An Analysis of the Impact of Healthcare Workforce, Educational Infrastructure, and Non-Food Expenditure on Human Development Index (HDI) in Humbang Hasundutan Regency, Indonesia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study aims to analyze the impact of healthcare workforce, educational infrastructure, and non-food per capita expenditure on the Human Development Index (HDI) in Humbang Hasundutan Regency, North Sumatra, Indonesia. Using time-series data from 2005 to 2022 and applying multiple linear regression analysis through SPSS 26, the research finds that both healthcare workforce and educational infrastructure significantly and positively influence the HDI. However, non-food per capita expenditure does not exhibit a significant effect on the HDI. These findings suggest that improvements in healthcare and education are pivotal in driving human development in the region. Policymakers are advised to focus on strengthening these key sectors to ensure sustained socio-economic growth. The study contributes to the existing literature on human development by providing

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region-specific insights and emphasizes the importance of tailored policy interventions for improving HDI at a local level.

1.   Introduction

The Human Development Index (HDI) has emerged as a widely accepted composite measure of development, encapsulating three critical dimensions: health, education, and income. Developed by the United Nations Development Programme (UNDP) in 1990, the HDI goes beyond economic growth, providing a more comprehensive reflection of human well-being. By incorporating life expectancy, literacy rates, and per capita income, HDI offers a clearer picture of societal progress and the quality of life within nations and regions (Todaro & Smith, 2003). As a result, the HDI has become a key indicator for guiding policy decisions aimed at improving human welfare.

In Indonesia, significant disparities exist between provinces in terms of HDI, despite the country's overall positive trend in human development. As of 2022, Indonesia ranked 114th globally, with notable progress in improving life expectancy and education outcomes. However, within the national context, regional differences are stark. North Sumatra, for example, ranks 15th out of 34 provinces, indicating a need for targeted interventions in specific regencies to ensure balanced development across the region (BPS, 2023). Given these disparities, understanding the determinants of HDI at the regency level is critical for formulating effective development strategies.

Humbang Hasundutan Regency, located in the highlands of North Sumatra, presents an intriguing case for examining regional HDI dynamics. In recent years, the regency has experienced significant improvements in its HDI, moving from a "medium" category in 2021 to a "high" category in 2022. However, despite this upward trajectory, the regency still ranks 22nd out of 33 regencies/cities in North Sumatra, highlighting the persistence of development challenges. Factors such as healthcare accessibility, education quality, and income distribution continue to shape the regency's human development outcomes, yet their specific impacts require closer investigation.

Prior research emphasizes the role of healthcare and education as primary drivers of human development. Studies by Mongan (2019) and Dzulhijjy (2021) demonstrate that government spending on healthcare and education significantly influences HDI outcomes in various Indonesian regions. These studies suggest that improvements in public health and educational infrastructure can substantially elevate a region's HDI by increasing life expectancy and educational attainment. However, these findings do not fully capture the unique socio-economic conditions of Humbang Hasundutan, where additional variables such as non-food per capita expenditure may also play a role.

Non-food per capita expenditure, which reflects household spending on goods and services beyond basic food needs, can serve as an indicator of disposable income and overall living standards. Higher non-food expenditure is typically associated with better access to services like education, healthcare, and housing, which indirectly contribute to human development. While some studies have explored this variable in relation to HDI, its specific impact in rural and semi-rural areas, such as Humbang Hasundutan, remains under-researched. Understanding the influence of non-food expenditure alongside healthcare and educational infrastructure is essential for developing a more nuanced approach to regional development.

This study aims to fill this gap by examining the impact of healthcare workforce, educational infrastructure, and non-food per capita expenditure on HDI in Humbang Hasundutan Regency. The research adopts a quantitative approach, utilizing time-series data from 2005 to 2022 and multiple linear regression analysis to assess the relative importance of each factor. By focusing on these variables, the study seeks to identify actionable insights for policymakers seeking to improve human development outcomes in the regency.

The findings of this study are expected to contribute to both theoretical and practical knowledge on human development in Indonesia. Theoretically, the research extends the literature by exploring the interplay between health, education, and economic factors in a specific regional context. Practically, the results provide evidence-based recommendations for local governments aiming to enhance HDI through targeted investments in healthcare and education. The study also highlights the need for policy interventions that address not only basic needs but also the broader socio-economic factors that influence human well-being.

