value suggests that random effects are better than pooled OLS. The p-value is significant at 1 percent level of significance.

Random effects technique assumes that there exists no correlation between country-specific characteristics and regressors while fixed effects, in contrast, assumes that there exists a correlation between regressors and country-specific characteristics. It controls time-invariant characteristics that can be correlated with the independent variables. Column 3 of Table 1 displays the results obtained from fixed effects techniques. All the variables possess expected signs according to the theory depicting that the results obtained are consistent and robust across the techniques. Safe drinking water improves the quality of life along with education, GDP, and number of physicians. For selection between random and fixed effects, the Hausman test was employed. The null hypothesis suggested that the random effect is better. The p-value is less than 5 percent indicating the rejection of the null hypothesis. It is clear from the Hausman test that country-specific characteristics are important in constructing the links among the explanatory variables and the dependent variable.

Moreover, one problem with the fixed effects is that it does not deal with the problem of endogeneity. Therefore, to address this problem, the study has used the IV-fixed effect technique.

Safe drinking water is being instrumentalized by its lag values along with regional dummies. The endogeneity-free results are reported in the 4th column of table 1. It depicts the positive relationship of safe drinking water and QoL and the result is statistically significant. Regarding the overall significance of the model, the value of F-statistics and Wald-Chi2 is depicting that all the independent variables are the true determinants of the QoL. Moreover, the value of R-square is also illustrating that almost 70-80 percent of the variations in the QoL is being explained by the independent variables and the model is the best fit.

4.2 Cross-Sectional Analysis

Table 2 reports the result attained from the cross-sectional analysis. The techniques used are OLS and Two-SLS. Column 1 present the results attained from OLS. There exists a positive and significant relationship between safe drinking water and QoL. The coefficient indicates that one percent increase in safe drinking water improves the quality of life by 0.0113 percent. These results are consistent with the study of UNESCO (2019), ADB (2016), UNDP (2006), and Nourzad and Powell (2003).

The study also used some control variables to check the stability and robustness of the model. Secondary school enrollment, GDP, and gross capital formation along with urbanization and no of physicians are being used. The coefficient of secondary school enrollment is depicting positive and significant relationship with quality of life. It is indicating that one percent increase in secondary school enrollment is associated with quality of life by 0.0024 percent. This infers that an increase in the level of education improves the quality of life by increasing job opportunities which leads to a better and healthier quality of life. The same results were obtained by Nourzad and Powell (2003).

Furthermore, the regression coefficient of GDP, urbanization, and no of physicians are also positive and highly significant showing a positive relationship with quality of life. The results show that one percent increase in GDP will boosts the quality of life by 0.0603 percent whereas an increase in urbanization is associated with a 0.0593 percent reduction in quality of life. These results are consistent with the finding of Asongu (2013) and Nourzad and Powell (2003). The number of

physicians was being taken to capture the effect of health expenditures on quality of life. The regression coefficient is positive and significant indicating that an increase in the number of physicians positively contributes to the quality of life. The results are consistent with the existing studies (Rehmat et al., 2020; Majeed and Liaqat; 2019; Majeed and Gillani (2017).

