Does Social Assistance Reduce Poverty for Sustainable Development? The Mediating Roles of Income Inequality and Human Development

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ABSTRACT

This study examines poverty reduction strategies implemented through government social assistance programs that are relevant to Sustainable Development Goal (SDG) 1 (No Poverty) and 10 (Reduced Inequalities) in Aceh, Indonesia. This study employed a mixed-method approach that combined field research and secondary data analysis. A cross-sectional survey was conducted in 2024, and primary data were collected through questionnaires in Pidie Regency. Descriptive statistics, regression analysis, and Structural Equation Modeling (SEM) were employed to analyze data from 152 households that had received social assistance for more than one year. The findings indicate that social assistance significantly reduces income inequality ($\beta = -0.590$, $p < 0.001$) and improves human development ($\beta = 0.475$, $p < 0.001$), while its direct effect on poverty is relatively weak ($\beta = -0.132$, $p < 0.10$). Income inequality has a strong positive effect on poverty ($\beta = 0.644$, $p < 0.001$), whereas human development does not significantly affect poverty. The structural model explains 51.6% ($R^2 = 0.516$) of the variance in poverty. The mediation analysis reveals that income inequality significantly mediates the effect of social assistance on poverty reduction ($\beta = -0.380$, $p < 0.001$), while human development does not currently mediate this relationship. It implies that social assistance can reduce poverty without immediate improvements in human development. The study concludes that social assistance contributes to poverty reduction primarily through its redistributive effects, highlighting the need for sustained government support and improved targeting to ensure the long-term sustainability of the program.

1. INTRODUCTION

Prosperity, a universal aspiration, is fundamental to sustainable development, as evidenced by the prominence of "no poverty" as the first Sustainable Development Goal (SDG) [1]. Poverty eradication is critical to the transformative 2030 agenda [2]. The interconnectedness of poverty with other sustainability elements is widely recognized, with survey results indicating that most participants consider poverty a significant obstacle to implementing the SDGs, particularly affecting (SDG) 1 (No Poverty), SDG 2 (Eradicate Hunger), SDG 3 (Health and Well-Being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequalities).

Governments worldwide continue implementing programs to alleviate poverty, recognizing it as a persistent challenge requiring modern, sustainable solutions [3]. However, the effectiveness of these efforts has been limited, necessitating a closer examination of the relationship between poverty reduction, income inequality, and human development. The

low quality of education [4] and limited purchasing power among communities underscore the urgency of this investigation. Research has demonstrated a significant correlation between areas of high-income inequality and low-income levels [5]. Lin [6] argued that high inequality necessitates a more focused approach to poverty alleviation. Additionally, human development indicators are crucial in assessing the quality of life in a region, with studies showing a strong correlation between the Human Development Index (HDI) and poverty levels [7].

This study focuses on relative and absolute poverty, examining the efficiency and effectiveness of macroeconomic policies, particularly fiscal policies such as social assistance programs. It addresses the pressing issues of income disparity and human development across Indonesian regions, with a focus on Aceh Province, which struggles with high poverty rates despite receiving Special Autonomy Funds. Previous research has explored various aspects of poverty, including its sensitivity to asset changes [8], the relationship between

income inequality and poverty reduction [9] and the impact of economic factors on inequality [10]. Hasan [7] highlighted the uneven economic growth across sectors in Indonesia as a factor exacerbating poverty. Other studies have employed diverse methodologies, including the use of Lorenz curves and Gini ratios [11], panel data approaches [12], and analyses of the impact of COVID-19 on poverty and global economies [13, 14].

This study distinguishes itself through its field-based approach, which utilizes cross-sectional data and employs mediating variables to analyze the direct and indirect effects of social assistance on poverty reduction. It focuses specifically on poor households receiving social assistance, examining how income inequality and human development mediate the effectiveness of these interventions. Understanding the interplay between social assistance, income inequality, and human development is crucial for designing effective strategies to alleviate poverty. This research contributes to the existing literature by providing empirical evidence on the mechanisms through which social assistance programs impact poverty reduction, emphasizing the importance of considering mediating variables. The findings aim to inform policymakers to refine their approaches to ensure more impactful and sustainable poverty reduction initiatives.

2. LITERATURE REVIEW

2.1 Poor households and poverty

Poverty is a multifaceted issue encompassing economic, social, and political dimensions. Due to varying economic, political, social, and ideological conditions across countries, no single definition adequately captures the complexity of poverty. Generally, poverty is defined as the inability to obtain life's necessities, resulting in reduced consumption and low levels of health, education, and basic needs fulfillment [15]. Qualitative measurements of poverty can also be based on expenditure perceptions [16]. The consequences of poverty are far-reaching, including malnutrition, nutritional deficiencies, disease spread, and widespread unemployment. Poor individuals often experience hunger, lack of education, and joblessness [17].

