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Bridging Financial Inclusion to Water and Sanitation: Insights from Indonesia

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Abstract

Lack of access to improved drinking water and sanitation has been a major worldwide challenge, especially in Indonesia. This study investigates the impact of financial inclusion on access to improved drinking water and sanitation among households in Indonesia. Using binary probit regression analysis complemented with dominance analysis, we assess the relative importance of various factors, including financial inclusion, socio-economic status, and residence, in determining access to improved drinking water and sanitation services. Our findings highlight the critical role of urban residents in facilitating access to improved drinking water and sanitation, with urban areas demonstrating significantly higher access rates. Furthermore, participation in savings emerges as a more influential factor than credit participation, particularly in improving access to sanitation facilities. This suggests that while savings and credit contribute to improved access, savings play a more pronounced role in addressing the higher upfront costs associated with sanitation infrastructure. Additionally, socio-economic factors such as household expenditure and education level significantly influence access to improved water and sanitation, underscoring the importance of addressing broader socio-economic disparities. Our study provides valuable insights for policymakers and institutions aiming to enhance access to clean water and sanitation. It emphasizes the need for comprehensive strategies that focus on infrastructure development and address socio-economic barriers to ensure universal access to these essential services.

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INTRODUCTION

Access to clean drinking water and adequate sanitation is imperative for human survival, yet a substantial portion of the global population continues to lack these essential services. The World Health Organization WHO (2023) reports that as of 2022, approximately 1.7 billion people rely on drinking water sources contaminated with fecal matter, resulting in around 505,000 deaths annually from diarrheal diseases. Similarly, the United Nation (2023) estimates that 1.5 billion people lacked access to improved sanitation facilities during the same period. Young children, particularly those under the age of five, are disproportionately affected by water, sanitation, and hygiene (WaSH)-related diseases, with (UNICEF, 2023a) highlighting that inadequate WaSH conditions contribute significantly to their vulnerability, causing approximately 300,000 annual deaths due to diarrhea.

In Indonesia, the challenges mirror global trends. Despite progress in improving drinking water services at the national level, as reported by UNICEF (2023b), significant obstacles remain, with only 11.9% of the population having access to safely managed drinking water services. Furthermore, WHO (2021) underscores the severity of the issue, with seven out of ten Indonesian households consuming drinking water contaminated with E. coli. Although there has been some improvement in the proportion of households utilizing improved sanitation services, challenges persist, as pneumonia and diarrhea remain the primary causes of death among children under five in Indonesia. Notably, 60% of diarrheal deaths in the country are attributed to poor WaSH services (United Nation - Sanitation and Water for All, 2022).

Addressing these urgent and imperative challenges aligns with the Sustainable Development Goals (SDGs), particularly SDG 6.1 and 6.2, which aim to ensure universal access to water and sanitation. Recognizing the importance of safely managed sanitation, UNICEF (2023a) identifies it as a critical priority for enhancing health, nutrition, and productivity, which aligns with SDG 6.

Numerous studies worldwide have explored the dynamics of WaSH, underscoring their critical importance for public health. Valcourt et al. (2020) conducted a systematic literature review categorizing past studies based on methodology, analytical complexity, interactions, factors, and data sources. Their findings indicate a significant focus on the financial factor, which comprises 74% of the studies, emphasizing its pivotal role in ensuring access to water, sanitation, and hygiene. Further supporting the significance of financial aspects in WaSH, Tseole et al. (2022) identified primary barriers to WaSH practices in Southern Africa, including inadequate funding for WaSH infrastructure, geographical remoteness, climate change, limited understanding of waterborne illnesses, and limited community engagement. Similar evidence from studies in India (Chand et al., 2020), Brazil (Ferreira et al., 2021), Sub-Saharan Africa (Dangui and Jia, 2022), and urban India (Davis et al., 2008) underscores the crucial role of financial considerations in infrastructure development, primarily WaSH.

Financial inclusion, recognized as a catalyst for achieving various SDGs, including health-related objectives (Ferrata, 2019), has garnered attention in African and Asian studies. Research in 33 African countries indicates that financial inclusion positively impacts population health, with increased financial access correlating with higher expenditures on medical products and appliances (Koomson, Abdul-Mumuni, and Abbam, 2021). Similarly, investigations in Nepal (Ranabhat et al., 2022) emphasize the socio-economic benefits of enhancing financial inclusion for overall well-being.

