Jejak Vol 17 (2) (2024): 43-51 DOI: https://doi.org/10.15294/jejak.v17i2.4551

JEJAK

Journal of Economics and Policy

http://journal.unnes.ac.id/nju/index.php/jejak

Measuring the intensity of smoking behavior among beneficiaries of subsidized health insurance: Item Response Theory (IRT) Analysis

Rizki Wibias Anwar Maulida[1]✉ , Rus'an Nasrudin[2]

[1]Faculty of Economics and Business, University of Indonesia, Jakarta
[2]Faculty of Economics and Business, University of Indonesia, Depok

Permalink/DOI: https://doi.org/10.15294/jejak.v17i2.4551

Received: 8 May 2024; Accepted: 8 Agustus 2024; Published: 15 September 2024

Abstract

The absence of sufficient income leaves the impoverished and near-poor particularly susceptible to economic shocks, yet they encounter significant barriers in accessing the health insurance market. The government introduced the Health Premium Assistance for the Poor and Near-Poor (Askeskin) program on January 1, 2005, to address this issue. However, individuals with lower socioeconomic status are disproportionately likely to smoke. Therefore, it is imperative to conduct screening and assess smoking intensity, particularly among those facing economic hardships, to effectively address smoking behavior. To assess the severity of smoking habits among beneficiaries of subsidized health insurance (Askeskin), this study utilized data from the IFLS survey and applied Item Response Theory (IRT). IRT facilitates the development of highly precise measurement tools that accurately capture variations in an individual's health and well-being. The findings indicate that this scale serves as a suitable instrument for examining heavy smoking intensity in research endeavors, particularly within the Indonesian context.

Key words : IRT, Askeskin, smoking behavior, IFLS, poverty

How to Cite : Maulida, R. W. A. & Nasrudin, R. (2024). Measuring the intensity of smoking behavior among beneficiaries of subsidized health insurance: Item Response Theory (IRT) Analysis. JEJAK: Jurnal Ekonomi dan Kebijakan. Doi: https://doi.org/10.15294/jejak.v17i2.4551

✉ Corresponding author : Rizki Wibias Anwar Maulida
Address: Bintara Alam Permai, Bintara Jaya, West Bekasi, Bekasi City, West Java
E-mail: rizkivicena@gmail.com

p-ISSN 1979-715X
e-ISSN 2460-5123

INTRODUCTION

The absence of sufficient income renders the poor and near-poor segments of society particularly susceptible to economic upheavals while simultaneously limiting their access to essential healthcare coverage. In response, the government initiated the Health Insurance for the Poor and Near-Poor (Askeskin) program on January 1, 2005, aiming to offer health premium assistance to these vulnerable groups. By subsidizing health insurance, the government seeks to empower the impoverished to enhance their well-being and productivity, facilitating their escape from poverty, while also providing a safety net for those teetering on the brink of economic instability.

In 2019, the Health Social Fund (DJS Kesehatan) faced a persistent deficit in its net assets, reaching a peak of Rp51 trillion. This deficit arises from an imbalance between the premium contributions received from participants and the claims issued for healthcare services provided. To address this challenge, the government enacted Presidential Regulation 82 of 2018 and Presidential Regulation 64 of 2020, which involved raising insurance premium rates.

Table 1. Participants and Income of BPJS from the JKN-PBI APBN Segment

JKN-PBI APBN	2016	2017	2018	2019	2020	2021
Number of Participants	91,099,279	92,380,352	92,107,598	96,516,666	96,600,414	99,947,748
BPJS Income (in million rupiah)	24,814,948	25,362,816	25,492,043	35,777,143	48,624,945	46,997,008

Source: DJSN - BPJS Kesehatan, 2022

From a revenue standpoint, Table 1 indicates a significant increase in BPJS income from the JKN-PNI segment, primarily fueled by government subsidies. Consequently, there has been a notable surge in the subsidies allocated by the government from 2019 to 2020. This underscores the direct correlation between the expansion of JKN PBI coverage and the corresponding increase in government subsidies, alongside the escalation of insurance premiums. However, it is imperative to minimize any rise in insurance premiums as it could adversely affect the government's fiscal position.

