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The Impact of Online Purchasing on Healthy Food Consumption in East Java, Indonesia

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ABSTRACT

With the rapid growth of e-commerce, online shopping has become an integral part of consumer behavior, transforming food purchasing patterns across various regions in Indonesia. This study investigates the impact of online purchasing behavior on healthy food consumption patterns among communities in East Java, Indonesia, utilizing survey data from 12,514 households. By applying a comprehensive analytical approach using a Probit model and Propensity Score Matching (PSM), the research identifies critical factors influencing the adoption of online shopping, such as household size, urban residency, gender, age, education level, mobile phone ownership, and monthly income. The findings indicate that urban residency, higher education levels, income, and mobile phone ownership positively affect online shopping adoption, while larger household size, male gender, and older age negatively influence this behavior. Importantly, the study reveals a significant negative association between online shopping and the proportion of expenditure allocated to healthy foods within household budgets. The Average Treatment Effect on the Treated (ATT) results suggest that households engaging in online shopping allocate a lower budget share to healthy foods compared to non-adopters, possibly due to preferences for more accessible, yet less nutritious, food options. These results highlight the need for targeted policies to encourage healthy food choices among online

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shoppers.

Keywords: Online Shopping; Healthy Food Consumption; Probit Model; Propensity Score Matching

1. Introduction

Recently, the trend of purchasing food online has surged significantly across various countries. According to a report by McKinsey & Company^[1], consumer intent to shop for food online has continued to rise even after the pandemic, especially for essential products. The report notes that services such as instant delivery and click-and-collect have gained immense popularity and are projected to expand further until 2030^[1]. This demonstrates that the rapid growth of online shopping has transformed consumer behavior globally. Online shopping refers to purchasing goods or services through the internet, noting its transformative effects on traditional retail spaces and shifting layouts to integrate both physical and cyber spaces^[2]. This phenomenon was accelerated by the emergence of the COVID-19 pandemic, which compelled a shift toward online shopping behaviors, including the purchase of healthy foods^[3]. Healthy food purchases saw a significant surge during the COVID-19 pandemic. Research conducted by OnePoll (2020), involving 28,000 respondents across 30 countries, including Indonesia, revealed that 41% of individuals adopted healthier eating habits during the pandemic. Additionally, this trend has been driven by technological advancements that are reshaping consumer behavior from in-store shopping to online shopping, particularly in food preferences^[4]. Online platforms often provide a diverse selection of healthy products that may not be available in physical stores. Karimi, Papamichail and Holland^[5] found that online shopping can alter consumption patterns by allowing consumers to make more informed purchasing decisions. Consumers can readily compare nutritional information and prices with the range of choices available online, which may encourage healthier choices^[6]. Online platforms have emerged as crucial bridges, connecting consumer demand for healthy food with more accessible and affordable options. Currently, gaps in the adoption of healthy eating habits are often caused by a variety of barriers, ranging from limited in-

formation and perceived high costs to restricted availability of healthy products in certain regions^[7]. Online platforms, such as food e-commerce, health food applications, and organic marketplaces, play a significant role in overcoming these obstacles, primarily by leveraging technology to directly connect consumers with producers or suppliers of healthy food^[8].

Although online shopping offers convenience and greater access to a wide variety of food options^[6], it is uncertain whether this convenience genuinely encourages consumers to opt for healthier foods^[9]. Concerns arise regarding features such as automated product recommendations, targeted advertisements, and discount promotions, which can sway consumers towards less healthy products^[10], ultimately influencing consumer preferences and purchasing behaviors. This issue is of particular concern in areas like East Java, where traditional diets rich in vegetables, fruits, and local grains are increasingly threatened by the availability of fast-food options that are easy to access yet lack nutritional value. This trend may inadvertently contribute to an increase in unhealthy food consumption, exacerbating issues such as obesity, diabetes, and other diet-related non-communicable diseases (NCDs) that are already on the rise in Indonesia. This research highlights how the trend of online food shopping, especially post-pandemic, impacts healthy food consumption in East Java, a region with unique socio-economic and demographic characteristics within the Indonesian context. This research holds particular relevance in East Java, a province marked by significant socio-economic and demographic diversity. Approximately 51% of the population lives in rural areas, where access to the internet and technology is limited, creating a stark contrast with the more digitally connected urban regions^[11]. This disparity affects online shopping patterns, including access to healthy food, which may be more costly and scarce. Additionally, there is an increasing shift in urban East Java towards more practical and affordable food preferences, such as fast food, indicating a dietary shift that may neg-

atively impact health outcomes. According to the East Java Health Department^[12], obesity rates have increased by roughly 3% over the past five years, with this trend largely attributed to evolving dietary habits.