Despite abundant studies on financial inclusion and health, research examining its influence on access to water and sanitation remains scarce. However, some analysis, such as that of Dangui and Jia (2023) in Togo, Africa, highlights the link between financial inclusion and improved access to drinking water sources, particularly in rural and impoverished areas and households headed by females. Regarding

sanitation, studies demonstrate a positive association between financial inclusion and sanitation practices, including reduced open defecation and increased adoption of hygienic waste disposal methods (Immurana, Kisseih, Yusif, et al., 2022; Immurana, Kisseih, Yakubu, et al., 2022). This finding is consistent across 84 low and middle-income countries (Cavoli et al., 2023). Moreover, research across 33 African countries in 2004-2018 (Immurana, Iddrisu, Mohammed, et al., 2022) reinforces the positive relationship between financial inclusion and access to improved water and sanitation services. Despite methodological variations, including PCA and regression analysis, these studies consistently support the notion that financial inclusion facilitates improved water and sanitation outcomes.

Satriani, Ilma, and Daniel (2022) reviewed the state of WaSH in Indonesia, revealing a scarcity of research on financial themes within the Indonesian context highlighting the need for more studies to address this gap. Given that the effect of financial inclusion on water and sanitation conditions is context-specific, it is pertinent to investigate whether financial themes, including financial inclusion, influence access to improved drinking water and sanitation. As previous studies in Indonesia have primarily overlooked this aspect, this study seeks to examine the relationships between financial inclusion and access to improved drinking water and sanitation among households in Indonesia. The findings of this research are crucial in emphasizing the significance of financial inclusion as a strategic approach to enhancing access to improved water and sanitation, thereby contributing to the broader objective of achieving the SDGs.

The subsequent sections of this paper are structured as follows: a comprehensive review of relevant literature to provide a contextual framework for the current research, elucidation of methodologies and data employed, presentation and discussion of results, and concluding insights and remarks summarizing the study's findings and implications.

RESEARCH METHODS

This study utilizes the Indonesia National Socio-Economic Survey (Susenas) year 2021. SUSENAS is a comprehensive nationwide survey conducted annually by the Indonesian Central Statistics Agency (BPS). Susenas comprises two types of questionnaires: core and module. The core questionnaire gathers data on household characteristics and the demographic information of household members. In contrast, the module questionnaire collects detailed information regarding household consumption patterns and expenditure behaviors, including food and non-food expenses. Susenas 2021 contains data on 340,032 households in 488 districts and 34 provinces of Indonesia. For the current study, we dropped 237 (0.07%) households with incomplete information.

Susenas 2021 considers three purposes for a household's primary water source: drinking, cooking, and bathing. Eleven sources are provided for water used for drinking: branded bottled water, refillable bottled water, metered piped water, pumped wells, protected wells, unprotected wells, protected springs, unprotected springs, rainwater, surface water, and others. On the sanitation topic, Susenas 2021 collects data on sanitation facilities, including household ownership of toilets, the type of closet used, the final disposal method, and the construction and drainage of septic tanks.

For this study, we utilize the information on water sources, categorizing them into improved and unimproved drinking water sources. Similarly, sanitation facilities are classified as improved or unimproved based on data regarding household toilet ownership and the type of closet used. Moreover, concerning financial inclusion, Susenas 2021 gathers data on households' savings and credit ownership and the types of credit held. This study measures financial inclusion by the household's utilization of savings and credit financial products.

The binary probit regression was used to conduct this study. This study has four distinct models based on the dependent variables, first and second, for access to improved drinking

water sources. In contrast, the remaining models examined improved access to sanitation sources.

Financial inclusion served as the primary independent variable, conceptualized based on previous studies, particularly the work of Immurana, Kisseih, Yakubu, et al. (2022), and the financial measurement study by Sarma (2012). According to Sarma (2012), financial inclusion can be assessed through 3 aspects: Penetration, Availability, and Usage. Therefore, based on data availability, this study uses the Usage aspect to measure financial inclusion. More usage means more financial inclusion since the demand for households using financial products is higher.

This study constructs four different financial inclusion. The first variable (saving_participation) is a dummy variable that determines whether the household head has or participates in a savings account as a financial product. The second variable (participation) is also a dummy variable, whether the household head has or participates in credit as a financial product. As the previous study by Immurana, Kisseih, Yakubu, et al. (2022) generated financial inclusion participation based on whether the household head contributes to either a saving account or credit scheme, this study splits the saving and the credit to see the effect separately. The last variable is financial inclusion based on total credit instruments owned by the household heads (variation of credit instruments). Based on the availability of the data questionnaire, the credits are classified into nine financial institutions/providers: Kredit Usaha Rakyat (People's Business Credit), credit from commercial banks, credit from Bank Perkreditan Rakyat, credit from cooperatives, pegadaian (pawnshop), leasing company, Badan Usaha Milik Desa (Village-Owned Enterprise), individuals with interest, and joint business group.

Binary dummy variables were employed for improved drinking water access, with 1 indicating improved drinking water sources and 0 for unimproved sources. Improved drinking water sources were classified based on the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (JMP) criteria (WHO/UNICEF, 2018), which include various safe water sources such as piped water, protected dug wells, boreholes or tubewells, packaged or delivered water, and rainwater.