Additional poverty measures suggest that the world's impoverished populations typically suffer from undernourishment, lack access to essential services such as electricity and clean drinking water, have limited educational opportunities, and experience poor health [18]. The World Bank defines low-income countries as those with an annual per capita income of less than $600. It employs an absolute poverty measure to compare poverty conditions across countries and over time, using a threshold of purchasing power parity (PPP) below US$1.9 per day [18].

2.2 Income inequality and poverty

Inequality is the unequal distribution of income, resources, opportunities, treatment, and rights. It manifests in various forms, including disparities in income and wealth. Inequality is defined and measured within the same scope as poverty, focusing on the degree of difference in the distribution of economic resources, capacities, or welfare [19]. Societies do not allocate resources equally across populations, resulting in

uneven income and economic resource distribution. Paul et al. [20] found that income increases neutralize approximately two-thirds of inequality increases. Kanbur [21] and Mayhew and Wills [22] argued that the close relationship between inequality and poverty necessitates reducing inequality to alleviate poverty, particularly absolute poverty. Marrero and Servén [23] noted a correlation between growth and inequality. However, this relationship is empirically fragile and can be either positive or negative, depending on the empirical specification and econometric approach. Nevertheless, inequality negatively affects growth through poverty.

2.3 Human development and poverty

Human development and poverty are closely interrelated. Poverty can impact people's health and education both directly and indirectly. Adequate income ensures educational continuity from early childhood through higher education. Engle and Black [24] stated that poverty directly impacts children, with limited attention given to the mechanisms linking poverty to children's educational development. Tran et al. [25] found that children living in poverty are significantly disadvantaged in terms of educational development, with those in countries with low HDI scores facing the highest risk of failing to reach their developmental potential. Poverty adversely affects the development of children in impoverished families, particularly during childhood and later life. Brea-Martinez et al. [26] noted that growing up in relative poverty is associated with low income and education in adulthood.

2.4 Social assistance and poverty

Governments worldwide have implemented various social assistance programs to achieve public welfare and alleviate poverty. Agustanta et al. [27] demonstrated that the social assistance program has a positive impact on reducing poverty. This impact can be enhanced by providing clear regulations and rules for implementing assistance, double-checking target beneficiaries, and regularly monitoring and evaluating program implementation. Using a sample from the Asia Pacific region [28], this study identifies significant issues that are likely to shape the future development of social assistance. First, the tax-transfer system and the global expansion of social assistance have emphasized the role of social investment. Strengthening social assistance will require resources for mobilization and sustainable, stable financing.

However, research by Mahanani and Adelia [29] highlights the challenges in effectively targeting social assistance. Their study found that social assistance does not significantly impact poverty levels due to difficulty identifying eligible recipients. Numerous studies on poverty research have been significant, encompassing multifaceted definitions, diverse measurement methods, and exploration of poverty's far-reaching consequences. Researchers have investigated the relationship between income inequality, growth, and poverty, revealing complex interactions. Studies have also examined the impact of poverty on human development, particularly in the context of children's education and long-term prospects. The effectiveness of social assistance programs in poverty reduction has been assessed, identifying factors that enhance their impact.

Nevertheless, several research gaps remain. These include developing more comprehensive and universally applicable

poverty definitions, investigating specific mechanisms that link poverty to children's educational development, and exploring the long-term effects of childhood poverty on adult outcomes. Further research is needed to better understand the complex relationships between growth, inequality, and poverty and to explore sustainable financing methods for social assistance programs. Addressing challenges in targeting social assistance effectively and evaluating program impacts across different contexts are also crucial areas for future study. These research gaps motivate further investigation to enhance our understanding of poverty dynamics and develop more effective strategies for poverty reduction.

3. MATERIALS AND METHODS

3.1 Research design

This study employs a cross-sectional approach, administering questionnaires during the research period to address elements of each variable factor defined in the study. Pidie Regency was selected based on the extreme poverty index data for primary data collection. The methodological approach utilizes statistical techniques and analytical procedures to investigate the relationships between Social Assistance and key socio-economic variables, including Income Inequality, Poverty, and Human Development. The research model incorporates direct and mediation effects analysis using data obtained from the field.

The Structural Equation Model (SEM) is employed, utilizing SmartPLS software for analysis. This multivariate analysis technique integrates several dimensions into a complex regression model. Path analysis integrates research variables and their indicators, which are linked to constructs and other constructs. A two-step approach is adopted for measuring complex variables. The first stage establishes a measurement model, assuming observed variables are perfect indicators of the underlying latent variable.

After model formation, various tests are conducted to identify whether the model can proceed. The second stage examines the profound influence of latent variables, providing a comprehensive understanding of the structure of the observed construct. The construct model, as illustrated in Figure 1, depicts the independent variable (poverty) as influenced by social assistance, mediated by human capital, and moderated by income inequality. Each variable or dimension has predetermined indicators based on relevant sources.

3.2 Data collection and research instruments

Data is collected from various socio-economic databases, government publications, and financial reports. A purposive sampling technique selects the target population of poor households receiving social assistance. The sample comprises 152 respondents from Pidie Regency, a district with high extreme poverty in Aceh Province. Constructs and their sources are outlined, each operationalized based on relevant indicators. A 5-point Likert scale is used for rating items, ranging from 1 (Strongly Disagree) to 5 (Agree).