Table 2
Cross-Sectional Analysis

	1	2	3	4	5
Variables	**OLS**	**TWO-SLS**	**Sensitivity Analysis**		
	Dependent Variable is QoL (HDI)				
Safe Drinking Water	0.0113***	0.0287*	0.0315**	0.0323***	0.0293**
	(0.0116)	(0.0151)	(0.0119)	(0.0112)	(0.0113)
Education	0.00240***	0.00234***	0.00244***	0.00225***	0.00253***
	(0.0014)	(0.0013)	(0.0014)	(0.0013)	(0.0013)
GDP	0.0603***	-0.0525***	0.0611***	0.0730***	0.0548***
	(0.0143)	(0.0151)	(0.0152)	(0.0165)	(0.0167)
Gross Capital Formation	0.0201	0.0240	0.0210	0.0214	0.0232
	(0.0187)	(0.0266)	(0.0194)	(0.0181)	(0.0184)
Urbanization	-0.0593***	0.0542***	-0.0597***	-0.0719***	-0.0533***
	(0.0148)	(0.0147)	(0.0153)	(0.0016)	(0.0175)
Physicians	0.00979**	0.00514	0.00990**	0.00639	0.0100**
	(0.0144)	(0.0147)	(0.0146)	(0.0144)	(0.0144)
FDI Inflows	-	-	0.00209	-	-
			(0.0141)		
Inflation	-	-	-	0.00938**	-
				(0.0137)	
Water Productivity	-	-	-		0.00394
					(0.0141)
Constant	-0.267***	-0.222**	-0.283***	-0.392***	-0.240***
	(0.0816)	(0.105)	(0.1011)	(0.0932)	(0.0810)
Observations	71	71	71	71	69
R-Square	0.954	0.954	0.953	0.957	0.958
F-Statistics	88.31		78.09	79.70	83.76
Wald-Chi2	-	1239.66	-	-	-
Sargan Score	-	0.112	-	-	-
Basman Score	-	0.106	-	-	-

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3 Two – SLS Results

When there exists a correlation between the explanatory variables and the error term, it creates the problem of endogeneity. In the presence of endogeneity, the OLS technique gives biased results. Therefore, to remove the problem of endogeneity the preferred technique is Two SLS. That is the extension of OLS. In 2SLS, instrumental variables are used for the variables that cause the problem of simultaneity. Instrumental variables should highly be correlated with the endogenous variable but there should not exist any correlation with the error term (Frankel, 2005).

Column 2 of Table 2 reports the result obtained from 2SLS. The endogenous variable in the study was safe drinking water. For this purpose, the study has used the initial values of safe drinking water along with the regional dummies as the exogenous variables. The results confirmed the role of safe drinking water in the improvement of QoL as the regression coefficient is significant at 10 percent level of significance. The validity of the instruments can be seen from the statistics of Sargan and Basman in column 2, which is indicating that the instruments are valid because the probability value is greater than the 5 % level of significance.

To analyze the strength of the empirical findings, the study has also done sensitivity analysis by incorporating other indicators that are FDI inflows, inflation, and water productivity. Results are presented from column 3 to 5 in table 2. The effect of safe drinking water remains highly significant in all the estimated models. Hence, the robustness of the result is also confirmed by sensitivity analysis. Moreover, the value of R-square lies between 0.954 to 0.958 in column (1-5), inferring that around 95 percent of the variation in the QoL is explained by the independent variables. The value of F-statistics is also significant indicating that the model is the best fit.

5 Conclusion

QoL is one of the fundamental aspects of economic development and to sustain it, the availability of safely managed water is required. The survival of life without safe and affordable drinking water is not possible as it is a dire need. For sustainable development, availability and affordability of safe water is of

supreme importance as it enhances QoL. Therefore, the current study explores the empirical links between safe drinking water and QoL in 71 United Nation member countries between 1990 and 2019. To fulfill the purpose, the study used HDI to measure QoL as it is a subjective measure. The study has conducted both panel as well as cross-sectional analysis. The results obtained from Pooled OLS, Random effects, Fixed effects, IV-Fixed effects, and Two-SLS are reported.

The results obtained support improved QoL through safely managed drinking water. The problem of endogeneity is addressed using IV-Fixed effects and Two-SLS. Our findings remain robust across the techniques. The IV-Fixed effects deal with endogeneity, time-variant, and time-invariant characteristics, respectively. The robustness of the results is confirmed through sensitivity analysis thus it is concluded that water plays a vital role in sustaining life and enhancing QoL. Safe drinking water is one of the powerful drivers of economic development. It extends opportunities, enhances, and boosts self-esteem and it also helps in creating the virtuous circle of improving health and increasing wealth which will, in turn, lead to improved quality of life and hence support economic development. The lack of access to clean and affordable drinking water leads to deprivation of health, dignity, low productivity, and a decrease in economic participation.