The first two models focused on improved drinking water access. Model 1 included saving_participation and credit_participation as independent variables and control variables. Model 2 incorporated total_credit instead of saving_participation and credit_participation.

Model 1:

$$Prob\,(Y_i^1 = 1|X_i) = \beta_0 + \beta_1.saving\_participation_i + \beta_2.credit\_participation_i + \beta_3.hhsize_i + \beta_4.sex_i + \beta_5.age_i + \beta_6.educ_i + \beta_7.urban_i + \beta_8.lexp_i + U_i \quad \text{..... (1)}$$

Model 2:

$$Prob\,(Y_i^1 = 1|X_i) = \beta_0 + \beta_1.total\_credit_i + \beta_2.hhsize_i + \beta_3.sex_i + \beta_4.age_i + \beta_5.educ_i + \beta_6.urban_i + \beta_7.lexp_i + U_i \text{.. (2)}$$

A similar approach was employed using binary dummy variables for sanitation access, with 1 indicating improved sanitation facilities and 0 for unimproved facilities. Improved sanitation facilities were defined based on JMP criteria, which include facilities designed to hygienically separate human excreta from direct human contact, i.e., composting toilets, pit latrines with slabs (including ventilated pit latrines), septic tanks or pit latrines, and flush/pour flush toilets connected to piped sewer systems (WHO/UNICEF, 2018). Models 3 and 4 focused on sanitation access, with similar independent and control variables as Models 1 and 2.

In addition, household size, household head years of schooling, household head age, household head gender, household expenditure, and household residency are used as control variables. The control variables are inspired by previous research that studies the socio-economic factors (Gomez, Perdiguero, and Sanz, 2019) and determinants of household access to improve drinking water (Simelane et al., 2020; Oyerinde

and Jacobs, 2022), and also the determinant access to sanitation (Akpakli et al., 2018).

Model 3:

$$Prob\ (Y_i^2 = 1|X_i) = \beta_0 + \beta_1.saving\_participation_i + \beta_2.credit\_participation_i + \beta_3.hhsize_i + \beta_4.sex_i + \beta_5.age_i + \beta_6.educ_i + \beta_7.urban_i + \beta_8.lexp_i + U_i \quad \text{.....(3)}$$

Model 4:

$$Prob\ (Y_i^2 = 1|X_i) = \beta_0 + \beta_1.total\_credit_i + \beta_2.size_i + \beta_3.sex_i + \beta_4.age_i + \beta_5.educ_i + \beta_6.urban_i + \beta_7.lexp_i + U_i \quad \text{.....(4)}$$

Where, Y_i^1 is Improved Drinking Water; Y_i^2 is Improved Sanitation; saving_participation$_i$ is Household Head Participation Status on Saving; credit_participation$_i$ is Household Head Participation Status on Credit; total_credit$_i$ is Number of Credit Instruments Owned by Household Head; hhsize$_i$ is Household Size; sex$_i$ is Household Head Gender; age$_i$ is Household Head Age; educ$_i$ is Household Head Years of Schooling; urban$_i$ is Household Residency; lexp$_i$ is Household Expenditure in Natural Logarithmic; and U$_i$ is Error Term.

Based on these models and the literature reviewed in the introduction section, several hypotheses are proposed, as outlined in Table 1. In this context, financial inclusion, through participation in savings and credit, is expected to increase the likelihood of access to improved drinking water and sanitation. Additionally, the number of credit instruments held by the head of the household may also enhance access to these services. The direction of influence for the control variables follows the patterns observed in previous studies.

Table 1. Hypotheses on the Relationship Between Financial Inclusion and Access to Improved Water and Sanitation

Topic	Variables	Hypotheses	
		Water	**Sanitation**
Financial Inclusion	HH head saving participation	(+)	(+)
	HH head credit participation	(+)	(+)
	Number of credit instruments owned by HH head	(+)	(+)
Socio-economic Characteristics	HH size	(+–)	(+–)
	Urban	(+)	(+)
	HH expenditure	(+)	(+)
	HH head sex	(+–)	(+–)
	HH head age	(+)	(+)
	HH head year of education	(+)	(+)

Notes: HH is household; A "+"," -"indicate a positive, respectively negative, expected effect of the variable on the switch

Source: Author Calculation, 2024

Descriptive statistics were used to summarize the socio-demographic characteristics of the respondents. Binary probit regression was then conducted to investigate the influence of financial inclusion on access to water and sanitation, controlling for other independent variables. This approach was chosen due to the discrete nature of the dependent variables, a characteristic that the Ordinary Least Square (OLS) estimator may not effectively capture (Cameron and Trivedi, 2005). Moreover, because it assumes 'independence of irrelevant alternatives, we do not use the binary logit regression' (Greene, 2012), which implies that access to improved drinking water and sanitation are independent of the existence of another.

