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Research Article

Multidimensional Energy Poverty (MEP) among Older Adults in Indonesia: Descriptive Evidence and Correlation Analysis

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ABSTRAK

Indonesia's rapidly ageing population faces an increasing risk of multidimensional energy poverty (MEP) due to limited household resources and persistent disparities in infrastructure and energy access. This study provides a descriptive and correlational assessment of MEP among individuals aged 60 years and above using pooled data from the 2019–2021 National Socio-Economic Survey (Susenas). An individual-level MEP index is constructed following the Alkire–Foster counting methodology across six dimensions: cooking, lighting, household appliances, education and entertainment, communication, and travel. At the conventional deprivation cutoff (k = 0.3), 72.0% of the 356,611 elderly individuals in the pooled sample are classified as multidimensionally energy poor. Descriptive comparisons show that MEP is most strongly associated with lower household expenditure, fewer years of schooling, rural residence, limited access to tap water, and lower rates of migration and land ownership, whereas house ownership is not significantly associated with MEP. Correlation analysis further identifies three broad patterns of association among the explanatory variables, corresponding to household roles, socioeconomic development, and asset ownership, while indicating no evidence of severe multicollinearity. Overall, household economic resources, educational attainment, and access to basic infrastructure emerge as the characteristics most strongly associated with MEP among Indonesia's elderly population. These findings provide an accessible and easily replicable evidence base for identifying vulnerable groups and may inform the targeting of energy assistance programmes and the implementation of Indonesia's Gender Equality, Disability, and Social Inclusion (GEDSI) agenda.

Kata Kunci: *Correlation analysis, Descriptive statistics, Elderly, Indonesia, Multidimensional energy poverty, Susenas*

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Introduction

Indonesia is undergoing a rapid demographic transition toward an aging society. The elderly population reached 29.3 million people, accounting for 10.82 percent of the total population in 2021, and is projected to approach one-fifth of the population by 2045. Despite this demographic shift, many older Indonesians remain economically vulnerable. Approximately 43.29 percent belong to households in the bottom 40 percent of the national expenditure distribution, limiting their ability to access modern energy services. This vulnerability is reflected in the continued reliance of many elderly households on traditional cooking fuels, such as firewood and charcoal, which are widely recognized as indicators of energy deprivation. As population aging accelerates, understanding the extent and determinants of multidimensional energy poverty among older Indonesians becomes increasingly important for designing effective social protection policies, improving energy access, and better targeting energy subsidy programs.

Because single indicators, such as access to clean cooking fuels or household energy expenditure, capture only one dimension of energy deprivation, this study adopts a multidimensional energy poverty (MEP) framework based on the Alkire–Foster counting approach to multidimensional poverty measurement (Alkire & Foster, 2011), as adapted to the energy context by Nussbaumer et al. (2012). This framework provides a more comprehensive assessment of household energy deprivation by simultaneously considering multiple dimensions of energy access and use.

Using nationally representative data from Indonesia's National Socioeconomic Survey (Susenas), this study provides a comprehensive descriptive profile of multidimensional energy poverty among older adults. It examines the distribution of MEP across individual, household, and regional characteristics and explores the correlations between MEP and these characteristics, as well as the interrelationships among the explanatory variables. By documenting these empirical patterns, the study contributes to a better understanding of energy deprivation among older Indonesians and provides evidence to support the design of more targeted social protection and energy access policies in an aging society.

Descriptive and correlational analyses provide an informative first step in understanding multidimensional energy poverty among older adults. By summarizing the distribution of MEP across population groups and examining the bivariate relationships between MEP and key individual, household, and regional characteristics, these approaches offer a clear empirical profile of energy deprivation that is readily interpretable by researchers, policymakers, and practitioners. They also provide a practical basis for routine monitoring as new rounds of nationally representative survey data become available.

Because the analysis focuses on descriptive patterns and bivariate associations, the findings should be interpreted as evidence of statistical relationships rather than causal effects or independently adjusted associations. This distinction is acknowledged throughout the paper, and the results are presented to identify groups that may warrant closer attention in future research and policy interventions.