Previous studies indicate that online food shopping may increase the consumption of low-quality foods, especially among younger age groups, who tend to favor fast food and widely available unhealthy snacks^[13]. The convenience of online shopping, combined with aggressive marketing strategies by food companies, can make it more challenging for consumers to make healthier choices^[14]. From the perspective of the Technology Acceptance Model (TAM), which emphasizes how perceived ease of use and perceived usefulness drive technology adoption, the convenience and efficiency of online food shopping platforms significantly enhance their perceived usefulness. Simultaneously, user-friendly and intuitive interfaces increase their perceived ease of use, particularly among younger demographics^[15]. When these factors are combined with targeted marketing and personalized recommendations, they shape consumer behavior, fostering a preference for low-quality, easily accessible foods over healthier alternatives^[14]. However, other findings suggest that the online shopping environment may reduce the frequency of unhealthy food purchases, as shown by a 2.3% decrease in spending on sugary items like sweets and candy following the introduction of online shopping services. When shopping online, the absence of checkout lanes and associated purchasing cues may lessen the likelihood of impulsively buying items such as candy bars, mints, gum, and other unhealthy options^[16]. The contrasting findings from these studies highlight the complexity of online purchasing behavior and its impact on healthy food consumption, underscoring the importance of further research in this area. While some evidence suggests that online shopping may increase the consumption of unhealthy foods due to ease of access and targeted marketing, other studies indicate it could reduce impulse purchases, potentially leading to healthier choices. This dual effect suggests that online food shopping can shape consumer behaviors in both positive and negative ways, making it essential to investigate under what conditions online shopping can support healthier dietary choices.

Previous studies have identified several factors that encourage individuals to choose healthier foods when shopping online. The first is the quality of information provided and the credibility of information sources^[17, 18]. Shang, Zhou and Zuo^[18] explain that individuals are more likely to exhibit healthy food purchasing behavior online when they receive adequate information from credible sources. In the context of online healthy food purchases, source credibility can be assessed based on websites or online stores that are verified and recognized by professional health organizations^[19]. In Indonesia, such organizations include BPOM and the Halal Product Assurance Agency for products that comply with Islamic law^[20]. Second, another factor is electronic health literacy, which refers to the level of skill in locating and utilizing credible online health information^[19]. Health literacy sources in Indonesia are quite diverse, including platforms such as Aladokter, Halodoc, Klikdokter, and others. Previous research has found that internet access significantly influences consumers' ease in choosing products, especially nutritious food options^[21].

An empirical study by Sumaedi et al.^[19] revealed that electronic health literacy does not have a strong correlation with online health information-sharing behavior. The results showed that technology integration-based intervention favored healthy changes in household food purchases and increased consumption of healthy food and healthy eating outcomes—albeit to different extents. Overall, technology apps are convenient and user-friendly tools to encourage a change in healthy food purchases and consumption among people^[22]. Current literature also lacks an in-depth exploration of the relationship between online purchasing and healthy food consumption, especially in Indonesia. Previous research has predominantly examined the impact of online purchasing on various food categories, with a strong emphasis on fast food, which is easily accessible but often lacks nutritional value (without looking deeper into healthy foods)^[23, 24]. However, there is a significant gap in the literature regarding the influence of online shopping on healthy food consumption, particularly in regions like East Java. In East Java, traditional diets rich in vegetables, fruits, and local grains

are at risk due to the growing presence of convenient, less nutritious food options offered online. While existing studies have investigated the broader implications of online shopping, few, if any, have focused on Indonesia or specifically in East Java. Notably, no research has combined advanced analytical methods such as Probit analysis and Propensity Score Matching (PSM) to evaluate the socio-economic and demographic factors, determinants of online shopping and its subsequent effects on healthy food consumption in this region. This lack of focused, methodological investigation underscores the need for this study.