After conducting the regression analysis, we performed a dominance analysis to ascertain each variable's contribution and hierarchical order in influencing access to improved water

and sanitation. Dominance Analysis (DA) is a statistical method to assess the relative importance of independent variables within a model. This method determines the dominance of an independent variable over others concerning the contribution to R-squared based on the entire subset of the model. There are three types of output in dominance analysis: general dominance statistics, conditional dominance statistics, and complete dominance destination. General dominance statistics divide the overall fit statistic associated with the pre-selected model into contributions associated with each independent variable. General dominance is defined by these general dominance statistics, which compare the magnitude of the statistic associated with each independent variable. Conditional dominance statistics are further decompositions of the pre-selected model's fit statistic ascribed to each independent variable but based on their contribution when a specific number is included in a sub-model. Complete dominance is designated differently from general and conditional dominance, as no statistics are computed for this designation. Complete dominance is defined by comparing the fit statistics produced by all sub-models between two independent variables that are not under constant consideration (Azen and D. V Budescu, 2006; Luchman, 2021).

The primary objective of this study is to assess the relative importance of individual variables. Consequently, this paper exclusively addresses the presentation of general dominance statistics derived from the estimated probit regression. In this context, each independent variable within the model is depicted through its standardized dominance statistic, representing a quantitative measure of contribution, wherein the aggregate sum equals 1 or 100%. Subsequently, a ranking metric has been established based on the contribution value of each independent variable, with a ranking of 1 assigned to the variable exhibiting the highest level of contribution in the model.

RESULTS AND DISCUSSION

The respondents' socio-demographic characteristics are displayed in Table 2. The analysis of access to improved drinking water and sanitation highlights the predominance of improved sources among households, with 89.85% utilizing improved water sources and 84.13% using improved sanitation sources. However, the presence of families relying on unimproved sources for both water and sanitation signals persistent challenges in ensuring universal access to safe water and sanitation facilities.

Examining financial inclusion participation status, the data shows that approximately half of household heads participate in saving accounts (48.91%), while a smaller proportion participate in credit instruments (21.15%). Interestingly, only 13.42% of household heads participate in both saving and credit schemes, indicating a limited overlap between these two forms of financial inclusion. Additionally, household heads' mean number of credit instruments is relatively low, suggesting a modest adoption of multiple financial products.

Further analysis reveals that most household heads are males (85.1%) with an average age of 48 years and an average of 8 years of schooling. These demographic characteristics provide valuable insights into the profile of household heads in the study population.

Table 2. Socio-demographic characteristics of respondents

Variable	% / [a]mean / [b]st.dev
Sanitation	
Unimproved Sanitation Source	15.87
Improved Sanitation Source	84.13
Drinking Water	
Unimproved Water Source	10.15
Improved Water Source	89.85
Financial Inclusion (FI) Participation by having:	
Saving Account	48.91
Without Saving Account	51.09
Credit Instrument	21.15
Without Credit Instrument	78.85
Both Savings & Credit	13.42
Without Saving & Credit	86.58
Household Head Sex	
Male	85.13
Female	14.87
Residence	
Rural	57.91
Urban	42.09
Number of Credit Instruments Owned by Household Head	[a]0.235 / [b]0.487
Household Head Age	[a]48.157 / [b]13.554
Household Years of Schooling	[a]8.419 / [b]4.349
Household Size	[a]3.757 / [b]1.701
Household Expenditure in Natural Logarithmic	[a]17.742 / [b]0.771

Source: Data Processed, 2024

In the next step, we analyze the results of the binary probit regression to understand the impact of financial inclusion on access to improved drinking water and sanitation (refer to Table 3). The regression models provide insights into how financial inclusion, measured by participation in saving and credit instruments and the number of credit instruments owned by household heads, influences access to improved water and sanitation.

In the first and second models (Table 3, column (1) and (2)), participation in saving and credit instruments is used to assess their impact on access to improved drinking water and sanitation. The results show that households where the head participates in saving accounts or credit instruments are more likely to access improved drinking water and sanitation than those who do not participate. The results show a positive effect of savings and credit participation on both accesses. In other words, households participating in savings and credit are more likely to have better access to improved water and sanitation.