The contribution of this study is threefold. First, it provides an updated, individual-level descriptive profile of multidimensional energy poverty (MEP) among older adults in Indonesia using nationally representative survey data. Second, it presents a systematic correlation analysis of the relationships between MEP and a broad set of sociodemographic, household, and regional characteristics, while also examining the interrelationships among these characteristics. Third, it offers an empirical evidence base for identifying population groups that are more likely to experience multidimensional energy poverty, thereby supporting the development of more targeted social protection and energy access policies in the context of Indonesia's rapidly aging population.

Literature Review

Measuring multidimensional energy poverty

Energy poverty has traditionally been measured using single indicators, such as the share of household expenditure devoted to energy, physical access to electricity, or reliance on solid cooking fuels. This perspective was formalized in the United Kingdom through the

Hills (2011) review of fuel poverty. While these indicators are useful for capturing specific aspects of energy deprivation, they provide only a partial picture of households' energy conditions because they do not account for the multiple ways in which inadequate energy access may affect daily life.

To address this limitation, Alkire and Foster (2011) proposed a counting-based methodology for multidimensional poverty measurement that identifies the poor using two thresholds: a deprivation cut-off within each dimension and a poverty cut-off based on the weighted combination of multiple deprivations. Building on this framework, Nussbaumer et al. (2012) introduced the Multidimensional Energy Poverty Index (MEPI), which measures deprivation across several dimensions of household energy services, including cooking, lighting, household appliances, entertainment and education, communication, and mobility. Since its introduction, the MEPI framework has been widely applied in both developed and developing countries, including India (Sadath & Acharya, 2017), the Philippines (Mendoza et al., 2019), and Indonesia.

In Indonesia, Rizal et al. (2024) constructed a household-level MEPI using Susenas data for 2014 and 2018 and found that although the incidence of multidimensional energy poverty declined over time, its intensity remained substantial. Their study also documented considerable variation across geographic regions and household characteristics, particularly the gender, education, and employment status of the household head. Sambodo and Novandra (2019) similarly reported pronounced regional disparities in energy poverty and highlighted their implications for household welfare. Complementing these multidimensional studies, Saputri et al. (2024) employed a single-indicator accessibility measure using Susenas data from 2015–2019 and showed that energy poverty was more prevalent among households with lower expenditure, smaller dwelling size, larger family size, female household heads, and lower educational attainment. More broadly, the energy ladder literature suggests that households move from traditional to cleaner energy sources gradually as their economic conditions improve, although this transition remains uneven across socioeconomic groups (Hanna & Oliva, 2015). Collectively, these studies demonstrate that multidimensional approaches provide a more comprehensive assessment of household energy deprivation than single-indicator measures and are therefore better suited to capturing the complexity of energy poverty.

Energy poverty among older populations

Research on energy poverty among older adults has expanded considerably over the past decade, with growing evidence that energy deprivation has important implications for health, wellbeing, and quality of life. In Australia, Fry et al. (2022) found that retirees relying primarily on public pensions face a substantially higher risk of multidimensional energy poverty than self-funded retirees, even after accounting for differences in income. Other Australian studies have shown that energy poverty is associated with poorer self-assessed health (Awaworyi Churchill & Smyth, 2021) and lower subjective wellbeing among older adults (Awaworyi Churchill et al., 2020). Similar findings have been reported in the United Kingdom, where fuel poverty has been linked to adverse health outcomes among older people, particularly in colder local climates (De Vries & Blane, 2013).

Evidence from Asia also points to important welfare consequences of energy deprivation in later life. In China, multidimensional energy poverty has been associated with higher risks of depression and lower life satisfaction among older adults (Hou et al., 2022; Li et al., 2022), while household energy poverty has been linked to poorer physical and mental health more generally (Zhang, Li, & Han, 2019; Zhang, Shu, Yi, & Wang, 2021). In Poland, Piekut (2021) reported that energy poverty among households headed by individuals aged 60 years and above is associated with lower overall life satisfaction. More broadly, studies on rural elderly populations in China have shown that multidimensional poverty is closely related to household composition, health status, access to credit, and the availability of basic amenities (Zhao et al., 2024), consistent with broader gerontological evidence that living arrangements and household resources are

important determinants of wellbeing in old age (Henning-Smith & Gonzales, 2020).