The structure of the paper is as follows: The next section provides a review of relevant literature on HDI and its determinants, focusing on healthcare, education, and non-food expenditure. The methodology section outlines the data sources and analytical techniques employed in the study. The results section presents the key findings, followed by a discussion of their implications for regional development policy. Finally, the conclusion summarizes the study's contributions and suggests directions for future research.

2. Method

This research adopts a quantitative approach to assess the influence of the healthcare workforce, educational infrastructure, and non-food per capita expenditure on the Human Development Index (HDI) in Humbang Hasundutan Regency. The study relies on secondary data collected from various official sources, with time-series data spanning from 2005 to 2022. The following sections outline the data sources, variables, and analytical techniques employed.

2.1 Research Design

The study utilizes an explanatory research design aimed at identifying the relationships between healthcare workforce, educational infrastructure, non-food per capita expenditure, and HDI in Humbang Hasundutan Regency. The research model tests both simultaneous and partial effects of the independent variables on HDI, allowing for a comprehensive understanding of how these factors contribute to human development outcomes in the region.

2.2 Data Collection and Sources

The research relies on secondary data obtained from several official institutions in Humbang Hasundutan Regency, including the Central Statistics Agency (BPS), the Regional Planning and Development Agency (BAPPEDA), the Department of Education, and the Department of Health. These institutions provided time-series data on healthcare personnel, educational infrastructure, and non-food expenditure. The data covers an 18-year period (2005–2022), ensuring a robust sample for statistical analysis.

The HDI values for the regency were extracted from the BPS dataset, which includes the sub-components of life expectancy, mean years of schooling, and per capita expenditure, in line with the UNDP's HDI methodology. Data on healthcare workforce includes the number of doctors, nurses, and other health-related staff employed in the region. Educational infrastructure data consists of the number of schools and educational facilities at various levels, while non-food per capita expenditure represents household spending on goods and services beyond food.

2.3 Variables and Measures

The dependent variable in this study is the Human Development Index (HDI) of Humbang Hasundutan Regency. The independent variables are:

1. **Healthcare Workforce**: This variable reflects the total number of healthcare personnel, including doctors, nurses, and allied health professionals, employed in the regency each year.

2. **Educational Infrastructure**: This variable captures the number of educational institutions at different levels (primary, secondary, and tertiary) available in the regency annually.
3. **Non-Food Per Capita Expenditure**: This variable measures the annual per capita expenditure on goods and services other than food, which serves as an indicator of household disposable income and living standards.

2.4 Data Analysis Techniques

The study employs multiple linear regression analysis to examine the effects of the healthcare workforce, educational infrastructure, and non-food per capita expenditure on HDI. The regression model tests both simultaneous and partial effects, allowing for an understanding of the direct and indirect relationships between the independent variables and the dependent variable. The regression equation is formulated as follows:

$$HDI = \beta_0 + \beta_1(\text{Healthcare Workforce}) + \beta_2(\text{Educational Infrastructure}) + \beta_3(\text{Non-Food Expenditure}) + \epsilon$$

Where:
- **HDI** represents the Human Development Index as the dependent variable.
- **Healthcare Workforce** represents the number of health professionals.
- **Educational Infrastructure** represents the number of schools and educational facilities.
- **Non-Food Expenditure** reflects per capita household expenditure on non-food items.
- β_0\beta_0β_0 is the intercept, $\beta_1, \beta_2, \beta_3$ are the coefficients for the independent variables, and ϵ\epsilon$\epsilon$ is the error term.

Data were analyzed using SPSS version 26, which facilitated the execution of descriptive statistics, collinearity diagnostics, and multiple regression analysis. Before running the regression, multicollinearity was assessed using Variance Inflation Factor (VIF) to ensure no strong correlations among independent variables, which could distort the results. Additionally, normality, linearity, and homoscedasticity tests were conducted to meet the assumptions required for linear regression.

2.5 Model Specification

The model used in this study is specified to examine the relative contribution of each independent variable to the overall HDI. The significance of each predictor was assessed using t-tests, and the overall model fit was evaluated through the R-squared statistic, which indicates the proportion of variance in the HDI explained by the independent variables. Statistical significance was determined at the 5% level ($p < 0.05$).