Table 3. Marginal Effect of Financial Inclusion Based on participation and Contributions on the Improved Access to drinking water & sanitation among Households in Indonesia, Susenas 2021

VARIABLES	(1) Water	(2) Sanitation	(3) Water	(4) Sanitation
Saving Participation	0.014***	0.060***		
	(0.001)	(0.001)		
Credit Participation	0.029***	0.037***		
	(0.001)	(0.002)		
Number of Credit Instruments Owned by Household Head			0.026***	0. 038***
			(0.001)	(0.001)
Urban	0.126***	0.125***	0.127***	0.127***
	(0.001)	(0. 001)	(0.001)	(0. 001)
Household Size	-0.008***	-0. 010***	-0. 008***	-0. 011***
	(0.000)	(0. 000)	(0.000)	(0. 000)
Household Expenditure in Natural Logarithmic	0.041***	0.076***	0.043***	0.084***
	(0.000)	(0.001)	(0.001)	(0.001)
Household Head Sex (1 = female)	0. 018***	0.017***	0. 019***	0. 026***
	(0.002)	(0. 002)	(0.002)	(0. 002)
Household Head Years of Schooling	0. 005***	0. 013***	0. 005***	0. 015***
	(0.000)	(0. 000)	(0.000)	(0. 000)
Household Head Age	0. 001***	0. 004***	0. 001***	0. 004***
	(0.000)	(0. 000)	(0.000)	(0. 000)
Observations	339,795	339,795	339,795	339,795
Pseudo R^2	0.114	0.163	0.114	0.155
Prob>chi2	0.000	0.000	0.000	0.000

Notes : Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
Sources: Data Processed, 2024

For households where the head participates in saving accounts, the probability of accessing improved water is higher by 1.4%. The difference is even more substantial for enhanced sanitation at 6%, compared to those who do not participate. Similarly, participation in credit instruments leads to a significantly higher probability of accessing improved water (2.9%) and sanitation (3.7%). These findings underscore the role of financial inclusion in enhancing access to essential services, primarily water and sanitation.

In columns (3) and (4) of Table 3, the analysis focuses on the number of credit instruments owned by household heads. The results indicate that households with more credit instruments experience a significant increase in the probability of accessing improved water (2.6%) and sanitation (3.8%). This suggests that a higher level of financial inclusion, as reflected by ownership of multiple credit instruments, is associated with improved access to essential services.

The four probit models were then evaluated through a feasibility test using the pseudo R-squared value. For models with the dependent variable of improved water (Models 1 and 3), the variation explained was 11.4%. Meanwhile, Models 2 and 4, which focused on improved sanitation, explained 16.3% and 15.5% of the variation, respectively. The model's goodness of fit was deemed satisfactory, consistent with Peterson (2023) findings on acceptable R-squared values in social science research.

Furthermore, based on the chi2 values, all four models had a prob>chi2 value of 0.000, indicating that at least one predictor variable in each model significantly influenced the respective dependent variable. Additionally, the probit estimation results for the four models underwent classification testing to assess the accuracy of their predictions (see annex section). The results demonstrated predictive solid accuracy, with all models correctly classifying more than 80% of cases.

Table 4. Dominance Analysis in Saving & Credit Participation and Total Credit Variation Owned by Household Head

Variable	Saving & Credit Participation				Number of Credit Instruments Owned by Household Head			
	Water (1)		Sanitation (2)		Water (3)		Sanitation (4)	
	[1]Std.	[2]Rank	[1]Std.	[2]Rank	[1]Std.	[2]Rank	[1]Std.	[2]Rank
Saving Participation	0.055	4	0.131	4				
Credit Participation	0.032	5	0.027	6				
Number of credit instruments owned by the household head					0.035	4	0.032	5
Urban	0.562	1	0.294	1	0.577	1	0.322	1
Household Size	0.020	7	0.014	7	0.022	6	0.016	6
Household Head Sex (1 = female)	0.008	8	0.005	8	0.009	7	0.007	7
Household Head Years of Schooling	0.124	3	0.223	2	0.142	3	0.276	2
Household Head Age	0.026	6	0.087	5	0.024	5	0.086	4
Logarithmic Per Capita Expenditure	0.174	2	0.219	3	0.191	2	0.262	3

Notes : [1]Standardized Dominance Statistics; [2]Sequence of Standardized Dominance Statistics
Sources: Data Processed, 2024

In addition to probit estimation, we conducted dominance analysis (DA) in this study. DA is a powerful statistical method for assessing the relative importance of independent variables within a model. It provides insights into which variables contribute the most to the variability explained by the model. In the current study, DA was applied to assess the importance of various factors, particularly financial inclusion and socio-economic variables, in influencing access to improved drinking water and sanitation among households in Indonesia. The findings of DA for all models are succinctly presented in Table 4.

Based on the results of the DA for the participation model of savings and credit (columns (1) and (2)), the foremost variable in terms of importance is the urban variable. In this context, residing in an urban area, particularly in the city, contributes 56.2% to improved access to drinking water and 29.4% to enhanced sanitation. Following closely, the second and third positions are occupied by the household head's expenditure and length of education.

While savings and credit contribute to improved access, savings are more critical for sanitation than drinking water. The contribution to savings stands at 5.5% for improved drinking water and 13.1% for enhanced sanitation. Meanwhile, the crucial contribution from credit is 3.2% for improved drinking water and 2.7% for enhanced sanitation. This suggests that sanitation facilities may require higher upfront costs, which are better addressed through savings.