Compared with the growing international literature, evidence for Indonesia remains limited. Existing studies have largely focused on household-level energy poverty, while relatively little attention has been given to older adults as a distinct population group. This gap is particularly important because Indonesia is undergoing rapid population aging, and many older people remain economically vulnerable. Employment continues to be an important source of livelihood in later life, as only 11.62 percent of older Indonesians receive social security benefits and only 8.70 percent receive a pension. Previous evidence suggests that older adults' decisions to remain economically active are shaped by both financial necessity and their relationship with subjective wellbeing (Jamalludin, 2020).

The existing literature provides valuable insights into the measurement of multidimensional energy poverty and its associations with socioeconomic disadvantage and wellbeing. Nevertheless, evidence focusing specifically on older Indonesians remains scarce. Moreover, while previous studies have primarily emphasized the prevalence or determinants of household energy poverty, less attention has been devoted to providing a comprehensive descriptive profile of multidimensional energy poverty among the elderly and examining how it is associated with individual, household, and regional characteristics. Addressing this gap, the present study uses nationally representative Susenas data to describe the distribution of multidimensional energy poverty among older adults in Indonesia and to examine its correlations with key sociodemographic, household, and regional characteristics. Rather than estimating causal effects, the study documents empirical patterns that can support future research and inform policies aimed at improving energy access and social protection for Indonesia's rapidly growing elderly population.

Data and Methods

Data

This study uses data from the National Socioeconomic Survey (Survei Sosial Ekonomi Nasional, Susenas) conducted annually by Statistics Indonesia (BPS). To improve the precision of the estimates and increase the sample size of the elderly population, data from the 2019, 2020, and 2021 survey rounds are pooled. The analysis is restricted to individuals aged 60 years and above residing in Indonesia's 34 provinces, resulting in an analytical sample of 356,611 older adults.

Constructing the MEP index

The dependent variable is multidimensional energy poverty (MEP), constructed using the Alkire–Foster counting methodology (Alkire & Foster, 2011) as adapted to the energy context by Nussbaumer et al. (2012). The index captures deprivation across six dimensions of household energy services: cooking, lighting, household appliances, education and entertainment, communication, and mobility. Following the standard MEPI approach, each individual receives a weighted deprivation score based on these dimensions. Individuals with a deprivation score of 0.30 or higher are classified as multidimensionally energy poor (MEP = 1), while those below the threshold are classified as non-MEP (MEP = 0).

Analytical Approach

The analysis combines descriptive and correlational methods to provide a comprehensive empirical profile of multidimensional energy poverty among older Indonesians.

First, descriptive statistics are presented to summarize the characteristics of the study population. Differences between older adults classified as MEP and non-MEP are then assessed using two-sample t-tests for twelve individual, household, and regional characteristics: gender, marital status, years of schooling, migration history, household size, household headship, access to drinking water, log per capita expenditure, house ownership, land ownership, urban–rural residence, and region elevation. These comparisons provide an initial assessment of whether the characteristics of elderly individuals differ systematically according to their MEP status.

Second, Pearson correlation coefficients are calculated among the explanatory variables to examine the strength and direction of their pairwise relationships. Besides describing how individual, household, and regional characteristics are associated with one another, these

correlations also provide a preliminary assessment of potential multicollinearity that may be relevant for future multivariate analyses.

Finally, because MEP is measured as a binary variable, point-biserial correlation coefficients are estimated to examine the bivariate association between MEP status and each explanatory variable. The point-biserial correlation is mathematically equivalent to Pearson's correlation when one variable is dichotomous, making it an appropriate measure for assessing the strength and direction of the association between multidimensional energy poverty and each individual, household, and regional characteristic. All analyses are conducted using the pooled individual-level Susenas data for the period 2019–2021.