This research aims to fill the identified gap by exploring how online shopping behaviors influence healthy food consumption patterns in East Java, particularly in the post-pandemic context. Using data from 12,514 respondents, the study employs a Probit model to analyze the socio-economic and demographic factors driving online shopping adoption and applies PSM to measure its effect on the proportion of spending allocated to healthy foods. With the Probit model, we hypothesize that the impact of online shopping on food choices varies based on demographic and socio-economic factors, including family size, marital status, gender, age, cellular ownership, and income. Furthermore, through PSM, we hypothesize a significant negative relationship between online shopping and healthy food consumption. By addressing this gap, the research seeks to provide actionable insights for policymakers to develop strategies that promote healthier food consumption in the context of rising online shopping behaviors in Indonesia.

2. Materials and Methods

2.1. Research Data

This study focuses on households in East Java, utilizing secondary data from the Indonesia Family Life Survey (IFLS). IFLS is a large-scale national longitudinal survey that provides data on health, education, employment, income, as well as household and environmental conditions, including coverage of the East Java region. Detailed data collection methods can be accessed at <https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html>.

The East Java province was selected due to its relatively high internet penetration rate and the socio-economic diversity between urban and rural areas. East Java provides a relevant variation for examining factors that influence online shopping behavior and healthy food consumption patterns. Data was collected through a survey covering 12,514 households across various regions in East Java. Key variables include online shopping behavior, proportion of spending on healthy foods, and socio-economic characteristics such as age, gender, marital status, education level, number of household members, monthly income, and access to the internet and mobile devices.

2.2. Research Variable

The dependent variables in this study include *i_buy*, a dummy variable that indicates the adoption of online shopping, where a value of 1 signifies that the respondent engages in online purchasing and 0 otherwise. Additionally, *per_hfshare* represents the percentage of expenditure on healthy foods relative to total food expenditure. This variable is used to assess the extent to which online shopping influences healthy food consumption.

2.2.1. Dependent Variable

This study was conducted in East Java Province, selected for its relatively high internet penetration rate and socio-economic diversity between urban and rural areas. East Java provides a relevant variation for examining factors influencing online shopping behavior and healthy food consumption patterns. Data was collected through a survey covering 12,514 households across various regions in East Java. Key variables include online shopping behavior, the proportion of spending on healthy foods, and socio-economic characteristics such as age, gender, marital status, education level, family size, monthly income, and access to the internet and mobile devices. A simple random sampling method was used to ensure a balanced representation of urban and rural areas.

2.2.2. Independent Variable

If categorized, the independent variables in this study encompass two aspects: First, demographic factors, including family size, age, gender, and marital sta-

tus. Second, socio-economic factors, comprising educational level in years, monthly income, mobile phone ownership, and urban vs. rural residence.

2.3. Estimation Strategy

To analyze the factors influencing the adoption of online shopping and its impact on healthy food consumption, this study employs a two-stage analysis, outlined as follows:

- The first stage: Probit Model for Analyzing Factors Influencing Online Shopping Adoption.

In the first stage of analysis, a Probit model is applied to examine the factors influencing an individual's decision to adopt online shopping. This model is selected due to the binary nature of the dependent variable, online purchasing (*i.buy*), which is coded as 0 for non-adopters and 1 for adopters, making it appropriate for binary regression analysis. The Probit model allows for an evaluation of how various demographic and socio-economic factors contribute to the likelihood of engaging in online shopping, with the model formulated to capture these influences systematically. The Probit model can be formulated as follows:

$$P(i_{buy} = 1|X) = \Phi(\alpha + \beta_1 \cdot age + \beta_2 \cdot gender + \beta_3 \cdot maritals + \beta_4 \cdot urban + \beta_5 \cdot hhz + \beta_6 \cdot head_yos + \beta_7 \cdot cellular + \beta_8 \cdot income + \epsilon) \quad (1)$$

Φ represents the cumulative normal distribution function, X denotes the set of independent variables, and ϵ is the error term. The coefficient values for each independent variable indicate its influence on the likelihood of online shopping adoption.

- The second stage: Propensity Score Matching (PSM) for Analyzing the Impact of Online Shopping on Healthy Food Consumption.