Therefore, based on our findings it is suggested that the governments of all countries should ensure the accessibility to clean and affordable water for all by using feasible and modern technology because it is the basic human right. Furthermore, access to clean and safe drinking water reduces the events of infectious diseases and increases participation in economic activities.

The study also has some limitations. The study was unable to conduct regional as well as country-specific analysis because of the data limitations in the case of safely managed drinking water. The analysis is based on only 71 "United Nations member countries" which can be extended to other member countries based on the availability of data.

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6 Appendix A

List of Countries

Albania	ALB	Germany	DEU	Nepal	NPL
Argentina	ARG	Ghana	GHA	Netherlands	NLD
Armenia	ARM	Greece	GRC	New Zealand	NZL
Australia	AUS	Guatemala	GTM	Nicaragua	NIC
Bahrain	BHR	Hungary	HUN	Norway	NOR
Bangladesh	BGD	Iceland	ISL	Oman	OMN
Belarus	BLR	Iran, Islamic Rep.	IRN	Pakistan	PAK
Belgium	BEL	Ireland	IRL	Peru	PER
Bhutan	BTN	Israel	ISR	Poland	POL
Bulgaria	BGR	Italy	ITA	Portugal	PRT
Cambodia	KHM	Japan	JPN	Serbia	SRB
Canada	CAN	Jordan	JOR	Slovenia	SVN
Chile	CHL	Korea, Rep.	KOR	Spain	ESP
China	CHN	Kuwait	KWT	Sweden	SWE
Colombia	COL	Kyrgyz Republic	KGZ	Switzerland	CHE
Costa Rica	CRI	Latvia	LVA	Tajikistan	TJK
Croatia	HRV	Lebanon	LBN	Thailand	THA
Cyprus	CYP	Lithuania	LTU	Turkey	TUR
Denmark	DNK	Luxembourg	LUX	Uganda	UGA
Ecuador	ECU	Malaysia	MYS	Ukraine	UKR
Estonia	EST	Malta	MLT	United Kingdom	GBR
Finland	FIN	Mexico	MEX	United States	USA
France	FRA	Moldova	MDA	Uzbekistan	UZB
Georgia	GEO	Morocco	MAR		

7 Appendix B

Variables Description

Variables	Definition	Unit	Source
Dependent Variable			
Human Development Index (HDI)	"The Human Development Index (HDI) is a statistical tool used to measure a country's overall achievement in its social and economic dimensions. The social and economic dimensions of a country are based on the health of people, their level of education attainment and their standard of living".	0-1	"UNDP (2019)"
Independent Variable (Focused)			
Safely Managed Drinking Water	"The percentage of people using drinking water from an improved source that is accessible on premises, available when needed and free from faecal and priority chemical contamination".	% of Population	"World Bank (2019)"
Independent Variables (Controlled)			
GDP	"GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources".	Constant 2010 US$	"World Bank (2019)"
Secondary School Enrollment	"Net enrollment rate is the ratio of children of official school age who are enrolled in school to the population of the corresponding official school age.	% Net	"World Bank (2019)"
Urban Population	Urban population refers to people living in urban areas as defined by national statistical offices.	% of Total Population	"World Bank (2019)"

Gross Capital Formation	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.	Constant 2010 US$	"World Bank (2019)"
Physicians	Physicians include generalist and specialist medical practitioners.	Per 1000 People	"World Bank (2019)"
Foreign Direct Investment	Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor.	Net Inflows	"World Bank (2019)"
Inflation	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	Annual %	"World Bank (2019)"
Water Productivity	Water productivity is calculated as GDP in constant prices divided by annual total water withdrawal.	Constant 2010 US$ GDP per cubic meter of total freshwater withdrawal	"World Bank (2019)"