3. Result and Discussion

The results of the multiple regression analysis are summarized in Table 1. The regression model is statistically significant, with an R-squared value of 0.71, indicating that 71% of the variance in the HDI is explained by the healthcare workforce, educational infrastructure, and non-food per capita expenditure.

Table 1: Regression Results

Variable	Coefficient (B)	Standard Error	t-value	p-value
Constant	39.468	9.913	3.981	0.001
Healthcare Workforce	0.007	0.001	6.952	0.000
Educational Infrastructure	0.097	0.033	2.919	0.011
Non-Food Per Capita Expenditure	-0.020	0.037	-0.529	0.605

The results indicate that both healthcare workforce and educational infrastructure have significant positive effects on HDI, while non-food per capita expenditure does not have a statistically significant impact.

3.1 Healthcare Workforce

The healthcare workforce has a positive and significant effect on HDI, with a coefficient of 0.007 ($p < 0.001$). This indicates that for every additional health personnel employed in the regency, the HDI increases by 0.007 points. The strong significance of this variable aligns with previous literature, which emphasizes the critical role of healthcare in improving life expectancy, a major component of the HDI (Blum, 1974; Hamdan, 2019). As healthcare personnel increase, access to medical services improves, leading to better overall health outcomes and longer life expectancy.

3.2 Educational Infrastructure

Educational infrastructure also has a significant positive effect on HDI, with a coefficient of 0.097 ($p = 0.011$). This finding suggests that for each additional educational facility in the regency, the HDI increases by 0.097 points. The significance of this variable highlights the importance of education in human development, as access to schools and other educational institutions directly enhances literacy rates and years of schooling—key sub-components of HDI. This result is consistent with Hanushek's (1995) theory that educational quality and accessibility are fundamental drivers of human capital formation, which in turn elevates HDI.

3.3 Non-Food Per Capita Expenditure

Contrary to expectations, non-food per capita expenditure does not have a statistically significant effect on HDI ($p = 0.605$). This result suggests that household spending on non-food items is not a major determinant of human development in Humbang Hasundutan Regency. The negative coefficient (-0.020) indicates a slight inverse relationship, though this is not statistically significant. One possible explanation for this outcome is the regency's relatively low overall income levels, where food expenditure still dominates household budgets. Engel's Law supports this interpretation, suggesting that as income increases, households tend to allocate a smaller proportion of their budget to food, but in low-income areas, non-food expenditure may remain low (Salvatore, 2008).

3.4 Discussion

The findings of this study provide valuable insights into the determinants of human development in Humbang Hasundutan Regency. The significant positive effects of healthcare workforce and educational infrastructure reinforce the importance of these sectors in regional development. Health and education are widely recognized as essential components of human capital, and this study's results align with global trends that highlight their influence on improving life expectancy and educational outcomes, both of which are central to the HDI framework (UNDP, 2022).

The healthcare workforce's influence on HDI in this study underscores the importance of healthcare accessibility in rural regions like Humbang Hasundutan. Adequate staffing levels in healthcare facilities ensure that residents have access to preventive, diagnostic, and curative services, which collectively contribute to improved health outcomes. The results suggest that local governments should prioritize the recruitment and retention of healthcare professionals to sustain HDI improvements. This recommendation is particularly relevant given the regency's current shortage of healthcare personnel, especially in specialized areas such as dentistry and pharmacy, as highlighted by previous research (Hamdan, 2019).

Similarly, the positive impact of educational infrastructure emphasizes the need for continued investment in schools and educational facilities. Expanding access to education,

especially in rural areas, is crucial for improving literacy rates and increasing years of schooling, both of which are directly tied to human development. The significant relationship between educational infrastructure and HDI in this study highlights the effectiveness of policies aimed at increasing the availability of educational resources, such as the construction of new schools and the upgrading of existing facilities. Future policy interventions should focus on improving both the quantity and quality of educational infrastructure to foster sustainable human capital development in the region.

The non-significant effect of non-food per capita expenditure is an unexpected finding, suggesting that household spending patterns may not directly influence human development outcomes in the context of Humbang Hasundutan. While non-food expenditure is generally considered an indicator of disposable income and living standards, its lack of significance in this study indicates that other factors, such as food security and basic needs, may take precedence in influencing HDI. This finding opens avenues for future research to explore the complex interactions between income, expenditure patterns, and human development, particularly in rural and economically disadvantaged regions.