Results

Descriptive Statistics

The pooled sample comprises 356,611 elderly individuals, of whom 256,837 (72.0 percent) are classified as multidimensionally energy poor at the k = 0.3 deprivation cut-off, indicating that multidimensional energy poverty is widespread among Indonesia's older population. Descriptive statistics further show that 52.3 percent are female, 50.8 percent report working, and the average educational attainment is 5.6 years of schooling. In addition, 60.9 percent are household heads, 40.9 percent reside in urban areas, and the mean log of per-capita household expenditure is 13.73. Elderly individuals classified as MEP have substantially less schooling, lower expenditure, lower rates of tap water access and land ownership, and are far more likely to live in rural areas at higher elevation. They are also more likely to be female and less likely to be married or to have ever migrated. House ownership is the one variable that does not differ meaningfully between poor and non-poor elderly (p = 0.07).

Table1. Summary Statistics of Main Variables and Comparison of Mean by MEP Condition

Variable	MEP = 0	MEP = 1	Difference	t-stat
Gender (%)	44.4	55.3	-10.8***	-58.46
Married (%)	68.8	58.4	10.4***	57.30
Years of schooling	8.47	4.47	4.00***	284.43
Ever migrated (%)	37.9	17.7	20.1***	130.49
Household size	4.09	3.49	0.60***	79.83
Household head (%)	62.5	60.3	2.2***	12.30
Tap water access (%)	60.5	28.6	31.9***	185.16
Log per-capita expenditure	14.20	13.55	0.66***	303.76
House ownership (%)	92.8	92.9	-0.2 (n.s.)	-1.81
Land ownership (%)	65.0	47.9	17.1***	92.97
Urban residence (%)	64.9	31.6	33.3***	190.45
Elevation (m)	133.3	155.7	-22.4***	-22.54
Observations	99,774	256,837		

Source: Susenas 2019-2021, BPS

Correlation Analysis

Table 2 presents the Pearson correlation matrix for the thirteen explanatory variables. The matrix summarizes the pairwise associations among the explanatory variables and does not include multidimensional energy poverty (MEP) status. It therefore serves two purposes: first, to describe how individual, household, and regional characteristics are associated within the elderly population in Indonesia; and second, to assess the potential presence of multicollinearity should these variables be incorporated into future multivariate analyses.

No pairwise correlation coefficient exceeds the conventional threshold of |r| = 0.60, suggesting that multicollinearity among the explanatory variables is unlikely to pose a concern. Overall, the correlation matrix indicates that the explanatory variables are associated in three broad dimensions, corresponding to household roles, socioeconomic conditions, and asset ownership.

Table 2. Pearson Correlation Matrix for the Explanatory Variables

Variable	gender	work	yos	marriage	migr.	number	hhead	water	logcap.	house	land	area	elev.
gender	1.00	-0.32	-0.19	-0.41	-0.05	-0.04	-0.57	0.00	-0.03	-0.02	-0.03	0.01	0.00
work	-0.32	1.00	-0.02	0.25	-0.05	-0.08	0.31	-0.11	-0.04	0.03	-0.03	-0.14	0.05
yos	-0.19	-0.02	1.00	0.17	0.20	0.02	0.14	0.24	0.40	-0.02	0.13	0.27	0.05
marriage	-0.41	0.25	0.17	1.00	0.04	0.07	0.01	-0.02	-0.02	0.06	0.06	-0.02	0.01
migr.	-0.05	-0.05	0.20	0.04	1.00	-0.02	0.04	0.16	0.24	-0.06	0.08	0.17	-0.08
number	-0.04	-0.08	0.02	0.07	-0.02	1.00	-0.25	0.05	-0.26	0.01	0.03	0.03	-0.05
hhead	-0.57	0.31	0.14	0.01	0.04	-0.25	1.00	-0.01	0.11	0.01	0.00	0.01	0.01
water	0.00	-0.11	0.24	-0.02	0.16	0.05	-0.01	1.00	0.30	-0.07	0.09	0.34	-0.07
logcap.	-0.03	-0.04	0.40	-0.02	0.24	-0.26	0.11	0.30	1.00	-0.01	0.13	0.27	0.01
house	-0.02	0.03	-0.02	0.06	-0.06	0.01	0.01	-0.07	-0.01	1.00	0.29	-0.09	-0.02
land	-0.03	-0.03	0.13	0.06	0.08	0.03	0.00	0.09	0.13	0.29	1.00	0.09	-0.07
area	0.01	-0.14	0.27	-0.02	0.17	0.03	0.01	0.34	0.27	-0.09	0.09	1.00	-0.04
elev.	0.00	0.05	0.05	0.01	-0.08	-0.05	0.01	-0.07	0.01	-0.02	-0.07	-0.04	1.00