In terms of expenses, a significant portion of BPJS Kesehatan's costs can be attributed to medical expenses linked to smoking-related diseases, constituting a major portion of the overall expenditure (Hindarti, 2022). The act of cigarette smoking increases the risk of various types of cancer incidents. Smoking more than 20 cigarettes per day significantly contributes to the incidence of malignant cancers (Hartono et al., 2019).

However, statistics reveal a troubling trend: between 2012 and 2017, the prevalence of smoking among males was alarmingly high in lower socioeconomic strata. In fact, the rates stood at 82% in the lowest quintile, 77.1% in the lower-middle quintile, 73.3% in the middle quintile, and 70.2% in the upper-middle class, gradually declining to 58.4% in the top quintile (TCSC-IAKMI, 2020). This data underscores a correlation between lower economic status and heightened tobacco consumption. Hence, it is imperative to implement proactive measures like screening and monitoring the intensity of smoking behavior, particularly within economically disadvantaged communities. This approach not only aims to curb this harmful habit and its associated health risks but also seeks to improve their overall well-being and productivity.

To examine smoking behavior among recipients of the Askeskin program, this study utilized data from the Indonesian Family Life Survey (IFLS), a renowned longitudinal survey known for capturing demographic, socio-economic, educational, and health-related information. Covering 83 percent of the Indonesian population, the IFLS provides a comprehensive dataset necessary for this investigation. The analysis focused on individual smoking behavior, drawing from Book 3B section KM, which includes variables such as cigarette consumption, weekly expenditure on cigarettes, year of smoking initiation, and other pertinent factors. Additionally, the possession of subsidized health insurance was assessed using data from Book 3B section AK.

Several recent studies have delved into smoking behavior across both developing and developed countries. Hindarti (2022) employed the use of a dummy variable termed "smoking status," while Putra (2020) and Asyary & Veruswati (2023) examined variables such as "Average cigarette consumption/day" and "Average cigarette expenditure/week". Furthermore, active smoking presents multifaceted challenges across various aspects of life, significantly impacting the economic well-being of households. Asyary & Veruswati (2023) discovered that one-third of household income is allocated to smoking, and individuals who engage in smoking are also more susceptible to financial stress, as evidenced by occurrences such as skipping meals or struggling to pay rent.

Likewise, among smokers, a greater expenditure on cigarettes correlates with an increased likelihood of experiencing financial stress (Siahpush et al., 2018). Hence, it is vital to evaluate the proportion of individual cigarette expenditures within households. From a health standpoint, an elevated smoking index emerges as a notable risk factor for intracranial aneurysm rupture (IAR). This highlights the necessity of assessing the individual smoking index.

Based on the provided explanation, five variables of interest will be employed to evaluate the intensity of smoking behavior among beneficiaries of subsidized health insurance (Askeskin): Smoking Status ($Yi0$), Average cigarette consumption/day ($Yi1$), Average cigarette expenditure/week ($Yi2$), Cigarette expenditure/total expenditure ($Yi3$), and Smoking index ($Yi4$). These variables have been carefully chosen to illustrate the level of smoking intensity in individuals, utilizing the Item Response Theory (IRT) method. IRT comprises a series of mathematical models that analyze item responses by considering the attributes of both examinees and items (Feuerstahler et al., 2020).

Originally developed for designing, constructing and evaluating for educational and psychological test (Hambleton et al., 1991), IRT has evolved into an innovative approach in health outcome assessment. It enables the creation of highly precise measurement instruments capable of effectively capturing variations in someone's well-being, including health status, functional abilities, and overall quality of life over time or in response to medical interventions. Within the domain of measuring patient-reported outcomes, IRT facilitates the assessment of measurement precision tailored to each individual patient (Brown and Croudace, 2015). Importantly, this method offers more robust item parameter estimation than the classical test theory, by providing examinee sample dependent (Hambleton and Slater, 1997).