Additionally, this study measures poverty and human development variables using household-level indicators based on respondents' perceptions, rather than monetary or composite indices (see Table 1). For the variable of poverty, this study applies the concept of perceived deprivation in meeting basic needs (e.g., food, housing, education, health, and asset ownership), rather than using formal poverty thresholds such as the PPP poverty line from the World Bank. Additionally, human development is measured in terms of perceived capability and well-being, encompassing access to information, work skills, productivity, and the quality of the living environment, rather than the official HDI, which is a macro-level indicator constructed from life expectancy, education, and income data.

Thus, this study employs perception-based indicators, which are suitable for assessing the micro-level impacts of social assistance programs on beneficiary households, as they reflect the lived experiences of deprivation and capability that are not fully captured by aggregate statistics. This approach complements SDG-based frameworks by providing household-level evidence relevant for evaluating policy effectiveness.

Table 1. Summary of research instruments

Variable(s)	Indicator(s)	Source(s)
Poverty	I have difficulties and shortages in getting proper food, clothing, and housing (Y1.1) I find it difficult to own land and production equipment to produce my products (Y1.2) I often experience conditions of vulnerability and disadvantage in the areas of health, education and economy (Y1.3) I feel that poverty makes it difficult to get education and knowledge (Y1.4) I feel that my current economic and income limitations mean that I have no savings (Y1.5)	[15, 16]
Income Inequality	Income cannot fulfil all of life's needs (Z1.1) The education of the people in the village is still low and far different from the city area (Z1.2) Inadequate production tools and facilities (Z1.3) Village facilities and infrastructure are limited, in contrast to urban areas (Z1.4)	[30]
Human Development	I get information to understand, learn, and gain experience at work (Z2.1) I can complete my work with enthusiasm and well (Z2.2) Skillful in completing work quickly and correctly with appropriate results (Z2.3) The environment where I live is well-maintained and has healthy sanitation (Z2.4)	[31]
Social Assistance	I feel that the Government Assistance (BPNT) is appropriate and right on target (X1.1) To the best of my knowledge, the authorized officer conducts socialization and notification when the program is implemented (X1.2) As a recipient, I understand that BPNT is provided to assist with food and enhance the community's welfare (X1.3) In our view, the amount and type of assistance have not been aligned with the actual needs and the objective of improving community welfare (X1.4)	[32]

3.3 Evaluating the measurement model

A pilot study uses Cronbach's Alpha and Composite Reliability (CR) to assess construct validity and reliability. The Fornell-Larcker criterion is widely used for assessing discriminant validity in SEM. This approach compares the square root of the average variance extracted (AVE) for each construct with the correlations between that construct and other constructs in the model. To evaluate discriminant validity using this criterion, researchers first calculate the AVE for each construct and then compute its square root. They also determine the correlations between all pairs of constructs. The assessment involves comparing the square root of AVE for each construct with its correlation to other constructs. The discriminant validity is established when a construct shares more variance with its indicators than with other constructs in the model.

Typically, researchers present this information in a matrix format, with the square root of AVE on the diagonal and correlations between constructs in the off-diagonal elements. Interpretation is straightforward: discriminant validity is confirmed if the diagonal elements (square root of AVE) exceed the off-diagonal elements in the corresponding rows and columns. While the Fornell-Larcker criterion offers a clear and widely accepted method for assessing discriminant validity, it may not detect issues in certain situations, particularly with highly correlated constructs. If discriminant validity is not established, researchers may need to refine the construct, remove problematic indicators, or reassess the theoretical distinctiveness of constructs.

3.4 Evaluating the structural model

R-squared and Adjusted R-squared are used to determine the explanatory power of models for income inequality, poverty, and human development. Direct effects analysis utilizes regression models to examine the relationships between social assistance, income inequality, poverty, and human development. Mediation analysis examines whether income inequality and human development serve as mediators of the relationship between social assistance and poverty.

4. RESULTS AND DISCUSSION

4.1 Descriptive statistics analysis

Table 2 presents the demographic profiles of the respondents, including their gender, age, marital status, and education. All respondents had been recipients of social assistance for more than one year. The study's findings, involving 152 respondents who had received social assistance for over a year, revealed several key demographic characteristics. The gender distribution among the respondents was nearly balanced, with 51.32% male and 46.68% female participants. This gender composition was determined through interviews with household heads or spouses when necessary. The age analysis of the respondents demonstrated a diverse range, with a predominance of social assistance beneficiaries aged 55 years and above, including those in their 60 s. This age group was categorized as having diminished productivity.