3.5 Policy Implications

The results of this study have important policy implications for local governments in Humbang Hasundutan Regency and similar rural areas. First, increasing the healthcare workforce and improving educational infrastructure should be top priorities for policymakers aiming to enhance HDI. Investment in these sectors will likely yield long-term benefits by improving health outcomes and educational attainment, both of which are critical for overall socio-economic development.

Additionally, the findings suggest that while non-food expenditure may not have a direct impact on HDI, policies aimed at increasing household income and reducing poverty could indirectly contribute to improved human development. Future development strategies should consider a holistic approach that addresses both basic needs and broader socio-economic factors, such as employment opportunities, income distribution, and social safety nets.

4. Conclusion and Recommendations

This study analyzed the impact of healthcare workforce, educational infrastructure, and non-food per capita expenditure on the Human Development Index (HDI) in Humbang Hasundutan Regency, North Sumatra. The results demonstrate that both the healthcare workforce and educational infrastructure have significant positive effects on HDI, affirming their critical roles in improving life expectancy and educational attainment—two key components of the HDI. Conversely, non-food per capita expenditure did not show a significant influence on HDI, suggesting that household spending patterns, particularly in a low-income context, do not directly drive human development outcomes in this region.

The findings underscore the importance of sustained investment in the healthcare and education sectors as a means of enhancing human development. The healthcare workforce, in particular, plays a pivotal role in improving access to essential health services, which directly contributes to increased life expectancy. Similarly, expanding educational infrastructure supports greater access to education, ultimately boosting literacy rates and years of schooling. These results highlight the need for policymakers to focus on strengthening these sectors to drive HDI improvements in Humbang Hasundutan.

While the role of non-food per capita expenditure was found to be non-significant, the study suggests that other socio-economic factors, such as income distribution and poverty reduction, may be more pertinent to improving living standards in the region. This indicates that a more holistic approach to development, one that includes addressing both basic needs and broader economic inequalities, is necessary for achieving sustainable human development.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. **Increase Investment in Healthcare Workforce**:

   To sustain improvements in HDI, the local government of Humbang Hasundutan should prioritize the recruitment and retention of healthcare personnel. Special attention should be given to addressing shortages in specialized fields such as dentistry, pharmacy, and nutrition. Expanding healthcare coverage will ensure that residents have consistent access to essential health services, which will contribute to longer life expectancy and improved overall health outcomes.

2. **Expand and Enhance Educational Infrastructure**:

   The significant impact of educational infrastructure on HDI highlights the need for continued investment in education. Policymakers should focus on constructing new schools, upgrading existing facilities, and improving access to quality education, especially in remote and underserved areas. This will enhance literacy rates and increase the number of years spent in formal education, both of which are crucial for human capital development.

3. **Adopt a Holistic Approach to Poverty Reduction**:

   Although non-food per capita expenditure did not have a direct effect on HDI, broader socio-economic policies aimed at reducing poverty and improving income distribution could indirectly enhance human development. The local government should implement programs that boost employment opportunities and provide social safety nets to support the most vulnerable populations. Such measures could raise overall living standards, creating an environment conducive to improved health and education outcomes.

4. **Incorporate Additional Variables in Future Research**:

   To gain a more comprehensive understanding of the factors influencing HDI in rural regions, future studies should consider incorporating additional variables such as government spending, private sector investment, and infrastructure development. Examining these factors could provide deeper insights into the complex interactions between economic, social, and environmental variables in shaping human development.

5. **Strengthen Public-Private Partnerships**:

   Collaboration between the public sector and private enterprises can be instrumental in improving both healthcare and educational infrastructure. The government should seek partnerships with private companies to co-fund health and education initiatives, especially in regions with limited public resources. Such partnerships can accelerate development and ensure the sustainability of essential services.

6. **Monitor and Evaluate Policy Implementation**:

   To ensure that investments in healthcare and education yield the desired outcomes, it is essential to establish monitoring and evaluation systems. Regular assessments of policy effectiveness will allow for timely adjustments and ensure that interventions are responsive to the evolving needs of the population.

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