RESEARCH METHODS

This study focuses on analyzing data spanning multiple waves from 1997, 2000, 2007, and 2014. The primary variables under scrutiny are the subsidized health insurance status and smoking habits. The study targets individuals aged 15 and above belonging to the bottom four quintiles of households. For the investigation, a control group comprising 8,871 individuals was established, consisting of those who had never received treatment under the Askeskin program in 2007 and 2014. Additionally, a treatment group of 2,345 individuals was identified, comprising those consistently treated by Askeskin during the aforementioned years. The analysis was conducted utilizing STATA programming for robust statistical examination.

Item Response Theory (IRT), also known as Latent Trait Theory (LTT), is a statistical framework employed for analyzing and interpreting responses to test items. Unlike Classical Test Theory (CTT), which assumes a constant difficulty level for each item, IRT takes into account both item difficulty and an individual's ability level to yield more precise estimations of these characteristics. By depicting the connection between item properties and individual responses, IRT empowers us to draw conclusions about an individual's latent traits, such as their knowledge, skills, or attitudes. Using IRT, in theory, an individual should obtain a consistent estimate of their ability, irrespective of the test administered, while the statistics of items should remain consistent across various demographic groups (Stage, 2003).

The process involves the following steps: Firstly, utilizing data from smokers only to observe the average smoking intensity for individual smokers. Subsequently, generating and assigning values to the variable IRTYi0 - IRTYi4. A value of 1 is allocated to each Yi if it exceeds the mean, while a value of 0 is assigned if it is less than or equal to the mean. Next, merging the initial dataset to generate and allocate values for the variable IRTYi0 - IRTYi4 for non-smoking individuals, where all IRTYi0 - IRTYi4 values are set to 0. Following this, constructing both an item characteristic curve and a test characteristic curve. Finally, computing theta.

Subsequently, we obtain values for each question (IRTYi0 - IRTYi4), where a value of 1 signifies smoking intensity surpassing that of average smokers, and a value of 0 indicates smoking intensity lower than that of average smokers or non-smokers. We will utilize the one-parameter/Rasch model within the IRT framework for analysis.

$$P(X_{ij} = x_{ij}|\theta_i, b_j) = \frac{exp(x_{ij}(\theta_i - b_j)}{1+exp(\theta_i - b_j)} \quad (1)$$

Source: Anwar & Nasrudin, 2021

An application of the model to measure smoking intensity interprets the θi parameters as reflections of the severity of smoking associated with the experiences captured by the various questions (IRTYi0 - IRTYi4). The bj parameters gauge the level of smoking intensity experienced by individual i, while Xij represents the random variable denoting the response of the i-th individual (i = 1,..., I) to the j-th item (j = 1,..., J). The realization of each item's response for an individual is denoted by xij. Additionally, the indices 0, 1, 2, 3, and 4 correspond to: 0 – Having smoking habits, 1 - Average cigarette consumption per day, 2 - Average cigarette expenditure per week, 3 - Cigarette expenditure as a ratio of total expenditure, and 4 – Smoking index.

The Item Characteristic Curve (ICC) illustrates the relationship between the probability of a correct response and the latent trait level. A steeper ICC suggests stronger discrimination, while shifts in curves indicate changes in item difficulty.

Item difficulty refers to the skill level required for a 50% chance of answering the item correctly (Hambleton et al., 1991). The values of bj parameters vary from about -2.0 (very easy or low trait levels) to +2.0 (very difficult or high trait levels) (Hambleton et al., 1991). Items with high discrimination can effectively differentiate between individuals with different trait levels.

The study employed Item Response Theory (IRT) to calculate a reliability coefficient for assessing the scale's reliability. According to (Kim and Feldt, 2010), the reliability coefficient derived from IRT tests is typically higher compared to Classical Test Theory (CTT). Furthermore, unlike CTT, which is limited to the test and the specific group, IRT analysis provides reliability estimates for additional groups beyond those initially included in the dataset.

The Test Information Function (TIF) or Item Information Function (IIF) provides an evaluation of measurement accuracy across different trait levels. It illustrates the amount of information the test provides for estimating an individual's ability at a specific trait level. Higher TIF values indicate enhanced measurement precision, facilitating a more accurate assessment of individual abilities.