Table 2. Result of demography profile of respondents

Description		Frequency	Percentage (%)
Gender	Male	78	51.32
	Female	74	48.68
Age	20-24	2	1.32
	24-29	6	3.95
	30-34	15	9.87
	35-39	18	11.84
	40-44	18	11.84
	45-49	23	15.13
	50-54	15	9.87
	55-59	56	36.84
	60 >	34	22.36
Marital Status	Married	129	84.87
	Living Divorced	5	3.29
	Death Divorced	15	9.87
	No Married Yet	3	1.97
Education	Elementary School	34	22.37
	Junior High School	30	19.74
	Senior High School	82	53.95
	College	6	3.95

Marital status and household size were also examined. The results showed that 3.29% of respondents were divorced, with an average family size of 1.625 members; 9.87% were widowed, with an average household size of 2.467 members; and 84.87% were married, with the largest average family size of 2.875. Additionally, 1.97% of poor households have never married. The larger family sizes among poor households suggested a high dependency on the family head. Educational attainment among respondents varied, with the majority (53.95%) having completed senior high school. The remaining distribution included 22.37% with elementary school education, 19.74% with junior high school education, and 3.9% with college education. This educational profile was considered relatively favorable for managing village development funds, as most fund managers had attained a high school education level. This finding suggested potential for effective management of central government transfer funds.

4.2 Evaluating the measurement model

4.2.1 Construct validity and reliability
Validity and reliability tests were conducted to ensure the robustness of the data-collection instruments. Validity assessment evaluated the questionnaire items' ability to accurately represent the concepts under investigation, whereas reliability testing confirmed consistency across repeated measurements under identical conditions. These tests are crucial in quantitative research because they ensure the accuracy and dependability of findings. The structural model illustrates the relationships among social assistance, income inequality, human development, and poverty, accompanied by validity, reliability, and outer loading results. Table 3 provides detailed information regarding validity and reliability.

Table 3. Result of construct validity and reliability

Variable(s)	Loadings	CA	CR	AVE
Human Development	0.920 0.504 0.873 0.866	0.804	0.878	0.653
Income Inequality	0.766 0.795 0.867 0.844	0.838	0.891	0.671
Poverty	0.682 0.745 0.817 0.712 0.638	0.773	0.844	0.521
Social Assistant	0.835 0.692 0.697 0.790 0.742	0.82	0.867	0.567

Note: CA is Cronbach's Alpha, CR is Composite Reliability

The results of the construct validity and reliability analysis for the four variables, namely human development, income inequality, poverty, and social assistance, are presented in Table 3. The result shows that all variables demonstrated satisfactory performance across the measured criteria. The internal consistency of the variables, as assessed by Cronbach's Alpha, exhibited strong reliability for all constructs. Human development yielded an alpha value of 0.804, while Income Inequality scored 0.838. Poverty showed a slightly lower but acceptable alpha of 0.773, while Social Assistance registered an alpha of 0.820. These findings suggest that the items used to measure these variables exhibit high consistency and reliability.

Among the four constructs, Income Inequality demonstrated the highest internal consistency. Additionally, the results showed that all variables exceeded the commonly accepted threshold of 0.70 for CR, indicating strong overall reliability. Human development and income inequality demonstrated robust reliability, with CR values of 0.878 and 0.891, respectively. Social assistance also exhibited good reliability at 0.867, while poverty, although slightly lower at 0.844, remained well within acceptable limits.

Additionally, we also report the result of convergence validity using AVE. Using AVE, we assess the proportion of variance accounted for by a construct relative to measurement error, further supporting the validity of these variables. Additionally, we noted that the indicator under the Human Development construct, with a loading of 0.504, was retained because the AVE exceeded the recommended threshold of 0.50, indicating adequate convergent validity. According to PLS-SEM guidelines, indicators with loadings between 0.40 and 0.70 may be retained if their removal does not lead to a significant improvement in AVE or CR [33]. Thus, we retained the indicator of Z2.2, with an item loading of 0.504 (see Figure 1), to maintain the content validity of the construct.

Human Development (0.653) and Income Inequality (0.671) demonstrated strong validity, capturing a significant portion of the variance in their respective indicators. Social assistance, with an AVE of 0.567, also displayed acceptable validity. Poverty, while meeting the minimum standard with an AVE of 0.521, explained slightly less variance than the other variables but remained within an adequate range for analysis. These findings suggest that the study's constructs

were reliable and valid, making them suitable for further analysis.

4.2.2 Discriminant validity

The discriminant validity test was employed to verify that the constructs measured by the instrument were significantly distinct (Tables 4 and 5). This test assesses the degree to which the measurement of one construct is empirically distinct from that of other constructs. A common approach to assessing discriminant validity involves comparing the correlation matrix or covariance values between the constructs under examination. One widely accepted method is to determine whether the square root of the AVE for each construct exceeds the correlation values between that construct and other constructs in the model. This comparison provides evidence of discriminant validity when the AVE square root values are indeed higher than the inter-construct correlations.