The DA results for the model assessing the number of credit instruments owned by the household head are presented in columns (3) and (4). The outcomes exhibit consistency with the previous model, wherein the foremost significant contribution is attributed to the residential factor (urban). Subsequently, the second and third positions remain consistent, occupied by the household head's expenditure and length of education. Notably, the number of credit instruments makes a significant but comparable contribution to access to improved drinking water (3.5%) and sanitation (3.2%).

The results show a nuanced difference in the impact of saving and credit participation on access to improved drinking water and sanitation. Saving participation appears to have a more significant effect on improving access to sanitation, while credit participation is more influential in improving access to improved drinking water. This difference can be attributed to the relative costs of obtaining improved drinking water and sanitation facilities. Access to drinking water is considered more urgent and less costly than sanitation (Chaitkin et al., 2022), leading to a higher coefficient for credit participation in accessing water.

Moreover, the analysis highlights the importance of household wealth, proxied by savings ownership, in obtaining improved water and sanitation facilities. Savings ownership, positively associated with household wealth (Dynan, Skinner, and Zeldes, 2004), plays a significant role in accessing sanitation facilities, which typically require higher investments than water facilities. On the other hand, as access to improved drinking water is considered more urgent than sanitation, the household head's participation in credit is an effort to meet current needs. The findings also align with basic demand theory, indicating that an increase in income, facilitated by financial inclusion (Immurana, Iddrisu, Mohammed, et al., 2022; Dogan, Madaleno, and Taskin, 2022; Mahmood et al., 2023), positively impacts the demand for essential goods and services, including improved water and sanitation facilities (Immurana, Kisseih, Yakubu, et al., 2022; Immurana, Iddrisu, Mohammed, et al., 2022).

This financial inclusion study is generally consistent with previous studies mentioned in the Literature Review section, regardless of different methodologies and observation levels. Our findings are in tandem with those of Dangui and Jia (2023) in Togo, Africa, who observed that financial inclusion correlates with heightened access to improved drinking water sources and reduced travel time to reach these water sources. According to the sanitation topic, our findings are also consistent with Immurana, Kisseih, Yusif, et al. (2022), who conducted research among households in Ghana and found that financial inclusion is generally associated with a lesser likelihood of open defecation and sharing of toilet facilities. Sanitation access Immurana, Kisseih, Yakubu, et al. (2022) found that households could opt for the collection (healthy) method of solid waste disposal. The same conclusion with country-level observation (33 African Countries by Immurana, Iddrisu, Mohammed, et al. (2022) and 84 low/middle-income countries by Cavoli et al. (2023) is also in line with our findings.

Additionally, the analysis highlights the significance of other socio-demographic factors such as residence, household size, household expenditure, sex, education, and age in influencing access to improved drinking water and sanitation. Urban households, for example, exhibit a higher probability of accessing drinking improved water and sanitation than those in rural areas, consistent with expectations due to higher economic affluence in urban areas and thus possessing a greater capacity to afford improved water and sanitation services (Immurana,

Kisseih, Yakubu, et al., 2022; Immurana, Kisseih, Yusif, et al., 2022; Simelane et al., 2020; Angoua et al., 2018; Gomez, Perdiguero, and Sanz, 2019). According to household size, one increase in household members reduces the probability of improved access to drinking water and sanitation. A bigger household size means higher water needs and more expenses, supported by the study of determinant household water demand (Oyerinde and Jacobs, 2022) and consistent with previous research by (Simelane et al., 2020; Angoua et al., 2018).

The remaining socio-economic factor variables are also as expected and in line with previous studies. The household head sex, education, and age are significantly connected to access to improved water and sanitation (Immurana, Kisseih, Yakubu, et al., 2022; Immurana, Kisseih, Yusif, et al., 2022; Gomez, Perdiguero, and Sanz, 2019; Angoua et al., 2018; Akpakli et al., 2018; Simelane et al., 2020). Female household heads increase the probability of the household's improved access to water and sanitation. This is because, in most societies, women are primarily responsible for maintaining their family's health, including providing adequate water and sanitation. This study also reveals that every year, an increase in the age and schooling of the household head will increase the probability of access to improved drinking water and sanitation since mature and better education will be a good understanding and more likely to earn higher than capable of providing reasonable access to improved water and sanitation. The last variable is household expenditure in natural logarithmic, which increases the probability of enhanced water and sanitation. The expenditure can be viewed as household wealth. Therefore, a higher expenditure is a higher household wealth that gives the household more access to improved water and sanitation.

The regression analysis results highlight the significant impact of financial inclusion on access to improved drinking water and sanitation in Indonesia. Participation in saving and credit instruments and the ownership of multiple credit instruments are associated with increased probabilities of accessing improved water and sanitation facilities. The findings suggest that financial inclusion plays a crucial role in addressing the challenges of water and sanitation access, particularly among households with limited resources. By facilitating access to financial services, policymakers can empower families to invest in essential infrastructure and services, ultimately contributing to improved health outcomes and quality of life.