Feuerstahler et al. (2020) explained that the precision of measurement across trait abilities could be indexed by a function called the test information function. This function is graphically represented, with the y-axis denoting the information value and the x-axis representing participants' ability scores. It illustrates areas where ability provides the most information and identifies the range of ability within which the scale demonstrates reliability.

RESULTS AND DISCUSSION

The table 2 highlights item means ranging from 0.069 to 0.294, indicating a predominant score of 0. This suggests that the majority of individuals responded with a "No" to all items, implying a non-heavy smoker state for most respondents. Conversely, a response value of 1 indicates that the individual is a heavy smoker, implying they smoke more intensively than the average smoker. However, their representation within the distribution is relatively low. Standard deviations (SD) showed values between 0.25 and 0.45, indicating that the items were hard to agree upon and elicited a widespread response, respectively. From a subsample, almost all item means of the treatment group are higher than the control group (except for IRTYi2), indicating that individuals who receive subsidized health insurance are more of heavy smokers.

Table 2. Descriptive Statistics

	All			Control group			Treatment group		
Variables	N	mean	sd	N	mean	sd	N	mean	sd
IRTYi0	35,861	0.294	0.456	28,303	0.285	0.451	7,558	0.331	0.470
IRTYi1	35,861	0.170	0.375	28,303	0.169	0.374	7,558	0.173	0.378
IRTYi2	35,861	0.117	0.322	28,303	0.119	0.324	7,558	0.108	0.311
IRTYi3	35,851	0.0698	0.255	28,294	0.0640	0.245	7,557	0.0916	0.288
IRTYi4	35,861	0.114	0.318	28,303	0.112	0.315	7,558	0.122	0.327

Source: Author's Own Calculations

The table 3 shows that the item discrimination parameter for all items is 5.479, which classifies them as good items in discriminating participants above 1.35, as outlined by Baker (2001). This suggests that two individuals with different smoking intensities will have varying predicted probabilities for a given item. The IRT model utilizes theta values to represent latent traits for measurement. The results of the IRT indicate that the theta values range from 0.68 (IRTYi0) to 1.51 (IRTYi3). This implies that the IRTYi0 question (smoking status) is the easiest, while the IRTYi3 question (The ratio of cigarette expenditure to total expenditure) is the most challenging. A higher theta value indicates a stronger indication of heavy smoking. The visualization of the item locations on the difficulty spectrum can be observed on the ICC graph.

Table 3. IRT Analysis Result

One-parameter logistic model					Number of obs = 35,861	
Log likelihood = -50734.464						
	Coefficient	Std. err	z	P>|z|	[95% conf. interval]	
Discrim	5. 479288	0.0765705	71.56	0.000	5.329212	5.629363
Diff						
IRTYi0	0.6899945	0.0047917	144.00	0.000	0.6806029	0.6993861
IRTYi1	1.09786	0.0068188	161.01	0.000	1.084496	1. 111225
IRTYi2	1.297539	0.0081102	159.99	0.000	1.281643	0.313435
IRTYi4	1.309828	0.0082067	159.60	0.000	1.293743	1.325913
IRTYi3	1.513979	0.010139	149.32	0.000	0.494107	1.533851

Source: Author's Own Calculations

The Item Characteristic Curve (ICC) serves to determine the coefficient of determination, quantifying the relationship between affirming each item from IRTYi0 to IRTYi4 and the latent measure of the smoking intensity. Moreover, the ICC considers the difficulty level associated with each question, taking into account respondents' ability to answer the respective items. The difficulty of each item is discerned by its position on the curves. As depicted in the figure 1, the sequence of item difficulty follows the order of IRTYi0, IRTYi1, IRTYi2, IRTYi4, and IRTYi3, representing the correct arrangement from easiest to most challenging in the questionnaire. This ordering effectively mirrors the stages of severity in smoking intensity, with heavier smokers progressing through the questions accordingly. The fit of the ICC to the implied empirical trace line is observed to be satisfactory for IRTYi0 - IRTYi4, a trend consistent across all items in the model. This suggests that a 1PL model may be suitable for all items.