Source: Susenas 2019-2021

The first pattern pertains to **household roles and demographic characteristics**. Gender exhibits a strong negative correlation with household headship (r = −0.57) and moderate negative correlations with marital status (r = −0.41) and working status (r = −0.32). These associations indicate that elderly women are less likely than elderly men to be household heads, currently married, or economically active. In addition, household headship is moderately positively correlated with working status (r = 0.31) and negatively correlated with household size (r = −0.25), suggesting that household heads are more likely to remain economically active while residing in relatively smaller households.

The second pattern reflects **socioeconomic development and access to basic services**. Years of schooling, log per-capita household expenditure, access to tap water, and urban residence are all moderately and positively correlated, with coefficients ranging from 0.24 to 0.40. The strongest associations are observed between years of schooling and household expenditure (r = 0.40), and between access to tap water and urban residence (r = 0.34). These relationships are consistent with the tendency for educational attainment, economic well-being, and access to basic infrastructure to co-occur within the elderly population.

The third pattern relates to **asset ownership**. House ownership and land ownership are moderately positively correlated (r = 0.29), while exhibiting only weak associations with the broader socioeconomic-development variables. This finding suggests that ownership of physical assets represents a distinct dimension of household welfare that is not fully captured by current income, educational attainment, or residential location.

Taken together, the correlation matrix indicates that the explanatory variables capture related but conceptually distinct aspects of individual, household, and regional characteristics. The absence of high pairwise correlations further supports the suitability of these variables for subsequent multivariate analyses, should such analyses be undertaken.

Bivariate Correlation with MEP Status

Table 3 presents the point-biserial correlation coefficients between each explanatory variable and multidimensional energy poverty (MEP) status. All correlations are statistically significant at the 1% level, with the exception of house ownership (p = 0.070), which exhibits no statistically significant association with MEP. This finding is consistent with the descriptive comparison reported in Table 1.

Table 3. Bivariate (Point-Biserial) Correlation with MEP Status

Variable	*r* with MEP	Significance
Log per-capita expenditure	-0.4534	p < 0.001
Years of schooling	-0.4300	p < 0.001
Urban residence	-0.3038	p < 0.001
Tap water access	-0.2962	p < 0.001
Ever migrated	-0.2135	p < 0.001
Land ownership	-0.1538	p < 0.001
Household size	-0.1325	p < 0.001
Female	0.0974	p < 0.001
Married	-0.0955	p < 0.001
Working status	0.0572	p < 0.001
Elevation	0.0377	p < 0.001
Household head	-0.0206	p < 0.001
House ownership	0.0030	p = 0.070 (n.s.)

Source : Susenas 2019-2021

Note. N = 356,611. MEP = multidimensional energy poverty status (1 = energy poor, k = 0.3 cut-off; 0 = not energy poor). Point-biserial correlation coefficients are reported for each variable's association with MEP status. n.s. = not statistically significant.

The results indicate that economic and human-capital characteristics are most strongly associated with MEP. Log per-capita household expenditure (r = −0.4534) and years of schooling (r = −0.4300) exhibit the largest negative correlations, suggesting that elderly who living in wealthier and more educated households are substantially less likely to experience multidimensional energy poverty. Infrastructure-related characteristics also show relatively strong negative associations, with urban residence (r = −0.3038) and access to tap water (r = −0.2962) both associated with a lower likelihood of MEP.

Moderate negative correlations are observed for migration experience (r = −0.2135), land ownership (r = −0.1538), and household size (r = −0.1325), indicating that these characteristics are also linked to a lower prevalence of energy poverty, although to a lesser extent. In contrast, demographic characteristics exhibit comparatively weak associations with MEP. Female elderly individuals are slightly more likely to experience MEP (r = 0.0974), whereas being married is weakly associated with a lower probability of MEP (r = −0.0955). Working status (r = 0.0572), elevation (r = 0.0377), and household headship (r = −0.0206) display only weak correlations, while house ownership shows no statistically significant relationship with MEP.