To assess the impact of online shopping adoption on healthy food consumption, this study employs the Propensity Score Matching (PSM) method^[25]. PSM is particularly well-suited for this analysis as it allows for a nuanced examination of how demographic and socio-economic factors influence online shopping behavior. This approach effectively reduces selection bias by matching respondents who engage in online shopping (treated) with those who do not based on similar char-

acteristics, thus enabling a more reliable estimate of the treatment effect. PSM is a robust choice for assessing the impact of online shopping on healthy food consumption because it matches online shoppers with non-shoppers who share similar backgrounds, mitigating confounding effects. Additionally, using Radius and Kernel matching techniques strengthens the analysis by providing alternative matching methods that enhance the reliability and depth of the findings.

The PSM procedure consists of:

1. Estimation of Propensity Score
Estimating the probability of each respondent engaging in online shopping based on characteristic variables (such as age, education, income, mobile ownership, etc.) is conducted using the Probit model.
2. Matching
Using two matching methods, namely Radius Matching and Kernel Matching, to pair each respondent who engages in online shopping with those who do not, based on their propensity scores.
3. Calculation of ATT (Average Treatment Effect on the Treated)
Assessing the impact of online shopping on the percentage of healthy food expenditure by calculating the average difference between the treated and control groups. This is formulated as follows:

$$ATT = E[Y(1)-Y(0)|Z = 1] \quad (2)$$

2.4. Research Framework

Socio-economic factors such as age, gender, urban versus rural residence, family size, education, cellular ownership, and monthly income are pivotal in shaping access to, and interest in, online purchasing. Gender, for instance, often influences shopping preferences and behaviors, with studies indicating that women tend to allocate a higher percentage toward online transactions than men^[26]. Younger individuals are often more adept at utilizing technology, making them more likely to engage in online purchasing compared to older demographics^[27]. Similarly, urban residents may have better internet access and exposure to online shopping platforms, enhancing their participation^[28]. Income levels play a critical role as well; individuals with higher

monthly incomes can afford more frequent and diverse purchases. Education, a significant determinant of digital literacy, impacts how consumers perceive the safety and convenience of online food transactions^[29]. Cellular ownership, in particular, plays a crucial role in facilitating online purchases, as mobile devices serve as primary tools for accessing e-commerce platforms. Additionally, families with larger household sizes, including children and elderly members, often face significant challenges in improving their consumption patterns, particularly in accessing online shopping because they have to save for uncertain conditions^[30]. Therefore, these socio-economic dimensions collectively create a foundation for engaging in online purchasing.

Research indicates that online food shopping may inadvertently increase the consumption of low-quality foods, particularly among younger age groups who often gravitate toward fast food and easily accessible unhealthy snacks^[13]. The convenience offered by online platforms, amplified by aggressive marketing strategies from food companies, creates additional hurdles for consumers striving to make healthier choices^[14]. Within the framework of the Technology Acceptance Model (TAM), the perceived usefulness of online food shopping is elevated by its efficiency and accessibility, while intuitive and user-friendly interfaces enhance its perceived ease of use, especially among tech-savvy younger demographics^[15]. These elements, combined with targeted advertising and personalized product recommendations, heavily influence consumer preferences, steering them toward low-quality, readily available options at the expense of healthier alternatives^[14]. Therefore, the consumption of healthy food is related to how consumers make purchases on online platforms. Based on the aforementioned explanation, the research frame-

work has been designed as illustrated in **Figure 1**.



Figure 1. Research framework.

3. Results and Discussion

3.1. Descriptive Statistic

Table 1 presents descriptive statistics for variables related to respondent characteristics and experiences in online shopping behavior and healthy food consumption. The findings reveal that an average of 5% of respondents make online purchases, with the proportion of spending on healthy food accounting for 4.07% of total food expenditures and a standard deviation of 1.33%. This behavior tends to be higher among older age groups, with the average age of respondents being 52.17 years. The majority of respondents are male (82%) and married (77%). Married respondents typically have larger family sizes, which influences their budget allocation. The average family size in this study is 3.44 members. In larger families, funds are more likely to be allocated to basic needs, thus reducing the proportion available for healthy food per family member. Over half of the respondents reside in urban areas (52%), which grants them greater access to mobile phones (63%) compared to respondents in rural areas. The education level of households is also relatively high, with an average of more than 7 years of schooling, and 39% have good internet access. Based on the average monthly household income, respondents earn IDR 3,602,557, indicating significant variation across the recorded income range from minimum to maximum.