Furthermore, in Dominance Analysis (DA), financial inclusion moderately influences access to improved water and sanitation. While important, it is just one of several factors affecting access, including socio-economic status and urbanization. The findings provide valuable insights for policymakers and organizations to improve clean water and sanitation access. The dominance of urban residents underscores the importance of addressing urban-rural disparities in water and sanitation access through targeted interventions and infrastructure development. Household expenditure and education level are pivotal in determining access to essential services, highlighting the need for socio-economic empowerment and educational initiatives. These findings highlight the importance of addressing infrastructure gaps and socio-economic disparities to achieve universal access to these essential services. Additionally, the findings underscore the need for tailored interventions that consider the specific community challenges and opportunities, such as promoting savings initiatives to improve access to sanitation facilities.

Overall, the findings emphasize the interconnected nature of financial inclusion, poverty alleviation, and access to essential services. The nuanced understanding of the relationship between financial inclusion and access to water and sanitation underscores the importance of tailored interventions and strategies. By targeting financial inclusion efforts toward communities with the greatest need, policymakers can maximize the impact of their interventions and promote more equitable access to improved services. By prioritizing financial inclusion as a critical component of development strategies, policymakers can work towards

achieving the Sustainable Development Goals and improving the well-being of communities

CONCLUSION

The challenge of inadequate access to fundamental drinking water and sanitation facilities persists globally and within Indonesia, posing significant hurdles in the fight against water and sanitation-related diseases. While financial inclusion holds promise as a critical factor in achieving proper access to water and sanitation, it has been relatively understudied in the Indonesian context. This paper aims to fill this gap by exploring the relationships between financial inclusion and access to improved drinking water and sanitation among households in Indonesia.

Furthermore, this paper addresses another gap by examining financial inclusion from the demand side, focusing on savings and credit ownership by the household head. The analysis explores the impact of financial inclusion through three variables: (1) savings ownership, (2) credit ownership, and (3) the number of credit instruments owned concerning access to improved water and sanitation. Additionally, we employed a dominance analysis to assess each variable's relative importance or contribution as another novelty. This allows for a comparison of the influence of financial inclusion relative to other factors.

The findings reveal that participation in savings, credit, and the total number of financial products household heads utilize significantly increases the probability of access to improved drinking water and sanitation. Notably, credit participation emerges as more dominant than savings in facilitating access to improved drinking water, while savings participation exhibits greater dominance in improving access to sanitation. Moreover, households, where the head participates in both saving and credit, demonstrate nuanced patterns, with lower probabilities of accessing improved drinking water but higher probabilities of accessing improved sanitation than households participating in only one financial product category. Furthermore, the dominance analysis underscores the substantial contribution of savings participation compared to credit participation, positioning financial inclusion as a moderate yet influential factor in enhancing access to improved drinking water and sanitation.

As the Indonesian government strives to address access gaps in water and sanitation facilities, focusing on financial inclusion emerges as a highly beneficial strategy. By promoting financial inclusion initiatives tailored to the needs of households, policymakers can significantly contribute to improving access to fundamental drinking water and sanitation services. Ultimately, these efforts will enhance public health outcomes and advance socio-economic development and equity across Indonesia.

Although this study sheds light on the influence of financial inclusion on access to improved sanitation and water in Indonesia, certain limitations must be acknowledged. Firstly, saving and credit participation as proxies for financial inclusion might not fully capture the multidimensional nature of financial services accessibility. Future research could incorporate additional indicators such as ATM or bank branch proximity to provide a more comprehensive understanding of financial inclusiveness. Secondly, the study overlooks environmental, geographical, and regional factors that could affect access to water and sanitation. Neglecting these aspects may lead to an incomplete assessment of the true impact of financial inclusion on access to essential services.

To address these limitations and further enhance the understanding of financial inclusion's role in improving access to water and sanitation, future research could adopt a more nuanced approach. This might involve incorporating a broader range of financial inclusion indicators, including proximity to financial service providers and utilization patterns. Additionally, accounting for environmental and regional disparities could provide a more accurate depiction of the challenges and opportunities in ensuring universal access to essential services.

Collaborative efforts between researchers, policymakers, and practitioners could facilitate the development of targeted interventions that address financial and non-financial barriers to water and sanitation access, ultimately contributing to more equitable outcomes across Indonesia.

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APPENDIX

A feasibility test of the probit model was conducted through classification model testing, as shown in Appendix 1. This test compares the predicted values with the actual values, providing a percentage that indicates the accuracy of the probit model's estimation results for the improved water and sanitation variables. The classification model test was applied to four models in this study. Models 1 and 2 examine the impact of financial inclusion, through household heads' participation in savings and credit, on improved water and sanitation, respectively. Meanwhile, Models 3 and 4 focus on the effect of financial inclusion measured by the number of credit instruments owned by the household head.