Table 4. Result of discrimination validity using the Fornell and Lucker Criterion

No.	Variable(s)	1	2	3	4
1	Human Development	0.808			
2	Income Inequality	-0.374	0.819		
3	Poverty	-0.275	0.711	0.722	
4	Social Assistance	0.475	-0.590	-0.498	0.753

Table 4 shows the result of discriminant validity using the Fornell and Lucker Criterion. The results revealed satisfactory levels of discriminant validity for all four variables: human development, income inequality, poverty, and social assistance. The square roots of the AVE for each variable, as reported in Table 3, exceeded the correlations between the variables, indicating stronger relationships between each variable and its indicators compared to those with other variables. For Human Development, the square root of AVE (0.808) surpassed its correlations with Income Inequality (-0.374), poverty (-0.275), and Social Assistance (0.475), demonstrating the distinctiveness of items measuring Human Development from those measuring other variables.

Similarly, the square root of Income Inequality's AVE (0.819) was higher than its correlations with Poverty (0.711) and Social Assistance (-0.590). Although a relatively high correlation between income inequality and poverty (r = 0.711) suggested some overlap, the discriminant validity criterion was still met, with a value of 0.819 exceeding the correlation value. Poverty exhibited a square root of AVE (0.722) that was greater than its correlations with Social Assistance (-0.498) and Human Development (-0.275), confirming its distinctiveness. Despite the strong correlation with Income Inequality, the AVE comparison demonstrated sufficient distinction between the two constructs. Social assistance displayed a square root of AVE (0.753) that surpassed its correlations with all other variables, including Human Development (0.475), Income Inequality (-0.590), and poverty (-0.498), indicating its distinct nature within the model. These results collectively confirmed the model's achievement of discriminant validity, demonstrating that each construct measured a distinct concept, and the variables were not excessively similar. This finding supports the validity of the measurement model for further analysis.

Additionally, this study employs the Heterotrait–Monotrait ratio (HTMT) to assess discriminant validity. The HTMT criterion evaluates the extent to which constructs are empirically distinct by comparing correlations across

constructs. Discriminant validity is established when HTMT values are below the recommended threshold of 0.85 [34].

Table 5. Result of discriminant validity using Heterotrait–Monotrait ratio (HTMT)

No.	Construct	1	2	3	4
1	Human Development	1.000			
2	Income Inequality	0.354	1.000		
3	Poverty	0.304	0.817	1.000	
4	Social Assistance	0.451	0.643	0.538	1.000

As presented in Table 5, this study evaluates the HTMT ratio; all HTMT values among the constructs are below the critical threshold (0.85) [33]. The highest HTMT value is observed between Income Inequality and Poverty (0.817), which remains within the acceptable limit, indicating that although the constructs are closely related, they are empirically distinguishable. The remaining HTMT values range from 0.304 to 0.643, further confirming adequate discriminant validity among the variables of Human Development, Income Inequality, Poverty, and Social Assistance. The HTMT results demonstrate that the measurement model satisfies the requirements for discriminant validity, allowing for further evaluation of the structural model.

4.3 Evaluating the structural model

4.3.1 Coefficient of determination (R-square)

The R test measures the extent to which independent variables can explain dependent variables in regression studies (Table 6). Higher R scores indicate that the study demonstrates a greater proportion of the variability in the dependent variables. The R-squared and R-squared Adjusted values for Human Development, Income Inequality, and Poverty indicate the proportion of variance in the dependent variable explained by the independent variables in the model.

Table 6. Result of coefficient determination (R Square)

Variable(s)	R Square	R Square Adjusted
Human Development	0.225	0.220
Income Inequality	0.348	0.343
Poverty	0.516	0.506

The regression analysis results provide insights into the model's explanatory power for three dependent variables: poverty, income inequality, and human development. The coefficient of determination (R-squared) values indicate varying levels of explanatory power across these variables. The model demonstrates the highest explanatory power for poverty, with an R-squared value of 0.516. It suggests that the predictors in the model account for 51.6% of the variance in poverty levels. The adjusted R-squared value of 0.506 indicates that, even after accounting for the number of predictors and potential overfitting, the model still explains 50.6% of the variance in poverty.

Income inequality shows a moderate level of explained variance, with an R-squared value of 0.348. It indicates that the predictors account for 34.8% of the variance in income inequality. The adjusted R-squared value of 0.343 suggests minimal overfitting and a reasonably good model fit. In contrast, the model's explanatory power for human development is relatively low, with an R-squared value of

0.225. It indicates that only 22.5% of the variation in human development can be explained by the included variables. The adjusted R-squared value of 0.220 further confirms the limited explanatory capability of the model for this variable. These results suggest that the regression model has a reasonably good explanatory capability for poverty and income inequality, but is less effective in explaining variability in human development. This implies that other factors not included in the current research may significantly influence human development outcomes.

4.3.2 Effect size (F-square)

The F-square statistic, a measure of effect size, is employed in SEM and Partial Least Squares (PLS) analyses to evaluate the relative impact of exogenous variables on endogenous variables within a model. The interpretation of F-square values is typically categorized into three ranges. Values of 0.02 or below indicate a small effect, suggesting a minor yet discernible influence. Values approximating 0.15 denote a medium effect, signifying a notable and meaningful impact. F-square values of 0.35 or greater represent a large effect, indicating a substantial influence of the variable on the outcome. These established thresholds provide researchers with a framework for assessing the significance and magnitude of relationships in statistical modeling.