Table 1. Descriptive statistic.

Variable	Measure	Mean	Std. Dev.
Online purchasing	Dummy variable, 1 if the respondent shops online; 0 otherwise	0.05	0.21
Healthy food	Percentage of healthy food expenditure relative to total food expenditure	4.07	1.33
Age	Age in years	52.17	13.45
Gender	Dummy variable, 1 if male; 0 if female	0.82	0.39
Marital status	Dummy variable, 1 if married; 0 otherwise	0.77	0.42
Urban	Dummy variable, 1 if urban; 0 if rural	0.52	0.50
Family size	Household size	3.44	1.52
Education	Education level in years	7.51	4.52

Table 1. Cont.

Variable	Measure	Mean	Std. Dev.
Cellular ownership	Dummy variable, 1 if owns a cell phone; 0 otherwise	0.63	0.48
Internet access	Dummy variable, 1 if has internet access; 0 otherwise	0.39	0.49
Income	Monthly income in Indonesian Rupiah (IDR)	3,602,557	3,448,417

3.2. Factors Influencing Online Purchasing Adoption: First Stage of the Probit Model

In the first stage of the Probit model, we conducted a model feasibility analysis, yielding a satisfactory fit in explaining the factors influencing online shopping adoption. The log-likelihood value of -4084.5271 and an LR $\chi^2(8)$ of 863.11 , with a highly significant $\text{Prob} > \chi^2(0.0000)$, indicate that the independent variables in this model collectively contribute significantly to the dependent variable. With a Pseudo R^2 of 0.0956 , this model explains a portion of the variation in online shopping adoption, though it is likely the influence of other factors outside the model that also affect individuals' decisions to shop online. These findings support the relevance of the variables used in this study to understand the key factors in technology adoption behavior within e-commerce. Significant factors determining online shopping adoption include household size, urban location, gender, age, education level, mobile phone ownership, and monthly income (see **Table 2**).

Family size can influence online shopping behavior. The findings reveal that household size has a significant negative relationship with online shopping adoption, indicating that individuals in larger families tend to shop online less frequently. This finding aligns with prior research suggesting that households with a larger number of dependents, such as children and elderly members, encounter significant obstacles in enhancing their consumption patterns, including engaging in online shopping. This is largely driven by the need to prioritize savings to address potential uncertainties in the future^[30]. Additionally, larger household members may have more varied needs and preferences that are not always met through online shopping, leading them to rely more on in-person purchases. Topino, Cacioppo and Gori^[31] explain that families with closer attachment patterns tend to reduce online shopping as a compulsive activity, sug-

gesting that larger families may exert stronger social influences in controlling online shopping behavior. Furthermore, gender and age show a significant negative influence. The results indicate that men are less likely to choose online shopping than women^[32]. In other words, the data suggest that women tend to allocate a higher percentage toward online transactions than men. This could be due to lifestyle differences between men and women, with men in this sample more frequently shopping in person compared to women who are more active online^[26]. This may indicate a gender gap in technology access for shopping or differing priorities between the two groups. Moreover, the negative influence of age on online shopping adoption is also supported by previous studies. For instance, the Pew Research Center^[33] notes that younger generations adopt online shopping more readily due to their familiarity with technology. Additionally, difficulties in adapting to new technology can be a barrier for older age groups to shop online^[27].

Furthermore, living in urban areas, owning a mobile phone, having a higher education level, and greater income are positively associated with online shopping adoption. Urban location has a significant positive impact on e-commerce adoption, consistent with prior research such as Li, Zeng and Ye^[28], which found that better digital infrastructure in urban areas facilitates access to and adoption of online shopping. Online shopping adoption is also closely linked to mobile phone ownership. Theoretically, residing in urban areas may drive an increase in online shopping due to broader access to technology. This phenomenon can be analyzed through the lens of the TAM, which elucidates how factors such as perceived ease of use and perceived usefulness influence the adoption of technology^[34]. According to Chandrasekhar et al.^[35], mobile phones provide convenient access to online shopping platforms, enabling purchases anytime and anywhere. Mobile phone usage enhances convenience, a primary driver of online shopping. The positive relationship between income and on-