Based on the predicted values, four classifications can be identified: (1) true positive—observations with improved access that are correctly predicted to have improved access; (2) false positive—observations with unimproved access but incorrectly predicted to have improved access, (3) true negative—observations with unimproved access that are correctly predicted to have unimproved access, and (4) false negative—observations with improved access but incorrectly predicted to have unimproved access. These four classifications are then combined into a probability framework to generate eight classification statistical parameters.

Model 1 (water) demonstrates an extremely high ability to identify true positive cases, with a sensitivity of 99.98%. This means that almost all instances where the outcome is positive are correctly classified. However, this high sensitivity comes at the cost of specificity, which is very low at only 0.05%. The model struggles to identify negative cases, frequently classifying them as positive correctly. As a result, while the model correctly predicts most positive cases (with a positive predictive value of 89.85%), its ability to accurately identify true negatives is limited, reflected in a low negative predictive value of 24.32%. The false positive rate is 99.95%, meaning nearly all negative cases are misclassified as positive. However, the false negative rate is almost negligible at 0.02%, indicating that the model rarely misses a positive case. 89.84% of cases are correctly classified, driven primarily by the model's strong performance in identifying positives.

Appendix 1. Model Classification Testing

Classification Statistics		(1) Water	(2) Sanitation	(3) Water	(4) Sanitation
Sensitivity	Pr(+|D)	99.98%	99.06%	99.98%	99.12%
Specificity	Pr(–|~D)	0.05%	8.80%	0.07%	8.25%
Positive predictive value	Pr(D|+)	89.85%	85.19%	89.85%	85.12%
Negative predictive value	Pr(~D|–)	24.32%	63.88%	26.44%	63.84%
False + rate for true ~D	Pr(+|~D)	99.95%	91.20%	99.93%	91.75%
False – rate for true D	Pr(–|D)	0.02%	0.94%	0.02%	0.88%
False + rate for classified +	Pr(~D |+)	10.15%	14.81%	10.15%	14.88%
False – rate for classified –	Pr(D|–)	75.68%	36.12%	73.56%	36.16%
Correctly classified		**89.84%**	**84.73%**	**89.84%**	**84.69%**

Notes: A "+" or "–" is improved/unimproved predicted value, and a "D" or "~D" is improved/unimproved actual value

Source: Data Processed, 2024

By contrast, model 2 (sanitation) offers a more balanced approach. Its sensitivity, while still high at 99.06%, is slightly lower than that of Model 1, but its specificity is much improved, rising to 8.80%. This means that Model 2 is better at distinguishing between positive and negative cases, reducing the number of false positives. The positive predictive value decreases slightly to 85.19%, indicating a slight drop in the accuracy of optimistic predictions. Still, the negative predictive value improves significantly to 63.88%, meaning the model is much better at identifying true negatives. This balance is also reflected in a reduced false positive rate of 91.20%, though the false negative rate is higher than in Model 1, at 0.94%. Although model 2's overall classification accuracy is lower at 84.73%, this may be an acceptable trade-off in situations where it is essential to classify both positive and negative cases correctly.

With the same improved water as the dependent variable, model 3 performs similarly to model 1, with almost identical sensitivity

(99.98%) and specificity (0.07%). Like Model 1, it excels at identifying true positive cases but struggles with negative cases, leading to a high false positive rate of 99.93%. The model's positive predictive value remains high at 89.85%, and its negative predictive value shows a slight improvement at 26.44%. Model 3, like model 1, rarely misses positive cases, with a false negative rate of 0.02%. It correctly classifies 89.84% of cases, matching model 1 in performance.

In addition, with the same improved sanitation as a dependent variable, model 4 offers a performance profile very similar to that of model 2. Its sensitivity is 99.12%, slightly higher than Model 2, while its specificity is 8.25%, indicating that it, too, achieves a more balanced performance compared to Model 1 and 3. The positive predictive value is 85.12%, showing that most predicted positives are correct, though not as high as in the more sensitive models. The negative predictive value is 63.84%, which is very close to that of model 2, meaning the model is reliable when it predicts a negative case. With a false positive rate of 91.75% and a false negative rate of 0.88%, the model performs slightly better than Model 2 in identifying positive cases while maintaining a reasonable rate of false positives. The overall classification accuracy of Model 4 is 84.69%, just slightly lower than Model 2.

In summary, improved water models (models 1 and 3) prioritize sensitivity, capturing nearly all true positives but at the expense of high false favorable rates and poor specificity. On the other hand, improved sanitation models (models 2 and 4) offer a more balanced performance. Overall, the probit model remains effective in predicting the impact of financial inclusion on access to improved water and sanitation, as evidenced by a correct classification rate exceeding 80%.