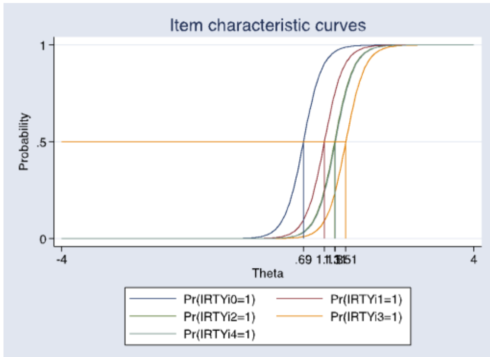


Figure 1. Item Characteristic Curve (ICC)

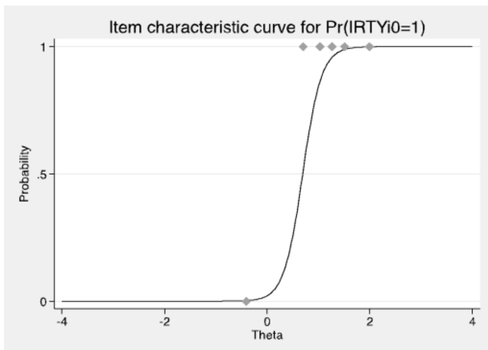


Figure 2. IIC for probability of IRTYi0=1

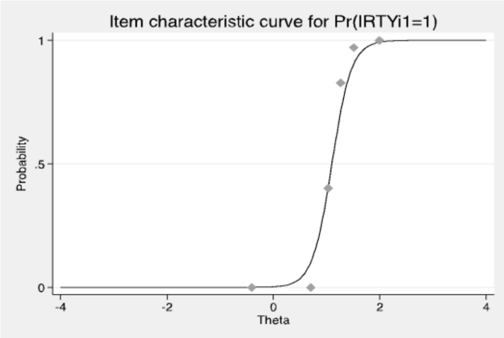


Figure 3. IIC for probability of IRTYi1=1

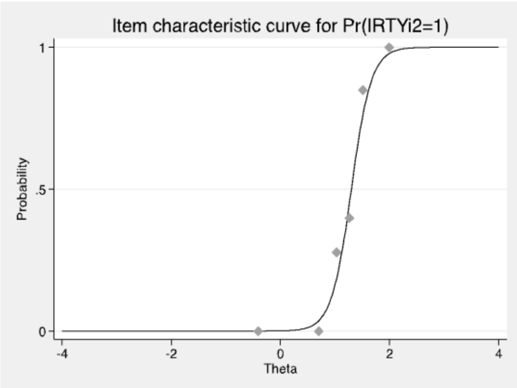


Figure 4. IIC for probability of IRTYi2=1

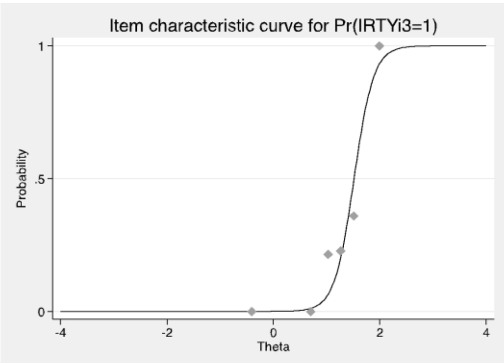


Figure 4. IIC for probability of IRTYi3=1

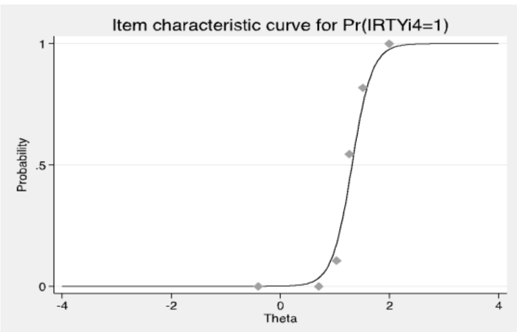


Figure 5. IIC for probability of IRTYi4=1

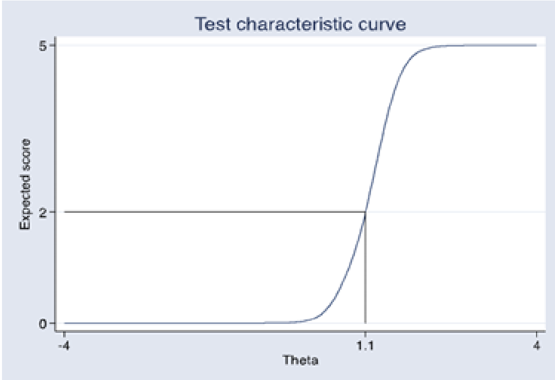
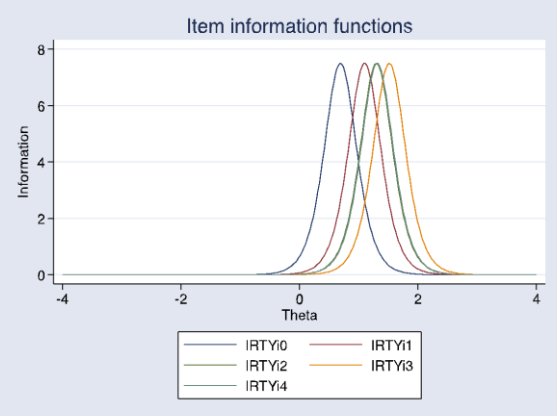


Figure 6. IRT Reliability Test

The total of the probabilities of all items provides us with the expected score for the entire test. A graphical representation of the expected score plotted against the latent trait is termed a test characteristic curve (TCC). As depicted in the figure 1, the TCCs reveal that individuals with a latent trait level of 1.1 or higher are anticipated to attain a score of 2 or higher on the test.

Amount of information that can be derived at various ability levels. As illustrated in the figure, the IIF graph reveals that all item-related information is in the positive segment of the latent trait (the higher end of the latent trait spectrum). The location of an IIF, and therefore the amount of information an item provides around the difficulty parameter, is proportional to the item's estimated discrimination. Each item provides ample information between abilities ranging from 0 to 2, suggesting its ability to differentiate individuals with moderate and severe levels of smoking behavior. This supports