line shopping adoption aligns with previous findings, such as those in Zatz et al.^[36], which suggest that low-income households tend to shop online less frequently compared to high-income households. This indicates that improved accessibility and resources increase the likelihood of individuals opting for online shopping. Education level has also proven to be a catalyst for online purchases. This finding aligns with research showing that higher education levels of Vietnamese people often enhance technological skills, ultimately encouraging in-

dividuals to participate in functional foods online shopping^[29]. Household heads with better educational backgrounds are more likely to embrace digital innovations, including e-commerce, as they better understand the benefits, convenience, and time efficiency of online purchases. Additionally, marital status appears not to play a significant role in influencing the choice to shop online in this study, indicating that whether one is married or not does not substantially impact their online shopping behavior.

Table 2. Factors influencing online purchasing adoption: Probit model first stage.

Variables	Coef.	Std. Err.	Z	P > Z
Family size	-0.056	0.013	-4.380	0.000***
Urban	0.168	0.035	4.760	0.000***
Marital status	-0.021	0.055	-0.380	0.704
Gender	-0.293	0.055	-5.310	0.000***
Age	-0.027	0.001	-18.100	0.000***
Education	0.038	0.004	9.290	0.000***
Cellular ownership	0.914	0.227	4.020	0.000***
Income	5-E-08	3-E-09	15.610	0.000***
_cons	-1.286	0.242	-5.320	0.000***
Log likelihood = -4084.5271				
LR chi2(8) = 863.11				
Prob > chi2 = 0.0000				
Pseudo R2 = 0.0956				
Number of obs = 12514				

Note: ≤ 0.01.

3.3. Impact of Online Shopping on Healthy Food Consumption: Second Stage with PSM

In the next stage of analysis, this study evaluates the impact of online shopping on healthy food consumption using the PSM method with two matching techniques, namely Radius Matching and Kernel Matching. **Table 3** shows a significant negative relationship between online shopping and healthy food consumption. The ATT value of -0.175 in both methods indicates that those who shop online tend to allocate a lower percentage to healthy food compared to those who do not. This behavior may be linked to impulsive tendencies often observed in consumers while shopping online, particularly for snack or fast-food categories high in sugar, salt, and fat^[37]. Research suggests that convenience, ease of transaction, and the wide availability of product options are key reasons consumers choose to buy less healthy

foods^[38]. These results are statistically significant, indicating that online shopping influences changes in food consumption patterns, potentially leading consumers to favor less healthy food options. These findings imply that online shopping may affect consumer preferences, which can have an impact on their dietary habits and overall health.

The study by Karimi, Papamichail and Holland^[5] found that online shopping can influence consumption patterns by providing consumers with opportunities to make more informed purchasing decisions. Through the wide variety of choices available online, consumers can easily compare nutritional information, prices, and more^[6]. However, according to Jansen, van Kleef and Van Loo^[9], this convenience does not necessarily encourage consumers to choose healthier foods. This is due to several factors, such as the higher price of healthy foods, which drives consumers to opt for processed products and cheaper fast foods, especially among low-

income groups^[39]. Additionally, the influence of frequent promotions and discounts on less healthy products, along with exposure to digital advertising for convenient foods, also impacts impulsive shopping behaviors, particularly for quick and easy-to-access ready-to-eat foods^[40]. Furthermore, on online platforms, healthy

foods are not always displayed attractively or prioritized in recommendations, causing these options to be frequently overlooked^[41]. These factors indicate that, despite the ease of access provided by online shopping, consumer preferences for healthy foods remain limited by practicality, price, and exposure to digital advertising.

Table 3. Impact of online purchasing on healthy food consumption: PSM second stage.

Matching Method	ATT	Std. Err.	T
Radius matching	-0.175	0.043	-4.076***
Kernel Matching method	-0.175	0.06	-2.936***

Note: *** ≤ 0.01.