Overall, the point-biserial correlations suggest that household economic resources, educational attainment, and access to basic infrastructure are more strongly associated with multidimensional energy poverty among Indonesia's elderly than demographic or household-role characteristics. These findings provide a useful descriptive ranking of the variables most closely associated with MEP, while recognizing that correlation measures association rather than causal relationships.

Discussion

The descriptive and correlational evidence presented in this study provides a coherent picture of the factors associated with multidimensional energy poverty among Indonesia's elderly population. Economic resources and human capital exhibit the strongest associations with MEP, followed by access to basic infrastructure and urban–rural location. Migration experience, land ownership, household composition, and demographic characteristics display comparatively weaker, although generally statistically significant, associations. This pattern is broadly consistent with previous evidence from Indonesia (Rizal et al., 2024; Saputri et al., 2024; Sambodo & Novandra, 2019) and with international studies showing that household socioeconomic conditions constitute the primary correlates of energy poverty among

older populations (Fry et al., 2022; Zhao et al., 2024).

These findings should, however, be interpreted within the scope of descriptive and correlational analysis. Correlation coefficients quantify the strength and direction of bivariate associations but do not establish causal relationships or isolate the independent contribution of individual characteristics. Consequently, the observed associations may partly reflect the influence of other correlated socioeconomic, household, or geographic factors. The results should therefore be interpreted as identifying characteristics that are systematically associated with MEP rather than as evidence of causal determinants.

From a policy perspective, the findings suggest that elderly individuals living in economically disadvantaged households, with lower educational attainment, limited access to basic infrastructure, and residence in rural areas constitute the groups most strongly associated with multidimensional energy poverty. These characteristics may therefore provide useful descriptive indicators for identifying vulnerable populations and informing the design of inclusive energy policies within Indonesia's energy transition and Gender Equality, Disability, and Social Inclusion (GEDSI) agenda. Nevertheless, establishing the relative importance or causal effects of these characteristics requires further multivariate and causal analyses beyond the scope of the present study.

Conclusion

This study provides a descriptive and correlational profile of multidimensional energy poverty (MEP) among Indonesia's elderly population using nationally representative data from the 2019–2021 National Socio-Economic Survey (Susenas). The findings indicate that 72.0% of elderly individuals are classified as multidimensionally energy poor at the conventional deprivation cut-off (k = 0.3), highlighting the widespread nature of energy deprivation among older Indonesians.

The descriptive and correlational analyses consistently show that household economic resources, educational attainment, and access to basic infrastructure are the characteristics most strongly associated with MEP. Elderly individuals living in households with lower per-capita expenditure, fewer years of schooling, limited access to tap water, and residence in rural areas exhibit a substantially higher prevalence of multidimensional energy poverty. In contrast, demographic characteristics such as gender, marital status, and household roles display comparatively weaker associations. The correlation matrix further indicates that the explanatory variables capture distinct dimensions of individual, household, and regional characteristics, with no evidence of severe multicollinearity.

These findings contribute to the growing literature on energy poverty by providing a comprehensive descriptive assessment of the characteristics associated with MEP among Indonesia's ageing population. From a policy perspective, the results suggest that interventions aimed at improving household economic conditions, expanding educational opportunities, and strengthening access to basic infrastructure may be particularly relevant for reducing energy deprivation among older adults. Moreover, the identified correlates may serve as useful descriptive indicators for identifying vulnerable populations and informing the implementation of Indonesia's energy transition and Gender Equality, Disability, and Social Inclusion (GEDSI) agenda.

Several limitations should be acknowledged. As a descriptive and correlational study, the analysis identifies statistical associations rather than causal relationships, and the observed correlations may reflect the influence of unobserved or correlated factors. In addition, the cross-sectional nature of the pooled Susenas data precludes an examination of changes in energy poverty over time. Future research could extend this work by employing multivariate or causal inference approaches to estimate the independent effects of individual, household, and regional characteristics on MEP, as well as by using longitudinal or qualitative data to better understand the pathways through which these characteristics influence energy deprivation among older Indonesians.

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