the notion that all items function effectively. As depicted in the figure 1, IRTYi3 is the most discriminating and occupies the rightmost position among the IIFs. The sum of all IIFs constitutes the TIF. The TIF plot indicates how well the instrument can estimate person locations.

7.1 Item Information Function (IIF)



7.2 Test Information Function (TIF)

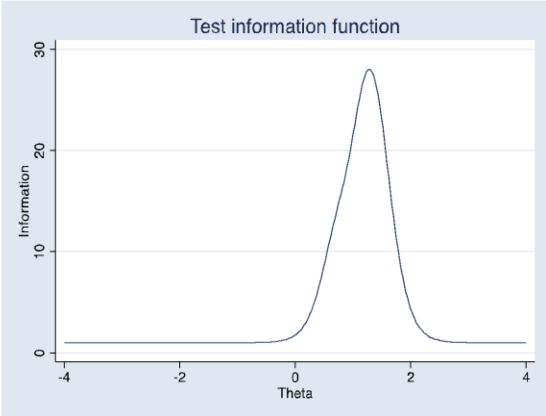


Figure 7. IRT Precision of Measurement test

To our knowledge, there is a scarcity of studies investigating the psychometric properties of smoking intensity traits in datasets such as IFLS. Hence, this study aims to elucidate the psychometric properties of the scale. Overall, the findings suggest that the scale exhibits robust psychometric properties for assessing symptoms of heavy smoking intensity traits within the Indonesian sample.

As this study utilizes data from IFLS 2-5, collected through a meticulous and comprehensive sampling procedure (Strauss et al., 2016), the findings can be generalized to Indonesian society. One of the novel ideas discussed in this study is the use of IRT model to measure the intensity of smoking behavior. However, this study also has some limitations. Firstly, it assumes the unidimensional (1PL) model of the scale. Future studies are recommended to explore the best model-data fit for this scale to investigate validity evidence based on the scale's internal structure in the Indonesian context. Secondly, given that this project solely focuses on beneficiaries of Askeskin, further studies are encouraged to examine the entire sample data of IFLS, expanding the scope to all BPJS users.