Table 7. Result of effect size (f^2)

Variable(s)	Poverty
Human Development	0.635
Income Inequality	0.376

Table 7 indicates that human development and income inequality have a substantial effect on poverty, as demonstrated by their respective effect size values. The effect sizes for human development ($f^2 = 0.635$) and for income inequality ($f^2 = 0.376$) both fall within the large category. According to Cohen's [35] benchmarks, where $f^2 = 0.02$ is considered small, 0.15 medium, and 0.35 large. From a statistical perspective, f^2 measures the incremental contribution of a predictor to the variance explained in poverty, after accounting for the effects of other variables in the model. An effect size of 0.635 suggests that human development makes a substantial contribution to unique explanatory power, while an effect size of 0.376 also indicates a robust and meaningful contribution from income inequality. These values imply that both predictors meaningfully increase the model's explanatory power, signifying that variations in human development and income inequality account for a sizable portion of the variance in poverty levels. Such strong effects are rarely observed in social science research, where effect sizes are often modest due to the complexity of socioeconomic phenomena. Therefore, this study concludes that human development and income inequality play statistically significant and practically important roles in determining poverty.

4.3.3 Collinearity (VIF) and bias-corrected bootstrapped confidence intervals

The indirect effects were evaluated using a bootstrapping procedure with confidence intervals to examine the mediating roles of Human Development and Income Inequality in the relationship between Social Assistance and Poverty. An indirect effect is considered statistically significant when the

confidence interval does not include zero. The results of the bootstrapping analysis with confidence intervals are presented in Table 8 below:

Table 8. Result of Variance Inflation Factor (VIF)

Path Analysis	VIF
Human Development -> Poverty	1.271
Income Inequality -> Poverty	1.556
Social Assistance -> Poverty	1.724

Table 8 presents the results of the collinearity analysis, using VIF values. For the structural paths leading to poverty, VIF is used to assess potential multicollinearity among predictor constructs in the PLS-SEM structural model. The results report that the VIF values for human development, income inequality, and social assistance are 1.271, 1.556, and 1.724, respectively. This study indicated that all VIF values are below the thresholds of 3.3 (a conservative criterion) and 5.0 (a traditional criterion). It means that there is no collinearity issue among the predictors of poverty. Additionally, this study reports bias-corrected confidence intervals. It aims to ensure robust inference, where an indirect effect is considered statistically significant if the interval does not include zero. Table 9 presents the bias-corrected bootstrapping results for the indirect effects in the structural model.

Table 9 shows the result of bias-corrected bootstrapped confidence intervals (BCa-CI). The bias-corrected bootstrapping is used to ensure reliable statistical inference, eliminating potential bias and non-normality in the sampling distribution. In this study, we use a 95% structural path confidence interval that excludes the value of zero.

The findings indicate that income inequality has a substantial and statistically significant positive effect on poverty ($\beta = 0.640$; CI = [LL = 0.528, UL = 0.768]). It means that income distribution plays a significant role in shaping poverty. Furthermore, social assistance has significantly enhanced human development ($\beta = 0.452$; CI = [LL = 0.306, UL = 0.552]). It means that social assistance can enhance human capital. Additionally, social assistance significantly reduces income inequality ($\beta = -0.591$; CI = [LL = -0.674, UL = -0.494]), confirming its redistributive function within the socioeconomic system.

Table 9. Result of bias-corrected bootstrapped confidence intervals for structural paths

Path Analysis	Coefficients	Bias	LL	UL
Human Development -> Poverty	0.012	0.001	-0.089	0.102
Income Inequality -> Poverty	0.640	0.001	0.528	0.768
Social Assistance -> Human Development	0.452	0.010	0.306	0.552
Social Assistance -> Income Inequality	-0.591	-0.674	-0.494	-0.494
Social Assistance -> Poverty	-0.127	-0.283	0.047	-0.347

On the other hand, the effect of human development towards poverty ($\beta = 0.012$; CI = [LL=-0.089, UL = 0.102]) and social assistance on poverty ($\beta = -0.127$; CI = [LL=-0.347, UL=0.047]) are not statistically significant, because the value of confidence intervals includes zero. This study found that the impact of human development and social assistance on poverty operates predominantly mediated by income inequality and human development. Thus, the results highlight the importance of accounting for mediating mechanisms in explaining poverty dynamics and reinforcing income inequality as a key transmission channel within the structural model.

4.3.4 PLS predict

The predictive relevance of the structural model was assessed using the Stone–Geisser Q^2 statistic obtained through the PLS Predict procedure. Q^2 values greater than zero indicate that the model has predictive relevance for a given endogenous construct. Result of PLS prediction as shown in Table 10.