4. Conclusions and Implication

4.1. Conclusions

This study assesses the impact of online shopping behavior on healthy food consumption among communities in East Java, Indonesia. Using survey data from 12,514 respondents, the study applies a comprehensive analytical approach, employing both the Probit Model and PSM. The research identifies several key factors influencing household decisions to shop online, including household size, place of residence, gender, age, education level, mobile phone ownership, and monthly income. The findings reveal that living in urban areas, having a higher education level and income, and owning a mobile phone are positively associated with the decision to shop online. Conversely, households with more members, males, and older individuals tend to shop online less frequently. Additionally, the analysis shows a significant negative impact between online shopping and the proportion of healthy food consumption within total household expenditure. The ATT results indicate that households engaging in online shopping tend to allocate a lower percentage of their budget to healthy foods compared to those who do not, possibly due to a preference for more accessible yet less nutritious foods.

4.2. Theoretical Implication

The findings of this study offer significant theoretical implications for understanding the evolving relationship between digital consumer behavior and nutritional

economics in developing regions. The observed negative correlation between online shopping and healthy food consumption challenges traditional economic theories that posit increased access and convenience as drivers of improved welfare, including dietary quality. This paradox highlights the need to refine behavioral economic models to account for the nuanced influences of digital platforms on consumer preferences, particularly in emerging markets where online marketplaces often prioritize affordability and convenience over nutritional value. Moreover, the demographic determinants—such as education, income, and urban residence—support the relevance of socio-economic and cultural factors in shaping digital consumption patterns. These insights call for an interdisciplinary approach, integrating theories from behavioral economics, public health, and technology adoption, to better capture the complex interplay between online shopping behaviors and household food consumption. Understanding these dynamics could inform targeted interventions and policies to leverage the digital economy for promoting healthier consumption practices in similar socio-economic contexts.

4.3. Policy Implication

Based on these findings, the following policy implications are relevant for promoting healthy food consumption in the digital age. First, the government could develop policies focused on providing targeted subsidies and discount programs for healthy food products on online shopping platforms, particularly for low-income and less-educated communities who tend to allocate less

budget for healthy foods. Second, in urban areas where online shopping is more common, educational campaign programs targeting urban households through digital ads and social media could raise awareness about the importance of choosing nutritious foods when shopping online. Additionally, policies to improve internet access in rural areas could support the affordability of healthy foods in these regions, making it easier for rural communities to purchase nutritious products. A technology-based approach that includes nutritional information on online shopping platforms would greatly assist consumers, especially those with limited education, in making healthier food choices. In this way, policies focused on these aspects would support a shift towards healthier and more sustainable consumption patterns across all regions.

5. Limitations and Future Research Directions

This study has several limitations, which offer opportunities for future research recommendations. First, the geographical scope limited to East Java Province constrains the generalizability of these findings to other regions; therefore, future studies should encompass a broader area or conduct inter-regional comparisons to achieve a more comprehensive understanding. Additionally, the use of cross-sectional surveys restricts this study's ability to capture dynamic changes in healthy food consumption behavior, making longitudinal studies highly valuable for analyzing shifts in consumption patterns over time. The limitations in analysis methods, including the Probit Model and PSM, restrict the capacity to account for unobserved external factors that may influence online shopping adoption, potentially introducing residual confounding effects. Specifically, the PSM approach, while robust, has inherent limitations in addressing unobserved confounders that could influence both the likelihood of online shopping and healthy food consumption. This study acknowledges that unmatched cases and imperfect balance between treated and control groups could impact the reliability of the results. Future studies could consider multi-method approaches, such as in-depth interviews or experiments, to comple-

ment survey findings and better address unobservable factors. Using Machine Learning Methods for Robust Matching offers many advantages, as these methods are designed to address challenges and complexities in the data matching process. Additionally, this study does not delve into the types of foods more frequently chosen or avoided in online shopping. Future research could explore specific product categories and the impact of product placement and promotions on digital platforms. Digital interventions, such as educational campaigns or health labels on e-commerce platforms, could also be studied to assess their effectiveness in encouraging consumers to choose healthier foods. Furthermore, expanding socio-economic variables to explore the impact of social and cultural norms on healthy food preferences on online platforms would provide a more nuanced understanding of consumer behavior in digital marketplaces.

Author Contributions

All authors contributed equally.

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Institutional Review Board Statement

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Informed Consent Statement

Informed consent information can be accessed at the official website of the data source: <https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html>.

Data Availability Statement

The data can be accessed at: <https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html>.

Conflicts of Interest

The authors declare no conflict of interest.

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