CONCLUSION

Conclusion: The results reveal that the five variables derived from ILFS showcase favorable psychometric properties. The scale exhibits excellent performance in distinguishing participants with moderate to severe smoking behaviour when considering all items. Consequently, this scale emerges as a suitable instrument for investigating heavy smoking intensity for research purposes, especially within the Indonesian context. It's important to note that this research exclusively focused on the 1-PL IRT for evaluating the Smoking Intensity Scale. The analysis was confined to aspects such as the discrimination index, item difficulty, and other psychometric properties encompassed in the 1-PL IRT analysis.

Recommendation: We advocate for BPJS Kesehatan to implement screening and measurement of the smoking intensity index for all users, alongside initiating preventive and preemptive measures for individuals with a high smoking habit. And also, it is imperative for the government to conduct a comprehensive cost-benefit analysis to evaluate policy options aimed at raising cigarette tariffs, thereby limiting access to cigarettes among the economically disadvantaged population.

RECOMMENDATION

We are deeply grateful to the RAND Corporation for granting permission to analyze the IFLS data survey. Additionally, we extend our sincere appreciation to Beta Yulianita Gitaharie for her valuable insights on the concept of item response theory applied in this paper. This work was supported by research grants from Lembaga Pengelola Dana Pendidikan (LPDP) awarded to Rizki Wibias Anwar Maulida.

Author's Contribution: We contributed to write all the sections within this article. author of the scale.

Conflict of Interest: We declare that there is no conflict of interest which can influence this study.

REFERENCES

Anwar, M., Nasrudin, R., 2021. The Household Food Insecurity Amidst the Covid-19 Pandemic in Indonesia. JEJAK 14, 244–260. https://doi.org/10.15294/jejak.v14i2.28511

Asyary, A., Veruswati, M., 2023. Smoking behavior and cigarette expenditure in a household: Evidence for smoke-free houses initiation in Indonesia. Int J Prev Med 14, 7. https://doi.org/10.4103/ijpvm.ijpvm_113_21

Brown, A., Croudace, T.J., 2015. Scoring and estimating score precision using IRT, in: Handbook of Item Response Theory Modeling: Applications to Typical Performance Assessment. Routledge/Taylor & Francis Group, pp. 307–333.

DJSN - BPJS Kesehatan, 2022. Statistik JKN 2016-2021.

Feuerstahler, L.M., Waller, N., MacDonald, A., 2020. Improving Measurement Precision in Experimental Psychopathology Using Item Response Theory. Educ Psychol Meas 80, 695–725. https://doi.org/10.1177/0013164419892049

Hambleton, R.K., Slater, S.C., 1997. Item Response Theory Models and Testing Practices: Current International Status and Future Directions* , **.

Hambleton, R.K., Swaminathan, Hariharan., Rogers, H.Jane., 1991. Fundamentals of item response theory. Sage Publications.

Hartono, R.K., Hamid, S.A., Hafizurrachman, M., 2019. Do the number of cigarettes smokes per day contribute to the incident of malignant cancer? Asian Pacific Journal of Cancer Prevention 20, 1403–1408. https://doi.org/10.31557/APJCP.2019.20.5.1403

Hindarti, S., 2022. Ex Ante Moral Hazard in the Health Insurance Market in Indonesia. Jurnal Indonesia Sosial Sains 3, 649–672. https://doi.org/10.36418/jiss.v3i4.580

Kim, S., Feldt, L.S., 2010. The estimation of the IRT reliability coefficient and its lower and upper bounds, with comparisons to CTT reliability statistics. Asia Pacific Education Review 11, 179–188. https://doi.org/10.1007/s12564-009-9062-8

Putra, N.F., 2020. Ex Ante Moral Hazard on the National Health Insurance System (NHIS) of Indonesia.

Siahpush, M., Farazi, P.A., Maloney, S.I., Dinkel, D., Nguyen, M.N., Singh, G.K., 2018. Socioeconomic status and cigarette expenditure among US households: Results from 2010 to 2015 Consumer Expenditure Survey. BMJ Open. https://doi.org/10.1136/bmjopen-2017-020571

Stage, C., 2003. Classical test theory or item response theory: The Swedish experience.

TCSC-IAKMI, 2020. Atlas Tembakau Indonesi.