Table 10. Result of predictive relevance (Q^2) and impact of predictive relevance (q^2)

Variable	Q^2	q^2
Human Development	0.158	0.086
Income Inequality	0.217	0.010
Poverty	0.226	-

The Q^2 values for Human Development ($Q^2 = 0.158$), Income Inequality ($Q^2 = 0.217$), and Poverty ($Q^2 = 0.226$) are all greater than zero, demonstrating that the model exhibits satisfactory predictive relevance for these endogenous variables. The highest predictive relevance is observed for Poverty, indicating that the model has stronger out-of-sample predictive capability for this construct. In contrast, Social Assistance shows no Q^2 value because it is treated as an exogenous variable in the model and therefore is not predicted by other constructs. Overall, the Q^2 results indicate that all endogenous constructs have values greater than zero, confirming that the proposed PLS-SEM model has adequate predictive relevance and demonstrates robustness in explaining the structural relationships among the variables.

Additionally, the analysis reveals that omitting human development significantly reduces the model's predictive capability for poverty, resulting in a q^2 value of 0.086. According to Hair [34], guidelines (0.02 = small, 0.15 = medium, 0.35 = large) indicate a small to moderate level of predictive relevance. Conversely, excluding income inequality results in only a slight decrease in predictive relevance, with a q^2 value of 0.010, which is below the threshold for even a small effect. The results suggest that although income inequality strongly explains poverty (as shown by its large f^2 value), its contribution to out-of-sample predictive performance is minimal. In contrast, human development plays a more substantial role in enhancing the model's predictive capability.

4.3.5 Hypothesis testing

Table 11 indicates that social assistance has a significantly negative impact on income inequality (coefficient = -0.590, p < 0.001), suggesting that increased social assistance contributes to a reduction in income inequality. Additionally, social assistance has a positive and significant effect on human development (coefficient = 0.475, p < 0.001), indicating that higher levels of social assistance are associated with improved human development outcomes. While negative, the direct

effect of social assistance on poverty is relatively weak (coefficient = -0.132) but statistically significant at the 10% level (p = 0.092). It suggests that social assistance has some potential to reduce poverty, albeit to a limited extent. Conversely, income inequality exhibits a strong, positive, and significant effect on poverty (coefficient = 0.644, p < 0.001), indicating that higher levels of income inequality are associated with higher poverty rates.

Table 11. Result of hypothesis testing (direct effect)

Path Analysis	Coefficients	STDEV	T Values
Social Assistance -> Income Inequality	-0.590	0.043	13.691***
Social assistance -> Poverty	-0.132	0.078	1.687*
Social Assistance -> Human Development	0.475	0.058	8.206***
Income Inequality -> Poverty	0.644	0.059	10.897***
Human Development -> Poverty	0.029	0.048	0.608

Note: ***, **, * are significant at levels 1, 5, and 10 percent

The negative and statistically significant impact of social assistance on income inequality (coefficient = -0.590, T-value = 13.691, p < 0.001) suggests that higher levels of social assistance contribute to reducing income inequality. This finding suggests that poor households receiving social assistance may better meet their basic needs through government-supported social programs, including non-cash food assistance, direct cash assistance, health program assistance (such as the Family Hope Program or PKH), and educational support for school education. These results align with previous research by Suriani et al. [36], Yavishan et al. [37], Agustanta et al. [27], and Ajisafe et al. [38], who reported similar findings using secondary data and examining the impact of social cash transfers on poverty and income equality.

However, the effect of human development on poverty is not statistically significant (coefficient = 0.029, p = 0.544), indicating that improvements in human development, as measured in this model, do not have a direct and significant impact on poverty reduction. This finding differs from those of El Hasanah et al. [39] and Suganda et al. [40], who reported that increased quality of human development can reduce poverty. The results suggest that addressing income inequality may be the most effective approach to reducing poverty, with social assistance indirectly influencing poverty by lowering inequality rather than through direct pathways such as human development. The strong positive influence of social assistance on human development (coefficient = 0.475, T-value = 8.206, p < 0.001) further supports the potential indirect effects of social assistance on poverty reduction.

The weak negative effect of social assistance on poverty (coefficient = -0.132, T-value = 1.687, p = 0.092) indicates that while social assistance influences poverty reduction, its impact is limited, possibly because the assistance received primarily meets basic needs. It suggests that additional skill empowerment programs may be necessary for poor households receiving social assistance to achieve more substantial poverty reduction outcomes.

Table 12. Result of hypothesis testing (indirect effect)

Path Analysis	Coefficients	STDEV	T Values
Social Assistance -> Income Inequality -> Poverty	-0.380	0.046	8.256***
Social Assistance -> Human Development -> Poverty	0.014	0.024	0.573

Note: ***, **, * are significant at levels 1, 5, and 10 percent
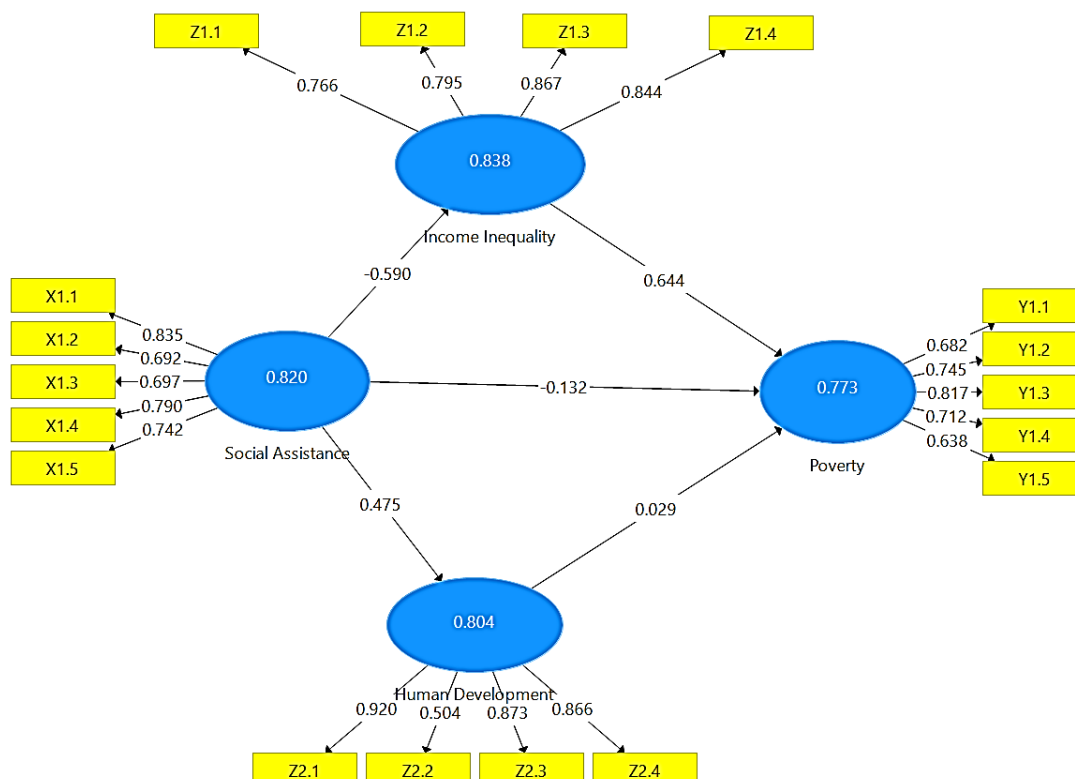

Figure 1. Result of SEM using PLS algorithm

The mediation analysis presented in Table 12 investigated the potential indirect effects of social assistance on poverty through two mediating variables: human development and income inequality. The results revealed contrasting outcomes for these two mediators. The mediation effect of social assistance on poverty via human development was weak and statistically non-significant (coefficient = 0.014, T-value = 0.573, P-value = 0.567). This finding suggests that human development does not serve as a significant mediator in the relationship between social assistance and poverty within the context of this model.

In contrast, the mediation of social assistance on poverty through income inequality demonstrated a substantial and statistically significant effect (coefficient = -0.380, T-value = 8.256, P-value = 0.000). The negative coefficient indicates an inverse relationship, suggesting that poverty levels decrease as social assistance increases and income inequality decreases. This result implies that social assistance indirectly reduces poverty by mitigating income inequality. These findings are consistent with previous research that has demonstrated the influence of income inequality on poverty [9, 41]. The results underscore the importance of considering income inequality as a mediating factor in the relationship between social assistance programs and efforts to reduce poverty. Figure 1 displays the results of hypothesis testing, including direct and indirect effects, using the PLS algorithm.

5. CONCLUSIONS

This study investigated the impact of social assistance on poverty reduction, mediated by human development and income inequality. Cross-sectional field research was conducted in the Pidie district of Aceh province in 2024, involving 152 respondents. The research employed multiple linear regression analysis with mediating variables. The analysis revealed a complex relationship between social assistance and key socio-economic variables, demonstrating direct and indirect effects. Social assistance significantly reduces income inequality and enhances human development.

However, its direct influence on poverty was negative and relatively weak, despite being statistically significant. The indirect effect of social assistance on poverty, mediated by income inequality, was substantial and statistically significant, whereas the indirect pathway through human development was not significant. The findings confirm that social assistance does not exacerbate poverty; instead, it contributes to poverty reduction both directly and indirectly, primarily through its redistributive effect on income inequality. Income inequality has been demonstrated to have a strong, positive, and statistically significant influence on poverty. In contrast, human development did not exhibit a significant direct effect on poverty within this model.

Accordingly, human development does not mediate the relationship between social assistance and poverty. Human development does not mediate the relationship between social assistance and poverty. It implies that social assistance has the potential to directly impact poverty reduction, necessitating inclusive action to sustain social assistance programs.

Income inequality emerged as a significant mediator between social assistance and poverty. The results indicated that social assistance reduces poverty by lowering income inequality, with this mediation effect being substantial and statistically significant. This finding highlights an important policy implication: poverty alleviation efforts should prioritize inequality reduction as a core mechanism of social assistance programs. These results underscore the importance of considering multiple pathways supported by empirical estimates when designing and implementing social assistance programs aimed at poverty reduction.

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